BUTTE CREEK WATERSHED

FLOODPLAIN MANAGEMENT PLAN

Prepared for:

The Butte Creek Watershed Conservancy

In Partnership with:

Butte County

Funded in Part by:

The California Bay-Delta Authority

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FOREWARD

Floodplains and development in floodplains have been at the forefront of much public debate as a result of very high profile events: The Jones Tract levee failure in 2003 during the non-flood season; the Paterno Decision that found the State of California responsible for failure of the Linda levee on the Yuba River in 1986; the Arreola v. Monterey County Decision of July 2002, holding local entities responsible for the 1995 flood damages caused by poor maintenance on the Pajaro River Project; and the Plumas Lakes issues more recently in Yuba County. This debate will continue as the pressure to develop to accommodate California's rapidly increasing population will target low-lying Valley lands, i.e., floodplains. At the same time, the regulatory process for dealing with flood protection has the public believing that if they have 100-year level of protection they are "safe." The fact that our record for hydrologic events is short is often overlooked. We have the benefit of being reminded of this fact every few years as we have the opportunity to experience more severe storms, thus providing the necessity to revisit our hydrology. The peak flow in Butte Creek in January 1997, of 37,500 cfs, put the FEMA 100-year flow of 30,000 cfs in perspective. Important at that time is the fact that the Butte Creek Flood Control System, designed and constructed by the U.S. Army Corps of Engineers in the 1950's to handle 40,000 cfs with water at the top of the levee contained the 37,500 cfs with water lapping at the levee crown in a few locations.

In January 2005, the California Department of Water Resources published a report, commonly referred to as the ***White Paper***, proposed a number of recommendations that should be of interest to Butte County that pertain to improving maintenance of flood control projects, creating the California Flood Insurance Fund, establishing a Central Valley Flood Control Assessment District, and encouraging FEMA to mandate flood insurance for homes protected by levees. With the completion of its Butte Creek Floodplain Management Plan, Butte County is better prepared to engage in these discussions.

The floodplains within the Butte Creek watershed are extensive. The majority are the product of hypothetical levee failures with overtopping of channel banks accounting for smaller areas. With time, Butte County will receive increasing pressure to develop within the floodplain protected by levees. The commitment of Butte County to not increase the risk to people, property, and livestock will continue to be tested.

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The preparation of the Butte Creek Watershed Floodplain Management Plan (Butte Creek Watershed FMP) was facilitated by the effort and foresight of the Butte Creek Watershed Conservancy (BCWC) in cooperation with Butte County.

The overall purpose of the Butte Creek Watershed FMP is to provide guidance to agencies and the public responsible for and interested in protecting life, property, and livestock, involved in land use planning, responsible for administering the Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP), and responsible for responding to flood emergencies within the Butte Creek watershed. Important in formulating the Butte Creek Watershed FMP was to ensure that proposed mitigation measures to address flooding hazards would not adversely affect fish and wildlife, and would maximize the potential to enhance fish and wildlife habitat. The Butte Creek Watershed FMP, intended as a tool to characterize and mitigate hazards related to flooding within the Butte Creek watershed, does not challenge past efforts and efforts currently underway to enhance riparian habitat and to assist the fish population growth.

The Steering Committee, with representatives from the Butte County Department of Public Works, Butte County Office of Emergency Services (OES), the BCWC, the California Department of Water Resources (DWR), and Wood Rodgers, Inc. met monthly for nearly two years to guide the planning and public involvement process, provide data and information, and to monitor the progress of Butte Creek Watershed FMP.

Public involvement was an important component in developing the Butte Creek Watershed FMP. Public meetings and presentations were conducted to obtain input from stakeholders on flood-related issues and concerns. The development of the Butte Creek Watershed FMP was publicized through various media, including television interviews, radio announcements, newspapers, mailings, and elementary school presentations. The draft Butte Creek Watershed FMP was made accessible for public input through the BCWC's Website and was widely distributed in hard copy and on CD.

The goal and objectives, reviewed by the public at several public meetings was adopted by the Steering Committee. These served as a guide in planning process developing the Butte Creek Watershed FMP. The goal and objectives include:

Goal: Minimize environmental impacts of required flood management.

Objective 1: Utilize relevant information to develop flood protection measures that protect life and property and enhance fish and wildlife habitat.

Objective 2: Support improved performance and coordination among and within agencies responsible for providing flood protection, post-flood restoration, and protection of habitat.

Objective 3: Support the development of pre-flood emergency response management.

Objective 4: Establish criteria for development within the floodplain, which would not adversely impact the floodplain, flood flow capacity, or neighboring properties.

Objective 5: Develop the document to comply with the Disaster Mitigation Act of 2000 (DMA 2000), Local Hazard Mitigation Plan.

The Butte Creek Watershed FMP fulfills the goal and objectives by providing:

- A risk assessment that profiles and discusses the FEMA regulatory floodplain, as provided on the Flood Insurance Rate Maps (FIRMs), and the actual floodplain, based upon historical flood events and existing vegetation conditions in the channel. Other hazards related to flooding, such as fire and seismic activity, were also evaluated.

- A flood vulnerability assessment, which includes an asset inventory and a monetary potential loss estimate to residential, commercial, and critical facilities.

- An evaluation of potential flood mitigation measures with a discussion feasibility and an overview of the potential mitigation measures.

- A recommended Action Program that includes Action Items for economically and environmentally feasible flood mitigation measures.

- A format to facilitate incorporation of the Butte Creek Watershed FMP into a Local Hazard Mitigation Plan.

The primary flood hazard issues and the corresponding resource that were identified, evaluated, and addressed in the Butte Creek Watershed FMP include:

For Butte Creek:

- Flood Insurance Study (FIS) Discrepancy
- Structural Integrity of the Levees
- Levee Freeboard Deficiencies
- Bridge Hydraulic Performance
- Channel Bank Overtopping

For Little Chico Creek-Butte Creek Diversion Channel:

- Structural Integrity of the Levees

- Levee Freeboard Deficiencies

For Little Chico Creek:

- Inadequate Channel Capacity
- For Butte Creek Watershed:
- Local Drainage Flooding
- Emergency Preparedness
- Development in Floodplains Protected by Levees

An Action Program, directed at mitigating the hazards associated with flooding, was developed. The Action Program is comprised of Action Items dealing with the following:

- Updating the hydrographic surveys and the hydrologic and hydraulic analyses for the Butte Creek flood control system.

- Conducting a geotechnical investigation to determine the structural integrity of the Butte Creek flood control system as it affects attaining certification for the purposes of complying with FEMA criteria.

- Establishing and implementing a channel maintenance program for Little Chico Creek, with participation and collaboration from agencies, organizations, watershed groups, and interested stakeholders, to eliminate excessive vegetation in the channel to restore some hydraulic capacity.

- Updating criteria for designing storm drainage facilities and preparing Storm Drainage Master Plans for Butte County and the City of Chico to accommodate planned development without adversely affecting other properties.

- Conducting a comprehensive inventory of bridges in the Butte Creek watershed that need to be repaired or replaced; redesign and reconstruct these bridges to accommodate reasonably anticipated water depth and flow; and provide planning, design, and cost analysis guidance based upon the bridge analyses conducted as part of this Butte Creek Watershed FMP.

- Preparing and implementing a flood Emergency Preparedness and Evacuation Plan.

- Updating the Butte County and incorporated cities' general plans and area plans to include land use guidance to limit development protected by levees.

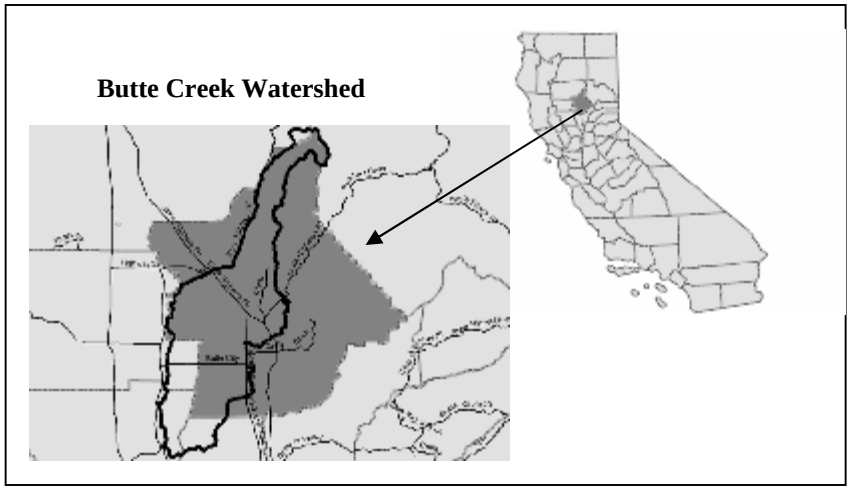
- Increasing public awareness of the flood hazards, flood response procedures, and maintain and update a database that includes land use information, elevation certificates, repetitive loss property information, public infrastructure, and critical facilities.

- Establishing and organizing a Butte Creek Watershed Floodplain Management Plan Implementation Committee.

Additional potential measures to mitigate flood hazards associated with the existing floodplains were evaluated; however, based on the information available, none were determined to be feasible at this time. Pending the results from implementing certain Action Items, the feasibility of certain measures can be reevaluated.

SECTION 1.0 INTRODUCTION

Butte County, founded on February 18, 1850, derived its name from the Sutter Buttes, which at one time were within the boundaries of Butte County. The majority of the Butte Creek watershed is within Butte County, with smaller portions in Glenn, Colusa, Plumas, Sutter, and Tehama counties. The focus of the Butte Creek Watershed Floodplain Management Plan (Butte Creek Watershed FMP) is Butte Creek within Butte County; however, since a significant portion of flood flow from Little Chico Creek is diverted into Butte Creek at the Little Chico Creek-Butte Creek Diversion, Little Chico Creek is also addressed.



Background

Physical Features

Butte County encompasses just over one million acres of land and is divided almost in half by two topographical features: the foothills and mountainous region of the northern Sierra Nevada and the Southern Cascade Mountains in the northeast and the valley section in the southwest.

The Butte Creek watershed is comprised of the Upper Butte and Lower Butte watersheds and is approximately 780 square miles. Butte Creek originates at the Upper Butte section of the watershed, at the northeast tip of Butte County, at an elevation of over 7,000 feet and flows approximately 25 miles before reaching the Lower Butte section at the Sacramento Valley, near the City of Chico. The Butte Creek watershed is illustrated on Map 1 (the Butte Creek watershed, as shown on Map 1, includes Little Chico Creek, Butte Creek, and the Dry Creek/Cherokee Canal watersheds, as defined by the Butte County Resource Conservation District).

The Lower Butte section of the watershed is approximately 45 miles in length, extending from Highway 99 near Chico to the point where Butte Creek first enters the Sacramento River either

through the Butte Slough outfall gates or via the Sacramento Slough, Sutter Bypass, and the Butte Slough, depending upon operations and river levels at the Butte Slough outfall gates.

Little Chico Creek originates at the northwestern edge of the Butte Creek watershed and flows southwest, parallel to Butte Creek, until it reaches the base of the foothills, where a diversion structure on Little Chico Creek diverts high flow into Butte Creek, before Little Chico Creek enters the City of Chico. Little Chico Creek flows through the City of Chico and parallels Big Chico Creek to the north. Flow from Little Chico Creek returns to Butte Creek through Angel Slough or contributes to the Butte Basin component of the Sacramento River Flood Control Project.

Climate

Butte County has a Mediterranean climate with cool, wet winters and hot, dry summers. Precipitation is normally in the form of rain, with snow in the higher elevations, and ranges from approximately 20 to 80 inches per year.

Population and Economy

Butte County currently has a population of just over 200,000 and has increased at a rate of 3 percent per year since 1970 (Butte County General Plan, 2000). Approximately 54 percent of Butte County's population resides in the cities of Chico, Paradise, Oroville, Gridley, and Biggs and 45 percent reside in the unincorporated areas of the County. Approximately one-third of the County's population lives within the Butte Creek watershed.

Cities	Population
Chico	64,600
Paradise	26,550
Oroville	13,100
Gridley	5,550
Biggs	1,810
Unincorporated	94,200
Total	205,810

Source: California Department of Finance, 2001.

Butte Creek Watershed Overview

The following section summarizes the reaches of Butte Creek and the waterways that affect Butte Creek flow (Map 2). The discussion in this section is primarily taken from the ***Butte Creek Existing Conditions Report***, written for the Butte Creek Watershed Conservancy (BCWC) by the Office of Watershed Projects at the California State University at Chico (CSUC). The ***Butte Creek Existing Conditions Report*** provides a detailed discussion of the topography, geology, and hydrology of the watershed.

The headwaters of Butte Creek start approximately 10 miles northeast of Butte Meadows and are fed by perennial streams that begin on the slopes of Colby Mountain, Snow Mountain, Humbug Summit, and Humboldt Peak. The Butte Creek Diversion Dam, approximately 10 miles downstream of Butte Meadows, is the first of the 10 major diversion structures on Butte Creek

(Map 2). The Butte Creek Diversion Dam diverts water through a canal and flume system to serve Pacific Gas and Electric Company's (PG&E) DeSabla Powerhouse.

Approximately two miles downstream from the Forks of Butte (the confluence with the west branch of Butte Creek), is the intake structure for the Forks of the Butte Hydroelectric Project, which is located just upstream of PG&E's DeSabla Powerhouse. Downstream from the DeSabla Powerhouse, water from Butte Creek is diverted at the PG&E Centerville Diversion Dam. Below Centerville Dam, the creek passes under Bailey Bridge, three private bridges, the Honey Run Road Bridge, and the historic Honey Run Covered Bridge before reaching the Parrott-Phelan Diversion Dam. Little Butte Creek, which runs through Magalia and Paradise reservoirs, enters Butte Creek less than one-half mile above the Honey Run Covered Bridge.

Just downstream of the Parrott-Phelan Diversion Dam, Butte Creek passes under Skyway and through the Durham Mutual Diversion Dam. Just downstream from the Durham Mutual Diversion Dam, the Little Chico Creek-Butte Creek Diversion channel enters Butte Creek. Little Chico Creek, which begins at the northwest edge of the Upper Butte Creek watershed, flows through the Upper Butte watershed section and the Chico urban area on its route to the Lower Butte section of the Butte Creek watershed.

As a result of flooding that overtopped the banks of Little Chico Creek and Butte Creek on December 22, 1944, Congress authorized flood control improvements on a part of Little Chico Creek and Butte Creek as part of the Sacramento River and the Major and Minor Tributaries Project. The project was implemented in two parts. Part I included clearing and excavating the Butte Creek channel and constructing levees (setback levees) for a distance of 8.7 miles downstream of Midway Road. This work was completed in the early 1950's (USACOE, 1955). Part II, completed in 1957, included constructing a diversion structure on Little Chico Creek and a diversion channel to Butte Creek, which is about three miles long (USACOE, 1960). Part II also included the construction of levees along Butte Creek from the junction with Little Chico Creek downstream, approximately 7.3 miles, to Midway Road (USCOE, 1960). The Butte Creek channel ranges in width from about 100 feet to 200 feet throughout the levee reach. The levees are approximately 400 feet apart from the Little Chico Creek-Butte Creek Diversion downstream to approximately 600 feet below the Durham-Dayton Highway. Downstream from this location, the levees are set back and the distance between them ranges from about 1,000 feet to 1,800 feet.

The project design flow for Little Chico Creek was 6,700 cfs. The Little Chico Creek-Butte Creek Diversion structure was designed to pass 2,200 cfs downstream in Little Chico Creek and to divert 4,500 cfs to Butte Creek. The project design flow for the Little Chico Creek-Butte Creek Diversion channel was 3,000 cfs with three feet of freeboard; however the channel would convey 4,500 cfs with zero freeboard.

The Butte Creek levee system was designed to convey the standard project flood of 40,000 cfs with zero freeboard or a design flow of 27,000 cfs with three feet of freeboard, depending upon which condition controlled. The responsibility for the operation and maintenance of Part I and

Part II were officially accepted by The State Reclamation Board in 1953 and 1958/1959, respectively.

Once Butte Creek reaches the Sanborn Slough bifurcation in the Butte Sink, the flow is divided between the Sanborn Slough Bifurcation and Butte Creek. Much of Butte Creek's flow is collected into a series of water supply and drainage ditches that service the waterfowl clubs in the Butte Sink.

The creek flows through the Butte Sink to Butte Slough, which has a structure at its confluence with the Sacramento River, known as the Butte Slough outfall gates (also known as Ward's Landing). The Butte Slough outfall gates allow floodwater from Butte Creek to drain into the Sacramento River when the water level of Butte Creek is higher than the river. As a drain, the gates are operated by the California Department of Water Resources (DWR). During the irrigation season, the gates are operated by Reclamation District No. 1004, to maintain the upstream water level in Butte Creek to allow diversions. Water diverted from Butte Creek into Butte Slough immediately upstream of the outfall gates is used to irrigate land in the Sutter Bypass. The Butte Slough outfall gates can either release floodwater from Butte Creek and the Butte Basin into the Sacramento River or redirect the flow into the Sutter Bypass for discharge into the river at the Sacramento Slough. The Butte Basin overflow area, Butte Slough, and the Sutter Bypass become inundated during flood events.

The Colusa Weir on the Sacramento River, located upstream of the Butte Slough outfall gates, allows flood flow from the river to flow into the Butte Sink, Butte Slough, and the Sutter Bypass system.

Waterways that Affect Flow in Butte Creek

Hamlin Slough, Nance Canyon, and Little Dry, Dry, Cottonwood, Gold Run, and Clear Creeks – Tributary streams that originate south of Paradise and flow into Butte Creek.

Cherokee Canal – Cottonwood Creek, Clear Creek, Gold Run Creek, and Dry Creek flow into the Cherokee Canal, which is used for irrigation, drainage, and flood protection. Cherokee Canal enters Butte Creek after flowing through the Butte Sink. Cherokee Canal is a levied flood control project that joins Butte Creek in the Butte Sink.

Richvale Canal – The Richvale Canal services the eastern portion of the Richvale Irrigation District and drainage eventually reaches Butte Creek and Cherokee Canal.

Main Canal Outlet – The only outlet from the south side of the Thermalito Afterbay. The Main Canal becomes the Sutter-Butte Canal 12 miles below the outlet, near Gridley. The Main Canal has several laterals that are major delivery structures. The tailwaters eventually enter Butte Creek.

Biggs-West Gridley Main Drain – The Biggs-West Gridley Main Drain drains a large portion of the watershed south of the Thermalito Afterbay, and enters Cherokee Canal just above the Biggs-West Gridley Main Drain confluence with Sanborn Slough.

Comanche Creek – Comanche Creek (also known as Crouch Ditch or Edgar Slough) diverts water from Butte Creek to Dayton Mutual Water Company, M&T Chico Ranch, Parrott Ranch, the U.S. Forest Service (USFS) Genetic Tree Improvement Center, and to several property owners.

Angel Slough – Angel Slough is used as a drain by M&T Chico Ranch and connects to Little Chico Creek to function as a drain through the southern areas of the M&T Chico Ranch. Water from Angel Slough flows through agricultural land until it joins Butte Creek in the lower Butte Basin.

Sacramento River – Two flood relief structures (FRS) (the M&T weir and Goose Lake) and one overflow area (the "Three B's"), collects floodwater in the Butte Sink, which is then diverted into the Sutter Bypass through Colusa, Tisdale, and Moulton weirs.

Butte Creek Fish and Wildlife Restoration

For over 10 years, many project efforts, initiated and implemented by the Butte Creek Watershed Conservancy, The Nature Conservancy, Ducks Unlimited, Inc., the California Waterfowl Association, as well as private landowners, local water districts, reclamation districts, and federal and state resources agencies, have focused on fish passage and improving riparian habitat in the entire Butte Creek system (California Department of Fish and Game (CDFG), 2003). Expenditures on restoration projects on Butte Creek have exceeded $33 million since 1993, including the construction of five positive barrier fish screens installed in a diversion to assist juvenile salmonids; the removal of five diversion dams; the installation of eleven fish ladders; the dedication of 45 cubic feet per second (cfs) for in-stream flow; the installation and operation 10 flow monitoring stations; the acquisition of 146 acres of riparian habitat; and performing 12 upper and lower watershed evaluations and 15 structure analyses; and completing the Butte Creek Existing Conditions and Watershed Management Strategy reports (CDFG, 2003 and CDFG, 2004).

According to the Geomorphic Assessment of Butte Creek, "…the increase from the 1995 spawners shows that the creek can be very productive and deserves the attention that it has recently received." The Geomorphic Assessment also states that the run of the spring-run Chinook salmon was estimated at 7,480 in 1995, and the return estimated in 1998 was over 20,000. These numbers were determined using the Ricker model, which provides a conservative estimate since the model declines the number of "recruits" at higher spawner density, making the "…sharp increase from 1995 to 1998-99 even more impressive" (Kondolf and Ginney, 2001). Clearly the work to date and the restoration of spring-run Chinook salmon is a success story and is recognized in the political, environmental, and water communities. With respect to fisheries, a

pending concern is the availability of habitat and the spatial distribution of the spring-run and fall-run Chinook spawners.

Purpose of the Floodplain Management Plan

The overall purpose of the Butte Creek Watershed FMP is to provide guidance to prevent the loss of life and property from flooding within the Butte Creek watershed, and to ensure that proposed mitigation measures to mitigate flood hazards do not adversely affect fish and wildlife and will maximize any potential to enhance the fish and wildlife within the watershed. The adopted goal and objectives of the Butte Creek Watershed FMP are as follows:

Goal: Minimize environmental impacts of required flood management.

Objective 1: Utilize relevant information to develop flood protection measures that protect life and property and enhance fish and wildlife habitat.

Objective 2: Support improved performance and coordination among and within agencies responsible for providing flood protection, post-flood restoration, and protection of habitat.
Objective 3: Support the development of pre-flood emergency response management.

Objective 4: Establish criteria for development within the floodplain, which would not adversely impact the floodplain, flood flow capacity, or neighboring properties.

As the Butte Creek Watershed FMP was being developed, an additional objective was included in the scope:

Objective 5: Develop the document to comply with the Disaster Mitigation Act of 2000 (DMA 2000), Local Hazard Mitigation Plan.

The Butte Creek Watershed FMP fulfills the goal and objectives by providing:

- A risk assessment that profiles and discusses the Federal Emergency Management Agency's (FEMA) regulatory floodplain, as provided on the Flood Insurance Rate Maps (FIRMs), and the actual floodplain, based upon historical flood events and existing vegetation conditions in the channel. Other hazards related to flooding, such as fire and seismic activity, were also evaluated.

- A flood vulnerability assessment in the watershed, which includes an asset inventory and a monetary potential loss estimate to residential, commercial, and critical facilities.

- An evaluation of potential flood hazard mitigation measures with a feasibility discussion and an overview of the recommended mitigation measures.

- An action program that includes an action plan for economically and environmentally feasible recommended flood mitigation measures.

- A format similar to a Local Hazard Mitigation Plan.

After the Butte Creek Watershed FMP is adopted, it could also be used as an important element of a Butte County Local Hazard Mitigation Plan (LHMP). In 2001, FEMA promulgated hazard mitigation planning regulations pursuant to the Disaster Mitigation Act of 2000 (DMA 2000). Subsequent to November 1, 2004, FEMA requires an LHMP as a prerequisite to be eligible for hazard mitigation funding. Detailed information about the DMA 2000 and the grants available under the program can be obtained from the FEMA Website:

http://www.fema.gov/fima/dma2k.shtm.

Elements of the adopted Butte Creek Watershed FMP are currently being incorporated into the countywide flood mitigation plan. A countywide flood mitigation plan will allow Butte County residents to be eligible for flood insurance premium reductions under FEMA's National Flood Insurance Program (NFIP) Community Rating System (CRS) program. The CRS gives credit points for preparing and adopting a comprehensive floodplain management plan. Additional discussion and information about FEMA's CRS program is available at FEMA's Website:

http://www.fema.gov/nfip/crs.shtm.

For communities receiving funding from the USACOE for a project designed to reduce local flood damage, the USACOE requires preparing a floodplain management plan within one year of signing a project cooperation agreement and to implement the floodplain management plan no later than one year after the project is constructed. A floodplain management plan that is approved in the FEMA CRS program is considered sufficient for being considered for funding by the USACOE (USACOE, 1997).

Existing Butte County Floodplain Regulations

Butte County adopted FEMA's Flood Insurance Study (FIS) and the accompanying Flood Insurance Rate Maps (FIRMs) (Map 3), which are used to delineate the "minimum area of applicability." FEMA conducts the FIS to examine, evaluate, and determine the flood hazards, and, if appropriate, the corresponding water surface elevations. Based upon the results of the FIS, FEMA develops a map with the 100- and 500-year floodplains, the base flood elevations (BFEs), and risk premium zones delineated. These maps are developed to assist insurance agents in issuing flood insurance policies to homeowners in communities that participate in FEMA's NFIP (FEMA, 2005).

The Butte County Department of Development Services enforces Flood Ordinance No. 3598, an amendment adopted on April 11, 2000, to Chapter 26, Article IV, "Flood Hazard Prevention" of

the Butte County Code (Chapter 8 and Chapter 26, Article IV of the Butte County Code is provided in Appendix A). The director of the Butte County Department of Development Services is also the Butte County appointed "Floodplain Administrator" responsible for administering FEMA's requirements under the NFIP.

According to the Butte County's Flood Ordinance, which takes precedence over all conflicting ordinances, any new construction, substantial improvements, or other developments in the FEMA-designated Special Flood Hazard Areas (SFHAs) in Butte County must be permitted, elevation certificates obtained, and submitted for review to the Butte County Department of Development Services for compliance with the NFIP. All structures must be built at least one foot above the BFE. Although the Butte County Ordinance applies to the incorporated cities in the county, the cities may adopt policies or ordinances with more stringent provisions.

In October 2003, FEMA conducted an audit in Butte County to confirm compliance with the NFIP. Structures within the FEMA-designated SFHA (Map 3) were found to be compliant with the NFIP, and no deficiencies were found in the Butte County floodplain management program. FEMA's audits use a random sampling of structures located in the SFHAs to assess a community's compliance with the NFIP guidelines. The 2003 audit sampled structures only in the Oroville and Palermo areas and did not address significant development in other portions of Butte County, including the areas north and south of the City of Chico. The next FEMA audit in Butte County is scheduled for 2008 (refer to Appendix C for a copy of the October, 2003 FEMA audit). According to the Butte County Department of Public Works, this was the first audit on record that was conducted by FEMA.

SECTION 2.0 PLANNING PROCESS

Public Involvement

Public involvement was important in developing the Butte Creek Watershed FMP. Public meetings and presentations were conducted to obtain input from stakeholders on flood-related issues and concerns. The Steering Committee, with representatives from the Butte County Department of Public Works, Butte County Office of Emergency Services (Butte County OES), BCWC, DWR, and Wood Rodgers, was formed with the responsibility of ensuring an effective planning process with an emphasis on public involvement. To ensure the application of a meaningful public involvement process, the California State University at Sacramento's (CSUS) Center for Collaborative Policy, Wood Rodgers, and members of the Steering Committee, were responsible for publishing newsletters and to schedule, publicize, and organize several public meetings. Newsletters, announcements, presentations, meeting agendas, and attendance sheets are provided in Appendix D.

Below is a summary of the planning process and public involvement:

- Conducted monthly Steering Committee meetings to discuss progress, review technical material, and ensure the public involvement process.

- Published and distributed a newsletter for the BCWC announcing the development of the Butte Creek Watershed FMP, the planning process strategy, and the upcoming town hall meetings.

- Publicized the development of the Butte Creek Watershed FMP through various media channels, such as announcements on KRCR TV-Channel 7, KHSL TV Channel 12, KNVN Channel 24, KCVU TV/UPN Channel 21, the Butte County Resource Conservation District Website, the Colusa Sun Herald, Willows Journal, Orland Press Register, and the Appeal Democrat. A link was created on the BCWC Website, to provide the public with information about the goals and objectives of the Butte Creek Watershed FMP, its progress, contact information, and dates and locations for public meetings (announcements and newsletters are included in Appendix D).

- Conducted televised interviews with a representative of the BCWC, the Butte County Department of Public Works, the City of Chico Council, and Wood Rodgers. The programs aired on the local KHSL TV Channel 12.

- Mailed announcements to over 1,600 residents, businesses, organizations, educational institutions, conservancies, federal and state agencies, and other local entities informing them of the development of the Butte Creek Watershed FMP and inviting them to public

meetings. A database was created that contains the contact information for the entities that received the mailings (provided in Appendix D).

- Conducted presentations on September 21 and November 22, 2004, as part of the public education component of the Butte Creek Watershed FMP. Wood Rodgers made presentations to the fifth grade classes of Durham Elementary School and Paradise Pines Elementary School, respectively, to discuss the principles of the hydrologic cycle, the effects of flooding, the effect of fire on flooding, the importance of watersheds, and the concept of floodplain management. A copy of the presentation given at the elementary schools and teacher evaluations are provided in Appendix D.

- The following public meetings were conducted to discuss the development, goals, and progress of the Butte Creek Watershed FMP and to receive input from stakeholders:

  - Ø April 24, 2003, 6:00-9:00 p.m. at Lt. Larry Estes Search and Rescue Building in Chico, California. Discussion included: The FEMA mapping process, the NFIP, the 1997 flood, current mapping resources, roles of government agencies, Little Chico Creek, Dead Horse Slough, PG&E, political issues, California Lake, emergency management, illegal dumping, and strategies for increased public participation.

  - Ø April 28, 2003, 6:00-9:00 p.m. at Colusa Industrial Properties in Colusa, California. No members of the public attended.

  - Ø May 7, 2003, 6:00-9:00 p.m. at Durham Recreation and Park District Memorial Hall in Durham, California. Discussion included: Private property rights and encroachment, creek diversions, property use compensation, HEC-RAS modeling, channel and levee maintenance, bridges, emergency management, agricultural issues, decision-making structures, the Feather River, CDFG, and environmental concerns.

  - Ø February 10, 2004, 5:30-8:00 p.m. at the Chico Association of Realtors, in Chico, California. Approximately 50 people attended. Discussion included: Planning, the effect of the Butte Creek Watershed FMP on the FEMA floodplain designations, the Little Chico Creek-Butte Creek diversion, discharge data accuracy, channel maintenance, Dead Horse Slough, future growth, Tiechert Pond, levee design and integrity, vegetation encroachment, bridge vulnerability to flooding, hypothetical levee failure analyses and dam failure maps, Little Chico Creek flow, the City of Chico Drainage Master Plan, hydraulic and hydrologic modeling criteria, a centralized data and information center for flooding, and detention ponds.

  - Ø July 21, 2004, 6:00 - 7:30 p.m. at the Durham Memorial Building in Durham, California. More than 30 people attended. Discussion included: Flood hazard areas, nonstructural and structural mitigation measures, Little Chico Creek maintenance,

implications and issues with maintenance plans, repetitive loss areas and costs, erosion, bridge damage, and environmental concerns.

- Distributed over 30 copies and 20 CDs of the draft Butte Creek Watershed FMP for public review and posted the draft report on the Butte Creek Watershed Conservancy Website.

- Presented the elements of the draft Butte Creek Watershed FMP to the Butte County Board of Supervisors in January 2005 (presentation included in Appendix D).

- Conducted a special meeting for those that submitted comments to the draft Butte Creek Watershed FMP in March 2005 (meeting notes and attendance sheets to this meeting are provided in Appendix D and the public comments are provided in Appendix E).

Information received from the public was documented and used by Wood Rodgers in confirming the goal and objectives of the Butte Creek Watershed FMP, identifying current flooding issues in the area, and assisting in identifying mitigation measures. The draft Butte Creek Watershed FMP was widely distributed and provided to the public through the BCWC Website. The comments received from the public assisted greatly in preparing the final report.

Agency Coordination

The agencies and organizations contacted for information or that provided information developed by their organization during the preparation of the Butte Creek Watershed FMP are listed in Table 2-1. Table 2-2 lists those agencies and organizations whose representatives participated in one or more public meetings.

Local Capability Assessment

Various programs and capabilities within Butte County were utilized as resources in the developing the Butte Creek Watershed FMP. These resources fall within three primary categories:

- Technical Resources
- Financial Resources
- Human Resources

Technical Resources: The agencies and respective technical resources used in preparing the Butte Creek Watershed FMP are presented in Table 2-3.

Human Resources: Personnel from agencies and organizations that assisted in the planning and development of the Butte Creek Watershed FMP are provided in Table 2-4.

TABLE 2-1
BUTTE CREEK WATERSHED FMP CONTRIBUTING AGENCIES

American Red Cross
Big Chico Creek Watershed Alliance
Butte County Department of Planning
Butte County Department of Public Works
Butte County Development Services
Butte County Development Services, GIS Division
Butte County Fire Department
Butte County Fire Safe Council
Butte County Office of Emergency Services
Butte County Sheriff Department
Butte County Department of Water and Resource Conservation
Butte Creek Watershed Conservancy
Butte Environmental Council
California Bay-Delta Authority
California Center for Natural Lands Management
California Department of Fish and Game
California Department of Forestry
California Department of Water Resources
California Governor's Office of Emergency Services
California Rivers Assessment
California State Reclamation Board
California State University at Chico
California Waterfowl Association
Cherokee Watershed Group
City of Chico Department of Public Works
City of Chico Fire Department
Ducks Unlimited, Inc.
Federal Emergency Management Agency
Friends of Butte Creek
Friends of the River
Little Chico Creek Watershed Group
National Weather Service
Natural Resources Conservation Service
Paradise Irrigation District
Salvation Army
The Nature Conservancy
U.S. Army Corps of Engineers
U.S. Bureau of Reclamation
U.S. Fish and Wildlife Service
U.S. Geological Survey
UC Davis California Rivers Assessment
Western Canal District

TABLE 2-2
BUTTE CREEK WATERSHED FMP
PUBLIC PARTICIPANT AGENCIES AND ORGANIZATIONS

Big Chico Creek Watershed Alliance
Butte County Department of Public Works
Butte County Development Services
Butte County Office of Emergency Services
Butte County Department of Water and Resource Conservation
City of Chico
California Department of Fish and Game
California Department of Forestry
California Department of Water Resources

TABLE 2-3
BUTTE CREEK WATERSHED FMP
TECHNICAL RESOURCES

Agency	Resources
Butte County Department of Development Services	General Plan, FEMA audit, and elevation data.
Butte County Department of Forestry	Geographic Information System (GIS) data, fire management plans, fire threat analysis, vegetation data, fire fighting and emergency management response plans.
Butte County Department of Public Works	Road and infrastructure information, road closure information, planning studies, storm water management plan, County municipal codes.
Butte County Department of Water and Resource Conservation	GIS files and data.
Butte County Office of Emergency Services	GIS data, disaster assistance and recovery information, dam failure analyses, hazard analyses.
Butte County Sheriff	Information for emergency response and management.
California Data Exchange Center, National Weather Service, United States Geological Survey, and the California Irrigation Management Information System	Current and historic precipitation, stream flow, stage, reservoir storage, and weather station data.
California Department of Water Resources	Maintenance information for levees and channels, land use data, groundwater and surface water system data.
California State University at Chico	Mapping and GIS data.
City of Chico Community Development Department Planning Division	City of Chico Master Environmental Assessment.
City of Chico Department of Public Works	City of Chico Storm Drainage Master plan.
City of Chico Fire Department	Information about emergency response, including animal rescue and evacuation information.
Paradise Irrigation District	Paradise and Magalia Dam Inundation maps.
Salvation Army and Red Cross	Information about the facilities and staff available for emergency response.

TABLE 2-4
BUTTE CREEK WATERSHED FMP
HUMAN RESOURCES

Butte County Department of Planning
Butte County Department of Public Works
Butte County Development Services
Butte County Development Services, GIS Division
Butte County Office of Emergency Services
Butte County Sheriff Department
Butte County Department of Water and Resource Conservation
Butte Creek Watershed Conservancy
California Bay-Delta Authority
California Department of Water Resources

Financial Resources: Current budgetary constraints have limited the availability of funding for various floodplain management programs within Butte County. However, the incorporation of this Butte Creek Watershed FMP into a countywide FMP and LHMP establishes eligibility for funding under several programs, such as FEMA's Pre-Disaster Mitigation (PDM) Program, the Flood Mitigation Assistance (FMA) Program, the Hazard Mitigation Grant Program (HMGP), the Public Assistance (PA) Program, the California Resources Agency's Urban Streams Restoration Program, and the Natural Resources Conservation Service (NRCS) Emergency Watershed Protection (EWP) Program. Presented below is a brief description of each program.

PDM Program – Authorized by DMA 2000, can provide funding to states, public agencies, communities, and tribes for cost-effective hazard mitigation planning activities that complement a comprehensive mitigation program and reduce injuries, loss of life, and property.

FMA Program – Provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other insurable structures. The three types of grants available through the FMA Program are planning, project, and technical assistance grants. Only communities that participate in the NFIP can apply for project and technical assistance grants. Planning grants are available to states and communities that prepare flood mitigation plans.

HMG Program – Provides grants to state, local, and tribal governments to implement long-term hazard mitigation measures after a major disaster declaration (up to 15 percent of the FEMA disaster funds they receive is for hazard mitigation planning and projects).

PA Program – Provides funding, following a disaster declaration, for repairing, restoring, or replacing damaged facilities belonging to governments and to private nonprofit entities, and for other associated expenses, including emergency protective measures and debris removal. The program also funds mitigation measures related to the repair of damaged public facilities.

Urban Streams Restoration Program – Supports activities that minimize property damage caused by flooding and bank erosion, restore the natural value of streams, and promote community stewardship. This program funds projects that have flood management or erosion control as a primary objective and maintain or improve the environmental characteristics of a stream or restore a stream to function naturally.

NRCS EWP Program – Assists sponsors and individuals in implementing emergency measures to relieve imminent hazards to life and property created by a natural disaster. Activities include providing financial and technical assistance to remove debris from streams, protecting destabilized stream banks, establishing cover on critically eroding lands, implementing conservation practices, and purchasing floodplain easements. The program is designed for recovery measures and it is not necessary for a national emergency to be declared for an area to be eligible for assistance.

SECTION 3.0 RISK ASSESSMENT

Following the evaluation and mapping of flood hazards, a risk assessment is performed on the vulnerability of the watershed. The risk assessment requires reviewing existing data; analyzing input received from federal, state, local agencies, and Steering Committee members; and compiling, evaluating, and utilizing specific information about the numbers and types of structures, potential economic losses, and land use trends in the watershed.

From 1950 through 1997, Butte County has had several California proclaimed state of emergencies including nine floods, two wildland fires, two droughts, and five major storms (OES, 1998). This section includes detailed descriptions of the primary flooding hazards. Factors such as wildland fire and seismic activity may significantly affect flooding in the Butte Creek watershed. These and other hazards, such as liquefaction, subsidence, seiches, and landslides were assessed and are included in Appendix C.

Flood Hazards

Flood hazards are evaluated for purposes of this Butte Creek Watershed FMP in relation to the FEMA FIRMs, local drainage, bridges, dam failures, and land use planning. Each of these areas are discussed below.

FEMA FIRMs

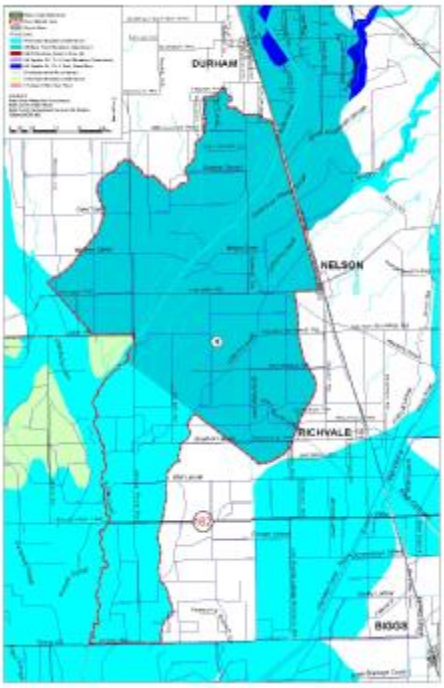
The flood hazards as they relate to development and activity within the floodplain in the Butte Creek watershed were evaluated using the FEMA FIRMs (Map 3) and profiles created in a Geographic Information System (GIS). The floodplains shown on the FEMA FIRMs were divided into six Flood Hazard Areas (Map 4).

To evaluate the conditions related to flood hydrology and hydraulics with respect to the flood control project features and Little Chico Creek within the respective Flood Hazard Areas, information related to the hydraulic design prepared by the USACOE in the 1950's and the FEMA FIS in the early 1990's was reviewed and summarized in Table 3-1.

In January 1997, a peak flow of 37,500 cfs was estimated at Butte Creek near Durham Station and 35,600 cfs at Butte Creek near Chico Station (USGS, DWR, 2004). The location for this flow is in Flood Hazard Area 2. From the information in Table 3-1, the flow of 35,700 cfs would be greater than a 100-year event but less than a 500-year event. This flow is greater than the USACOE design flow of 27,000 cfs with three feet of freeboard; however, the flow is less than the capacity with zero freeboard, which is 40,000 cfs. Anecdotal information indicates that the water surface in Butte Creek was near the top of the levee in some locations, which would be expected in the conditions of the 1997 event. There were no reported conditions of levee overtopping.

To better understand the conditions related to the FEMA FIRMs, HEC-RAS hydraulic models were run using the 100-year flow and 500-year flow in the FEMA FIS. This analysis was performed for Butte Creek, the Little Chico Creek-Butte Creek Diversion channel, and for Little Chico Creek. The results of these model profiles are presented on Figures 3-1, 3-2, and 3-3, respectively. To estimate what the actual 100-year and 500-year flood elevations are compared to the flood elevations in the FEMA FIS, a profile for Butte Creek, Little Chico Creek, and the Little Chico Creek-Butte Creek Diversion channel was developed that reflects the 100-year and 500-year flood elevations as determined by the FIS, as well as the 100-year and 500-year flood elevations modeled with the existing vegetation conditions of the channels. The existing condition of the Butte Creek channel was modeled using the roughness coefficient, Manning's "n" value of 0.4, to reflect the maximum hydraulic capacity of Butte Creek, to compare with the Manning's "n" values used in the FIS. The Little Chico Creek channel was modeled using an adjusted roughness coefficient to account for the vegetation in the channel, as determined on numerous site visits. The channels were not resurveyed, so the channel elevations provided in the FIS were used in the modeling to produce the profiles. These results will be discussed below in relation to the respective Flood Hazard Areas.

Flood Hazard Area 1 – Referring to Figure 3-1, the levees along both banks of Butte Creek throughout this Flood Hazard Area are shown to have inadequate freeboard, and some areas are shown to be overtopped in a 100-year event. Although flood flow was estimated at 37,500 cfs in 1997, the contribution from Hamlin Slough is not known. In any case, these levees were not overtopped in 1997.



In view of the deficiencies in freeboard, these levees were assumed to fail in developing the FEMA FIRMs. The levee failure analysis assumes the levee along one bank fails and the levee on the opposite bank is left in tact and vice-versa. This type of analysis provides an "envelope" or "worse-case" flooding scenario. In addition to the levees being deficient in freeboard, there is no documentation to determine the condition of the levees with respect to structural integrity and seepage.

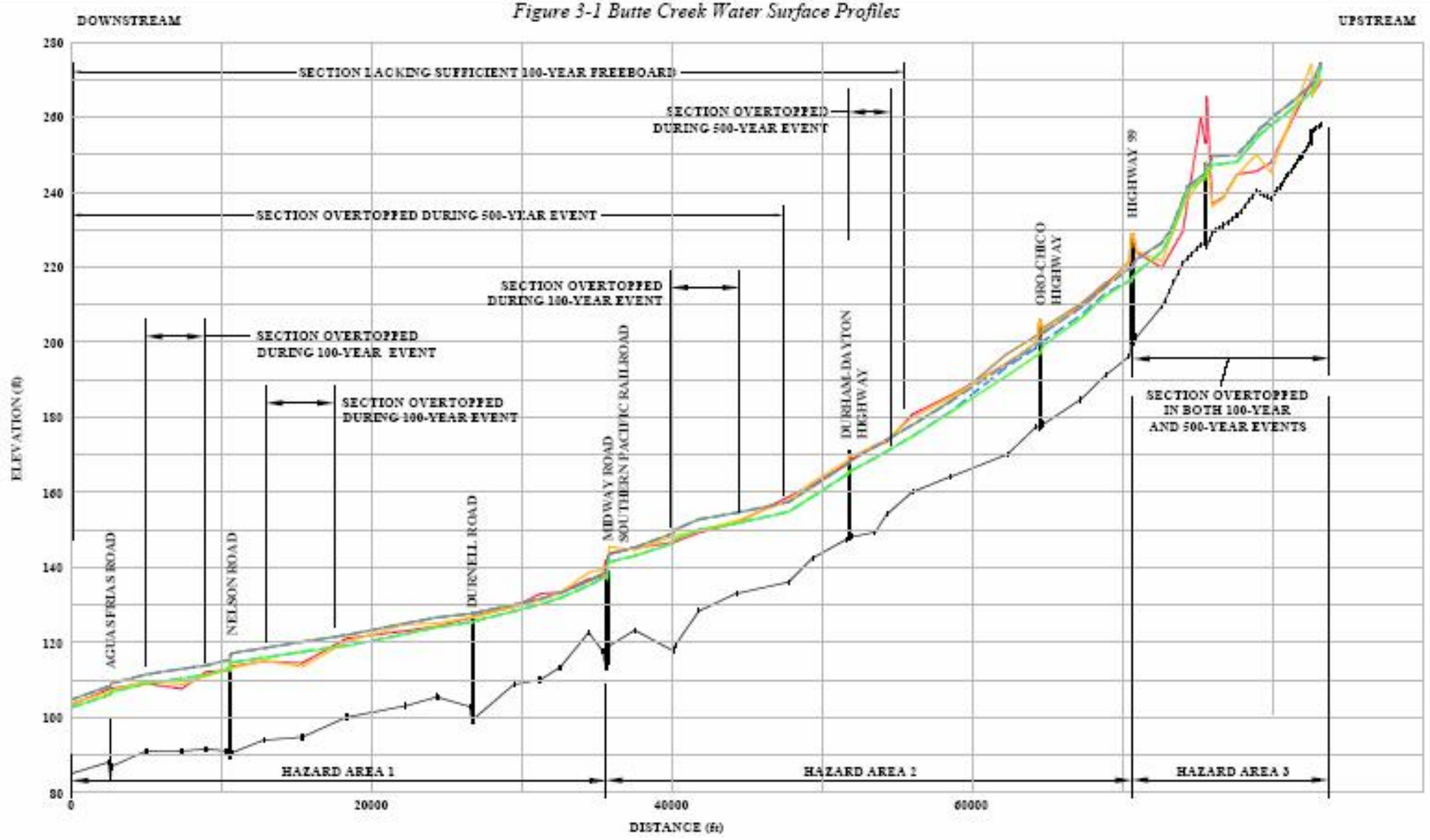
TABLE 3-1
FEMA FIS HYDROLOGY AND USACOE DESIGN FLOWS

Flood Hazard Area	FIS Flows[1] (cfs)		USACOE Flows[2] (cfs)	
	100-Year	500-Year	With Freeboard	Without Freeboard
1. Butte Creek Downstream of Hamlin Slough	34,900	51,100	27,000	40,000
Butte Creek Upstream of Hamlin Slough	30,300	44,800	27,000	40,000
2. Butte Creek	30,300	44,800	27,000	40,000
3. Butte Creek	25,000	34,000	-	-
4. Little Chico Creek Diversion	3,300	6,600	3,000	4,500
5. Little Chico Creek Diversion	3,300	6,600	3,000	4,500
6. Little Chico Creek Upstream of Dead Horse Slough	3,700	4,700	-	-
Little Chico Creek Downstream of Dead Horse Slough	4,000	5,100		

[1]FEMA, Butte County, California, Flood Insurance Studies for Butte Creek, Little Chico Creek, Comanche Creek, and Hamlin Slough, Hydrologic Analysis, Borcalli & Associates, March 1992

[2]USACOE, Operation and Maintenance Manual Upper Butte Creek – Part No. 1 and Part No. 2, 1955 and 1960, respectively.

Figure 3-1 Butte Creek Water Surface Profiles



LEGEND

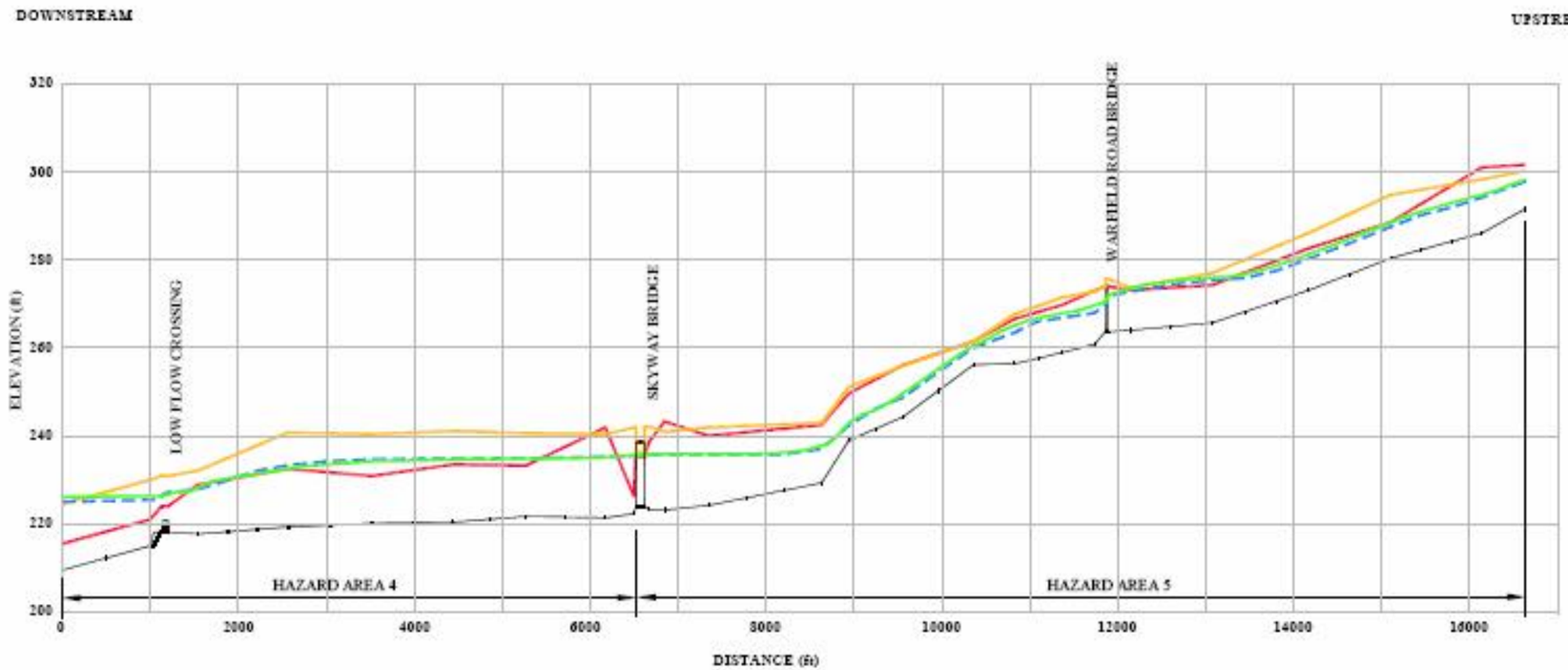
- CHANNEL INVERT
- 500-YEAR WSEL (EXISTING)
- 500-YEAR WSEL (FIS)
- 100-YEAR WSEL (EXISTING)
- 100-YEAR WSEL (FIS)
- EXISTING TOP OF LEFT BANK
- EXISTING TOP OF RIGHT BANK

NOTE:

Profile sections determined to overtop are based on the results of the Federal Emergency Management Agency's Flood Insurance Study (FIS) modeling and the FIS modeling with adjusted roughness coefficients (existing), based on existing vegetation conditions. These areas do not denote areas that have actually overtopped in past events.

Drawing is not to scale.

Figure 3-2 Little Chico Creek - Butte Creek Diversion
Channel Water Surface Profiles



LEGEND

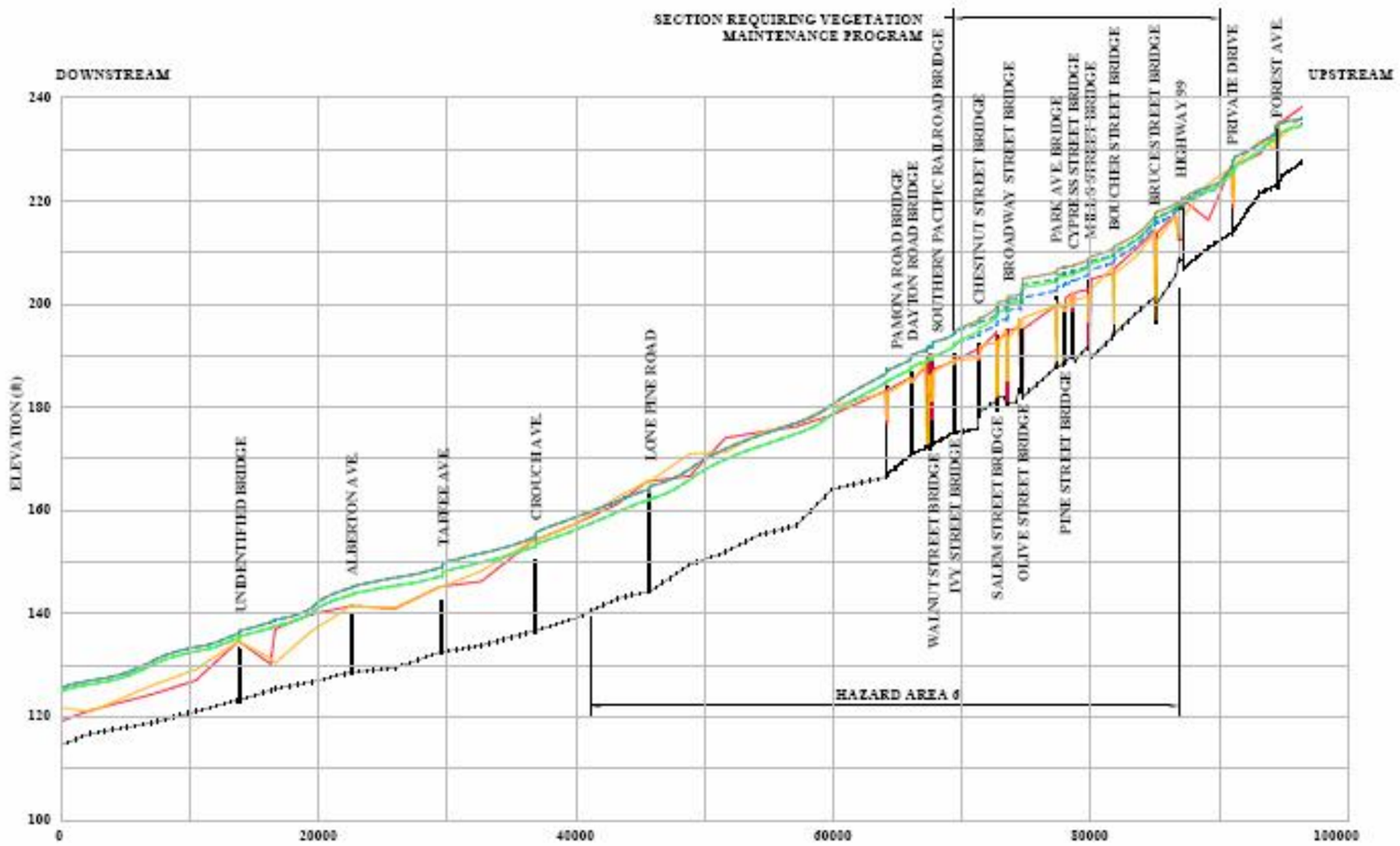
- CHANNEL INVERT
- 100-YEAR WSEL (EXISTING)
- 100-YEAR WSEL (FIS)
- EXISTING TOP OF LEFT BANK
- EXISTING TOP OF RIGHT BANK

NOTE:

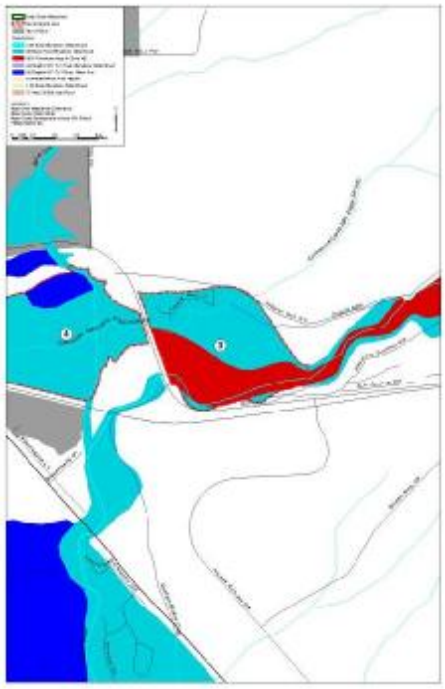
[1] Profile sections determined to overtop are based on the results of the Federal Emergency Management Agency's Flood Insurance Study (FIS) modeling and the FIS modeling with adjusted roughness coefficients, based on existing vegetation conditions. These areas do not denote areas that have actually overtopped in past events.

Drawing is not to scale.

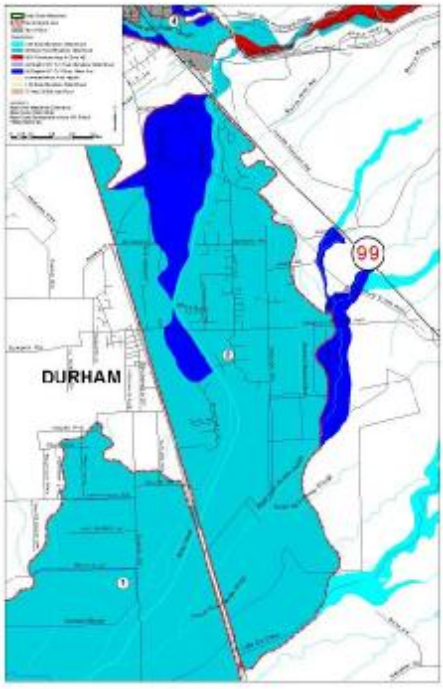
Figure 3-3 Little Chico Creek Water Surface Profiles



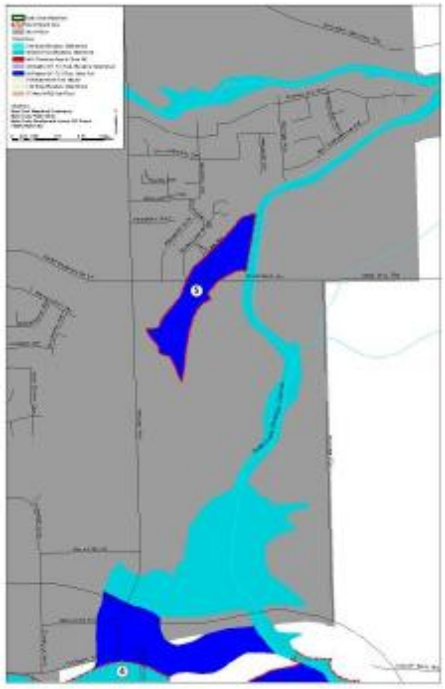
Flood Hazard Area 2 – Referring to Figure 3-1, the levees along both banks of Butte Creek throughout this hazard area are shown to be overtopped throughout a reach of nearly 4,000 feet, beginning from approximately 4,000 feet upstream of Midway Road, during a 100-year event. Important to note is that the levees in this reach were not overtopped during the 1997 event when the peak flow through this area was estimated at 37,500 cfs. According to the profiles, there is inadequate freeboard approximately 3,700 feet upstream of the Durham-Dayton Highway to Midway Road. As is the case with all of the project levees, there was no documentation to determine the structural integrity of the levees or the extent to which seepage could be a problem. Accordingly, the levees were assumed to fail in developing the FEMA FIRMs.



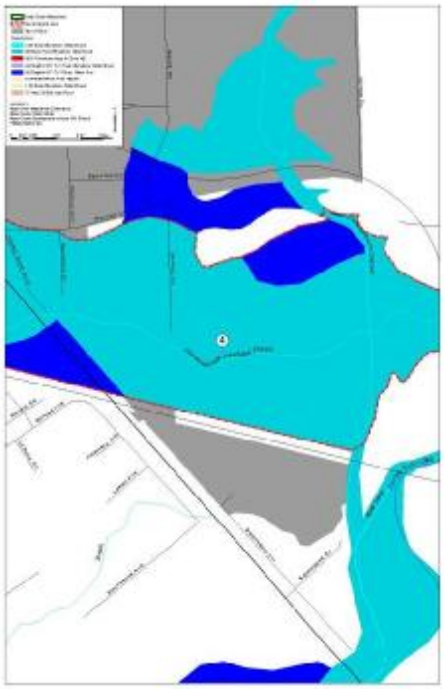
Flood Hazard Area 3 – Referring to Figure 3-1, a significant part of Butte Creek through this hazard area is shown to overtop its banks under a 100-year and 500-year event. Where levees have been constructed, the deficiencies noted above for Flood Hazard Area 1 and Flood Hazard Area 2 would apply as well.



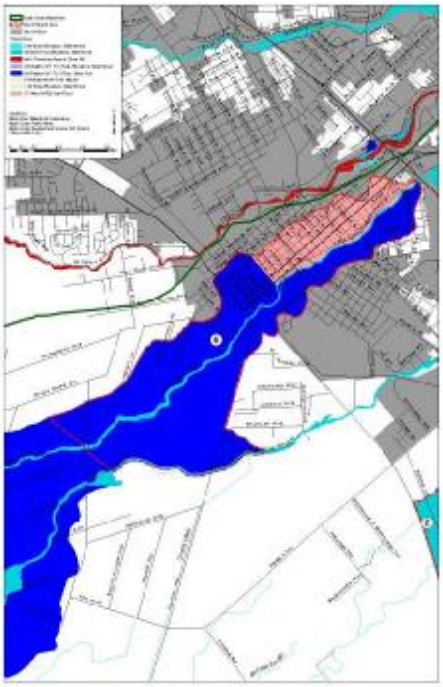
Flood Hazard Area 4 – Referring to Figure 3-2, the right bank levee of the Little Chico Creek-Butte Creek Diversion channel has adequate freeboard to convey the 100-year flow with adequate freeboard. However, when Butte Creek overtops its banks, water will overtop the left levee of the Little Chico Creek-Butte Creek Diversion channel and encroach on the right bank freeboard. In view of the hydraulic deficiency when accounting for Butte Creek overbank flows, and the uncertainties with respect to the structural integrity of the levees, it was failed in developing the FEMA FIRMs.



Flood Hazard Area 5 – Referring to Figure 3-2, there is essentially zero freeboard for the 100-year event for nearly 1,000 feet upstream of the Warfield Road Bridge. This reach of the Little Chico Creek-Butte Creek Diversion channel is largely an excavated section unlike the downstream reach, which has levees.



Flood Hazard Area 6 – Referring to Figure 3-3, the reach of Little Chico Creek throughout this Flood Hazard Area is shown to overtop its banks during a 100-year event. At the time the USACOE constructed the flood control project, the non-damaging flow for Little Chico Creek was 2,200 cfs. A hydraulic analysis, performed as part of the development of the Butte Creek Watershed FMP, indicates that with the increased vegetation, the channel capacity is currently approximately 1,800 cfs. As shown in Table 3-1, the 100-year flow in Little Chico Creek, based upon the FEMA FIS, was estimated at 3,300 cfs upstream of Dead Horse Slough and 3,700 cfs downstream of Dead Horse Slough. Vegetative growth within the Little Chico Creek channel will reduce its hydraulic conveyance capacity.



Local Drainage Flooding

Several issues cause drainage problems that lead to flooding in the watershed. Ditches and storm water systems are needed to convey storm water away from developed areas; however, in some areas the topography prevents surface water from draining quickly to a ditch, stream, or storm drain. Typically, storm water systems are designed to handle storm runoff for events smaller than the 100-year event, such as a 10-year event. Older storm water systems typically designed to convey the 10-year storm or less may become inadequate as additional watershed development and associated runoff increases. Storm water systems, ditches, and other waterways can be blocked by debris, resulting in ponding storm water prior to the storm water system clearing. Many roads not in the FEMA-designated floodplain have undergone damage in the past due to flooding (Map 5).

Bridges


Durham-Dayton Hwy Bridge, 01/03/1997

Bridge damage and collapse due to high velocity flow and debris blockage can cause damage to property, structures, and poses a risk to life. According to a Flood Damage Survey Report (DSR) conducted by the Natural Resource Conservation Service (NRCS) for FEMA, the flood event in 1997 caused erosion of the piers and the bank on the north side of the Honey Run Covered Bridge, which is located on Butte Creek approximately one-half mile downstream of the Little Butte Creek and Butte Creek confluence. The bridge had to be repaired to its original condition, costing $16,000. It was reported that the Durham-Dayton Highway Bridge, located on Butte Creek, had extensive damage caused by the 1997 storm event due to heavy debris accumulation and high water velocities. Excessive high water in 1997 caused embankment failure to the Oroville-Chico Highway, 1.1 miles east of Midway Road. The eroded material was replaced with rock fill to the original profile, resulting in $21,000 in repairs. The Butte Creek Bridge on Nelson Road, eight miles west of Highway 99, had extensive damage to the support columns and embankment as a result of the 1997 event. The columns and the embankment were repaired to the pre-disaster condition, resulting in $66,000 in repairs.

Levee Failure

Areas protected by levees are always at risk to flooding due to a levee failure or being overtopped. The recorded data available for hydrology in Butte County is relatively short, which in general, indicates that the potential exists for having a flood event of a greater magnitude than the design capacity of the levees. This is illustrated by the fact that the flood event in 1997 exceeded any flow previously recorded on Butte Creek. Even levees considered to be structurally sound have the potential of failing as a result of unforeseen damage caused by rodents or other activities. Currently, Butte County does not have a comprehensive emergency preparedness and evacuation plan to guide responding entities in alerting and evacuating people and livestock, which would be necessary in a levee failure or overtopping.

Dam Failure

Dam failure analyses are not included when determining the 100-year floodplain for the FEMA FIS and FIRMs discussed previously. Accordingly, dams that would create a significant

flooding hazard within the Butte Creek watershed due to failure are included in the following discussion.

Paradise and Magalia reservoirs, owned and operated by the Paradise Irrigation District (PID), are located on Butte Creek, above Paradise. Paradise Dam is an earth-filled structure and Magalia Dam is a hydraulic fill structure. Failure of Paradise Dam would overtop Magalia Dam and result in temporary flooding in the City of Chico planning area and along Butte Creek (Map 6). According to communications with the CDSOD, the Magalia Reservoir has restricted water surface levels to ensure safety following a seismic event due to the higher liquefaction potential at this location. The system integrity at Paradise Reservoir is considered adequate for an earthquake of the magnitudes that CDSOD has studied.

Oroville Dam is a large earthen dam located on the Feather River, near the City of Oroville. The dam was constructed as a major component of the State Water Project to provide water for the growing population of California, irrigation in central and southern California, flood control, and hydroelectricity. The dam is over 700 feet high and is almost 7,000 feet long at the top. The failure of Oroville Dam would inundate a large portion of the Butte Creek watershed's valley section (Map 7).

Black Butte Dam was constructed on Stoney Creek by the USACOE and is operated by the U.S. Bureau of Reclamation (USBR). It is an earth-filled structure located approximately 24 miles west of the Sacramento River, outside of the Butte Creek watershed. The dam is located below the Stoney Creek, Stoney Gorge, and East Park reservoirs. The combined storage capacities of these reservoirs are estimated at 160,000 acre-feet. Should the dams upstream of Black Butte fail, Black Butte Dam could not withstand the volume of water and would also fail and flood the area approximately eight miles east of the Sacramento River into the Butte Creek watershed and the City of Chico (Map 8) (City of Chico Master Environmental Assessment, 1999).

Whiskeytown Dam was constructed as a feature of the federal Central Valley Project and is operated by the USBR. It is located along Clear Creek approximately 65 miles northwest of the City of Chico. In the event of a dam failure, flow would travel along Clear Creek and into the Sacramento River, inundating almost 20 miles east of the Sacramento River into the Butte Creek watershed and the City of Chico planning area (Map 9) (City of Chico Master Environmental Assessment, 1999).

Shasta Dam was constructed as a feature of the federal Central Valley Project and is operated by the USBR. It is located approximately 70 miles north of the City of Chico with an estimated capacity of 4.5 million acre-feet. In the event of a failure, water would flow into the Sacramento River and inundate roughly 30 miles east of the Sacramento River into the Butte Creek watershed and the City of Chico (Map 10) (City of Chico Master Environmental Assessment, 1999).

Currently, Butte County does not have a comprehensive emergency preparedness and evacuation plan for people and livestock, to anticipate possible inundation from dam failure.

Land Use Planning

Flooding potential changes as areas sustain increased development. Increased constriction of natural drainage, floodplains, and increased impervious surfaces could have a cumulative affect on flooding and could overwhelm existing storm drainage and flood control facilities.

The population in Butte County has increased approximately 11.6 percent from 1990 to 2000, compared to California at 13.6 percent (U.S. Census Bureau, 2003). A small percentage of land in Butte County is devoted to urban uses, while the majority of Butte County's land uses include agriculture, timber, and grazing (Map 11 and Map 12). According to the Butte County General Plan, migration from California's metropolitan areas is expected to continue and would represent the largest part of the county's population growth in coming years. The City of Chico anticipates that growth in the urban area would move toward the northeast and southeast, as infill opportunities become limited and as Greenline policies restrict growth to the west (Butte County Master Environmental Assessment, 1996).

The relatively minimal reported damages and loss of life attributed to flooding over the past 25 years in Butte County indicates that the current land use management practices in Butte County have proven effective. However, increasing development and population growth will require disciplined land use management practices to ensure that urbanization of land protected by levees does not occur and is not allowed to exacerbate the affects of flooding in other areas.

Assessing Watershed Vulnerability: Identifying Assets

Identifying Assets

After flooding hazards are identified and profiled, it is necessary to evaluate how these hazards affect the structural and nonstructural assets of the watershed. Identifying these assets in relation to the locations of various flooding hazards is an integral part of the process of estimating potential losses associated with flooding.

Critical Facilities

A critical facility, either in the public or private sectors, provides essential products and services to the general public, which are necessary to preserve the welfare and quality of life in the watershed or fulfills important public safety, emergency response, and/or disaster recovery functions. According to FEMA, critical facilities consist of the following:

Essential Facilities – Medical care facilities, emergency response facilities, shelters, and those vital to emergency response and recovery following a disaster.

Transportation Lifeline Systems – Highways, railways, light rail, bus systems, ports, ferry systems, and airports.

Utility Lifeline Systems – Potable water, electric power, wastewater, communications, and liquid fuels (oil and gas).

Hazardous Materials Facilities – Structures that house industrial/hazardous materials, such as corrosives, flammable materials, radioactive materials, and toxins.

A critical facilities inventory was obtained from the FEMA HAZUS 99 loss estimation model program, and was subsequently reviewed and revised by the BCWC. Table 3-2 is an inventory of the critical facilities in the watershed (Map 13).

Of the critical facilities in the watershed, 23 are in the FEMA-designated SFHAs (listed in Table 3-3 and shown on Map 13).

An inventory of improvements in the 100-year floodplain, which includes residential, commercial, industrial, agricultural, and utilities (such as power or water treatment plants) was obtained from the Butte County Tax Assessor's office. Table 3-4 provides an inventory of the building stock and land within the watershed, within the FEMA SFHAs, which is worth an estimated $1 billion (inaccuracies with this valuation are explained in "Estimating Potential Losses," later in this section of the Butte Creek Watershed FMP). The structures in the FEMA 100-year floodplains in the Butte Creek watershed are primarily residential, constituting almost three percent of the housing stock in the entire County (California Department of Finance, 2001).

Assessing Watershed Vulnerability: Estimating Potential Losses

To estimate the potential economic loss associated with the threat of flooding, an improvements inventory in the 100-year floodplain was obtained from the Butte County Tax Assessor's office, which includes residential, commercial, industrial, agricultural, and utilities. The total assessed value of structures within the FEMA SFHA is approximately $1 billion (Table 3-4). This value should be considered very low since it does not include federal, state, and other exempt facilities, and because of the inherent inaccuracies of the parcel value information. The parcel data collected from the Butte County Tax Assessor has inaccuracies inherent to the provisions in Proposition 13. Proposition 13, passed by the California voters in 1978, reduced property taxes by 57 percent. Under the tax cut measure, property tax valuation was set at the 1976 assessed value. Property tax increase on any given property was limited to no more than two percent a year as long as the property was not sold. Once sold, the property is reassessed at one percent of the new market value with the two percent yearly cap placed on this new assessment.

TABLE 3-2
CRITICAL FACILITIES IN THE BUTTE CREEK WATERSHED

Number on Map	Type	Name
1	Essential Facility - Hospital	Feather River Hospital
2	Essential Facility - Hospital	Biggs Gridley Memorial Hospital
3	Essential Facility - Hospital	Urgent Care Center
4	Essential Facility - School	Biggs Unified School District, Richvale
5	Essential Facility - School	Butte Community College District
6	Essential Facility - School	Butte County Schools Special Education
7	Essential Facility - School	Christian Church Of Paradise
8	Essential Facility - School	Durham Unified School District
9	Essential Facility - School	Golden Feather Elementary School
10	Essential Facility - School	Notre Dame School
11	Essential Facility - School	Paradise Christian School
12	Essential Facility - School	Paradise Unified School District
13	Essential Facility - School	Paradise Unified School District
14	Essential Facility - School	Paradise Unified School District
15	Essential Facility - School	Parkview Elementary School
16	Essential Facility - School	Richvale Elementary School
17	Essential Facility - School	Saint Thomas More Catholic Church
18	Essential Facility - School	St Johns Parish School
19	Essential Facility - School	Stirling City Elementary School
20	Essential Facility - Shelter	North Valley Plaza Mall
21	Essential Facility - Shelter	Magalia Community Church
22	Essential Facility - Shelter	Paradise Pines Community Center
23	Essential Facility - Shelter	First Baptist Church Of Paradise
24	Essential Facility - Shelter	Forrest Ranch Community Center
25	Essential Facility - Shelter	Craig & Gordon Hall
26	Essential Facility - Shelter	Paradise Lutheran Church
27	Essential Facility - Shelter	Salvation Army Shelter 1
28	Essential Facility - Shelter	Salvation Army Shelter 2
29	Essential Facility - Shelter	Salvation Army Shelter 3
30	Essential Facility - Shelter	Salvation Army Shelter 4
31	Essential Facility - Shelter/School	Rosedale Elementary School
32	Essential Facility - Shelter/School	Emma Wilson Elementary School
33	Essential Facility - Shelter/School	Durham Elementary School
34	Essential Facility - Shelter/School	Fairview High School
35	Essential Facility - Shelter/School	Forrest Ranch Elementary School
36	Essential Facility - Shelter/School	Little Chico Creek Elementary School
37	Essential Facility - Shelter/School	Paradise Intermediate School
38	Essential Facility - Shelter/School	Paradise Pines Elementary School
39	Essential Facility - Shelter/School	Ponderosa Elementary School
40	Essential Facility - Shelter/School	Biggs Elementary School
41	Essential Facility - Shelter/School	Biggs High-Middle School
42	Essential Facility - Shelter/School	Chapman Elementary School

TABLE 3-2
CRITICAL FACILITIES IN THE BUTTE CREEK WATERSHED

Number on Map	Type	Name
43	Essential Facility - Shelter/School	Paradise Adventist Academy
44	Essential Facility - Shelter/School	Paradise High School
45	Essential Facility-Fire Station	Chico Fire Department
46	Essential Facility-Fire Station	D W Stuermer Landscape & Fire
47	Essential Facility-Fire Station	De Sabla Volunteer Fire Station
48	Essential Facility-Fire Station	Paradise Fire Department
49	Essential Facility-Fire Station	Chico City of Fire Department
50	Essential Facility-Police Station	Biggs Police Department
51	Essential Facility-Police Station	Chico Police Department
52	Essential Facility-Police Station	Gridley Police Department
53	Essential Facility-Police Station	Paradise Police Department
54	Hazardous Materials Facility	WREX Products Inc. Site
55	Hazardous Materials Facility	Victor Industries
56	Hazardous Materials Facility	Louisiana-Pacific Corporation, Site 1
57	Hazardous Materials Facility	US Army, Chico
58	Hazardous Materials Facility	City of Chico Wastewater Treatment Plant
59	Hazardous Materials Facility	Chemtec
60	Hazardous Materials Facility	Tosco Corporation Chico Terminal
61	Hazardous Materials Facility	Shell Oil Company
62	Hazardous Materials Facility	Louisiana-Pacific Corporation Site 2
63	Hazardous Materials Facility	Miracle Auto Painting
64	Hazardous Materials Facility	Butte County Rice Growers Association
65	Hazardous Materials Facility	Gridley Country Ford Mercury
66	Hazardous Materials Facility	A C Industrial Cleaning Company
67	Hazardous Materials Facility	Moser Dental Manufacturing Company
68	Hazardous Materials Facility	Cruces Classic Cars
69	Hazardous Materials Facility	Chemtec Agri Chems, Inc.
70	Hazardous Materials Facility	Gary Younie Truck & Auto, Inc.
71	Hazardous Materials Facility	Spray-Chem
72	Hazardous Materials Facility	Butte County Department of Public Works
73	Hazardous Materials Facility	Oberti Olive Company
74	Hazardous Materials Facility	Ed Wittmeier Ford Lincoln Mercury
75	Hazardous Materials Facility	Wittmeier Honda
76	Hazardous Materials Facility	Ye Olde Car Shoppe
77	Hazardous Materials Facility	Georges Pest Control, Inc.
78	Hazardous Materials Facility	PG&E Chico Service Center
79	Hazardous Materials Facility	Quality Cleaners
80	Hazardous Materials Facility	Crystal Aire Cleaners
81	Hazardous Materials Facility	Lobdell Cleaners
82	Hazardous Materials Facility	Paradise Garbage Disposal
83	Hazardous Materials Facility	Hobbie Chevrolet

TABLE 3-2
CRITICAL FACILITIES IN THE BUTTE CREEK WATERSHED

Number on Map	Type	Name
84	Hazardous Materials Facility	Gridley Growers, Inc.
85	Hazardous Materials Facility	Temples Auto Body & Paint
86	Hazardous Materials Facility	PG&E Table Mountain Substation
87	Hazardous Materials Facility	Chico Enterprise Record
88	Hazardous Materials Facility	Downtown Auto Body
89	Hazardous Materials Facility	Chico Metal Finishing, Inc.
90	Hazardous Materials Facility	Viking Freight System, Inc.
91	Hazardous Materials Facility	B&B Diesel Repair
92	Hazardous Materials Facility	Johns Garage
93	Hazardous Materials Facility	Gold Nugget Auto
94	Hazardous Materials Facility	Teagues Auto Repair
95	Hazardous Materials Facility	Bills Auto Repair
96	Hazardous Materials Facility	S & T Logging
97	Hazardous Materials Facility	Shade Tree Garage
98	Hazardous Materials Facility	Skyway Towing & Auto
99	Hazardous Materials Facility	Chuck Jones Flying Service
100	Hazardous Materials Facility	Chico Auto Parts, Inc.
101	Hazardous Materials Facility	Benson Cleaners
102	Hazardous Materials Facility	Caltrans District 03
103	Hazardous Materials Facility	Golden State Coach
104	Hazardous Materials Facility	Gridley Automotive Machine
105	Hazardous Materials Facility	K-Mart #9541
106	Hazardous Materials Facility	Puritz Oil Company
107	Hazardous Materials Facility	Randys Auto Service
108	Hazardous Materials Facility	Baldwin Contracting Shop
109	Hazardous Materials Facility	Mid State Linen & Industrial
110	Hazardous Materials Facility	Wittmeier Collision Center
111	Hazardous Materials Facility	Lifetouch National School Stud
112	Hazardous Materials Facility	Universal Equipment Mfg Co, Inc.
113	Hazardous Materials Facility	Transmatic, Inc.
114	Hazardous Materials Facility	Chico Cleaners
115	Hazardous Materials Facility	Blue Diamond Growers
116	Hazardous Materials Facility	The Graphic Fox, Inc.
117	Hazardous Materials Facility	Paradise Unified Transportation
118	Hazardous Materials Facility	Paradise High School
119	Hazardous Materials Facility	Chico Independent Auto
120	Hazardous Materials Facility	Paradise Printing Company
121	Hazardous Materials Facility	Wittmeier Auto Center
122	Hazardous Materials Facility	Metal Air Ironworks, Inc.
123	Hazardous Materials Facility	U S Forming, Inc.
124	Hazardous Materials Facility	Duckback Products, Inc.
125	Hazardous Materials Facility	Big O Tires
126	Hazardous Materials Facility	Photo Fast

TABLE 3-2
CRITICAL FACILITIES IN THE BUTTE CREEK WATERSHED

Number on Map	Type	Name
127	Hazardous Materials Facility	Quadco Printing, Inc.
128	Hazardous Materials Facility	Jiffy Lube International No.728
129	Hazardous Materials Facility	Apple Photo
130	Hazardous Materials Facility	Oroville County Airport
131	Hazardous Materials Facility	Paradise Auto Body
132	Hazardous Materials Facility	CostCo No.136
133	Hazardous Materials Facility	Fmc Corp Agri Chem Group
134	Hazardous Materials Facility	Simplot Soilbuilders
135	Hazardous Materials Facility	Southern Pacific Pipe Lines
136	Hazardous Materials Facility	Pacific Bell Site 1
137	Hazardous Materials Facility	Pacific Bell Site 2
138	Hazardous Materials Facility	Pacific Bell Site 3
139	Hazardous Materials Facility	Pacific Bell Site 4
140	Hazardous Materials Facility	Pacific Bell Site 5
141	Hazardous Materials Facility	Pacific Bell Site 6
142	Hazardous Materials Facility	Pacific Bell Site 7
143	Hazardous Materials Facility	Pacific Bell Site 8
144	Hazardous Materials Facility	Pacific Bell Site 9
145	Hazardous Materials Facility	Pacific Bell Site 10
146	Hazardous Materials Facility	Pacific Bell Site 11
147	Hazardous Materials Facility	Pacific Bell Site 12
148	Hazardous Materials Facility	Pacific Bell Site 13
149	Hazardous Materials Facility	Pacific Bell Site 14
150	Hazardous Materials Facility	Kits Camera, Inc. No.101
151	Hazardous Materials Facility	Evergreen Oil, Chico
152	Hazardous Materials Facility	Raleys No.287
153	Hazardous Materials Facility	Cruces Auto Body
154	Hazardous Materials Facility	Chico Collision Center
155	Hazardous Materials Facility	JPS Paint And Body Works
156	Hazardous Materials Facility	WREX Products Inc. Site
157	Hazardous Materials Facility	Koppers Industries Inc.
158	Hazardous Materials Facility	Louisiana-Pacific Corporation, Oroville
159	Hazardous Materials Facility	Santa Fe Pacific Pipelines
160	Transportation Lifeline System - Airport	Paradise Skypark
161	Transportation Lifeline System - Airport	Oroville County Airport
162	Transportation Lifeline System - Heliport	Enloe Hospital
163	Transportation Lifeline System - Heliport	DeSabla Powerhouse
164	Transportation Lifeline System - Heliport	Butte Fire Center Ball Field
165	Transportation Lifeline System - Heliport	Mountain Ridge Middle School
166	Transportation Lifeline System - Heliport	Old Magalia Church
167	Transportation Lifeline System - Heliport	Paradise Dam
168	Transportation Lifeline System - Heliport	Lomo, Hwy.32 at Humboldt Road
169	Transportation Lifeline System - Heliport	Platt East Mountain

TABLE 3-2
CRITICAL FACILITIES IN THE BUTTE CREEK WATERSHED

Number on Map	Type	Name
170	Transportation Lifeline System - Heliport	Butte College Fire Training Ground
171	Transportation Lifeline System - Heliport	Community of Durham
172	Transportation Lifeline System - Heliport	Richvale School
173	Transportation Lifeline System - Heliport	Butte County Rice Growers Association
174	Transportation Lifeline System - Heliport	Richvale Airport
175	Transportation Lifeline System - Heliport	Nelson Park
176	Utility Lifeline System - Powerhouse	Forks of the Butte
177	Utility Lifeline System - Powerhouse	DeSabla Powerhouse
178	Utility Lifeline System - Powerhouse	Centerville Powerhouse
179	Utility Lifeline System - Radio Tower	KHSL Am 1290
180	Utility Lifeline System - Radio Tower	KNVR Fm 96.7
181	Utility Lifeline System - Radio Tower	KPAY Am 1060
182	Utility Lifeline System - Radio Tower	KRIJ Fm 92.7
183	Utility Lifeline System - Tankfarm	Shell/Texaco/Unocal

TABLE 3-3
CRITICAL FACILITIES IN THE BUTTE CREEK WATERSHED
IN THE FEMA SFHA

Number on Map	Type	Name
6	Essential Facility - School	Biggs Unified School District
13	Essential Facility - School	Notre Dame School
21	Essential Facility - School	St. Johns Parish School
30	Essential Facility - Shelter	Salvation Army Shelter 1
33	Essential Facility - Shelter	Salvation Army Shelter 4
47	Essential Facility - Shelter/School	Biggs Elementary School
66	Hazardous Materials Facility	City of Chico Wastewater Treatment Plant
71	Hazardous Materials Facility	Miracle Auto Painting
75	Hazardous Materials Facility	Moser Dental Manufacturing Co
78	Hazardous Materials Facility	Ed Wittmeier Ford
80	Hazardous Materials Facility	Spray-Chem
83	Hazardous Materials Facility	Ed Wittmeier Ford Linc Merc
108	Hazardous Materials Facility	Chuck Jones Flying Service
115	Hazardous Materials Facility	Puritz Oil Company
118	Hazardous Materials Facility	Mid State Linen & Industrial
123	Hazardous Materials Facility	Chico Cleaners
124	Hazardous Materials Facility	Blue Diamond Growers
139	Hazardous Materials Facility	Oroville County Airport
143	Hazardous Materials Facility	Simplot Soilbuilders
147	Hazardous Materials Facility	Pacific Bell Site 3
150	Hazardous Materials Facility	Pacific Bell Site 6
151	Hazardous Materials Facility	Pacific Bell Site 7
154	Hazardous Materials Facility	Pacific Bell Site 10

TABLE 3-4
INVENTORY OF BUILDING STOCK
IN THE BUTTE CREEK WATERSHED
IN THE FEMA SFHAs

Type of Structure	Structures in the FEMA SFHA in the Butte Creek Watershed	Structures in the FEMA SFHA in the Butte Creek Watershed, %	Structures in the FEMA SFHA in the Butte Creek Watershed, $	Land in the FEMA SFHA in the Butte Creek Watershed, $
Residential	2,338	74	277,757,429	161,425,975
Commercial	133	4	37,417,102	29,634,076
Industrial	60	2	28,322,117	10,139,767
Agricultural	620	20	76,884,836	270,927,069
Utilities	0	0	0	76,000
TOTAL	**3,151**	**100**	**420,381,484**	**472,202,887**

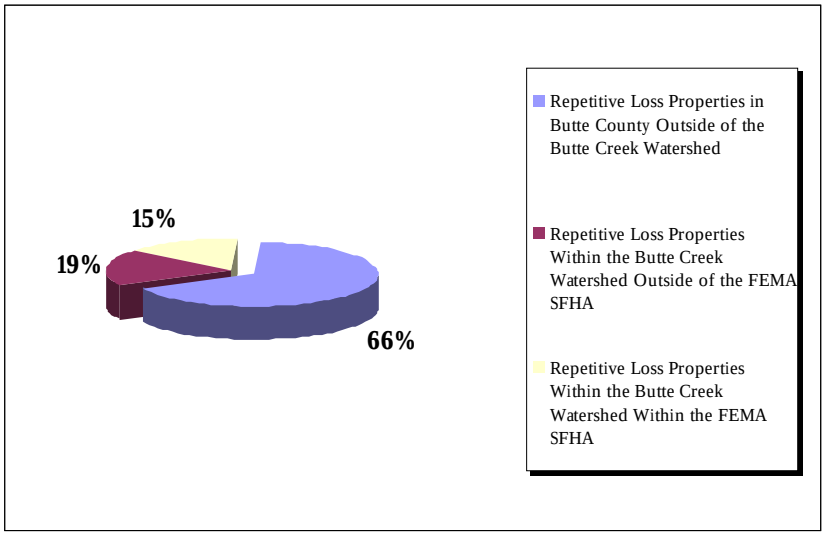
As a result, the parcel value information that was obtained from the Butte County Tax Assessor contains taxable value information for properties that have not changed hands over the last few years, thus that property has not been re-evaluated for the current taxable value. The value for many of the properties in the Butte Creek watershed do not reflect the current true market value; instead it is the market value at the time it was last assessed, which for many properties was over 20 years ago. This information must be taken into account when noting the estimated monetary losses due to flooding.

Nevertheless, estimating the approximate dollar value of the assets in the floodplain assists in evaluating the economic feasibility of the proposed mitigation measures. This valuation process includes monetary expenditures in the form of flood insurance premiums and investments in rebuilding structures facing repetitive loss.

Flood Insurance Premiums and Claims

Between July 2003 and July 2004, the dollars paid in flood insurance premiums for all of Butte County greatly exceeds the average annual total dollars paid in claims since 1978 (Table 3-5). Although it is understood that averaging annual values does not account for spikes in claim payments, such as in 1997, it does emphasize the volume of monetary losses as a result of flooding as it relates to flood insurance premiums paid and the imbalance of premiums paid to flood insurance claims.

Repetitive Losses



According to FEMA, a "repetitive loss property" has received two or more flood insurance claim payments for at least $1,000 each within any 10-year period, since 1978. These properties are important to the NFIP because they account for one-third of Butte Country's flood insurance claim payments. Monetary losses associated with repetitive loss properties within the watershed, although low compared to other California counties, are substantial. One-third of the repetitive loss properties in Butte County are within the watershed (refer to pie chart), and only a small portion of the repetitive loss properties in Butte County are in the Butte Creek watershed 100-year floodplains (15%). Map 14 illustrates the locations of the repetitive and one-time losses in Butte County.

TABLE 3-5
NUMBER OF POLICIES AND PREMIUMS PAID
FROM JULY 2003 TO JULY 2004

Location	Number of Policies	Total Premiums Paid, $	Average Annual Paid in Claims (since 1978), $
City of Chico	406	226,164	54,066
City of Biggs	21	5,958	260
Gridley	34	10,958	2,563
City of Oroville	56	21,339	31,363
Paradise	1	137	499
Butte County (Unincorporated)	1,362	716,408	86,188
TOTAL	**1,880**	**980,964**	**174,939**

Note: 2003 dollars
Source: FEMA

Damage Survey Reports

The NRCS and Butte County conducted flood damage surveys in Butte County after the flood events of 1995, 1997, and the February 1998 storms, to itemize known physical damage and estimate monetary flood damage. Most of the flood damage surveys were conducted along Butte Creek and outside of the watershed northwest of Chico and near the Oroville area. All flood damage surveys with estimated repair costs over $10,000 are included on Map 14; however, there were many that had repair costs that fell below this dollar amount. The total estimated cost for repairs from damage caused by flooding reached over $400,000 in 1995, over $700,000 in 1997, and close to $300,000 due to storms in 1998 (Butte County Damage Survey Reports 1995, 1997, and 1998).

Potential Losses Estimate

FEMA published a series of How-To guides for state and local mitigation planning that addresses the different elements necessary for hazard mitigation planning, including a process for estimating losses associated with potential flooding hazards. This methodology was used to determine the percentage of damage for one-story, two-story, and manufactured homes for one, two, and three feet of flooding in the Butte Creek watershed. Flooding depth is determined based upon the BFEs provided for the 100-year floodplain on the FEMA FIRMs. Corresponding flood depth and loss percentages used in estimating the potential losses are given in Table 3-6.

Table 3-7 is taken from FEMA's How-To guide on the typical content loss based upon the percent of structure value and according to occupancy class.

The improvement inventory provided by the Butte County Tax Assessor did not specify whether the residential, commercial, utility, agricultural, and industrial structures are one-story, two-story, a manufactured home or contained basements. Based upon communications with the Tax Assessor's office, it is difficult to ascertain a percentage of each type of structure in the watershed's floodplain. It was estimated, based upon discussion in the Land Use Element of the Butte County General Plan regarding dominant residential characteristics, that 60 percent of the total structure value ($420,381,484, Table 3-4) is portioned to one-story and two-story structures (30 percent each) and 40 percent of the total structure value is distributed to manufactured homes. The total structure value was distributed to the three structure types according to these estimated percentages and is presented in Table 3-8. The total content values, listed in Table 3-8, were calculated using the structural values in Table 3-8, and multiplied against the building damage percentages provided in Table 3-7.

TABLE 3-6
POTENTIAL LOSS ESTIMATION

Flood Depth (ft)	Type of Flooding Loss					
	One-Story – No Basement		Two-Story – No Basement		Manufactured Home	
	Building (% Building Damage)	Contents (% Contents Damage)	Building (% Building Damage)	Contents (% Contents Damage)	Building (% Building Damage)	Contents (% Contents Damage)
1	14	21	9	13.5	44	66
2	22	33	13	19.5	63	90
3	27	40.5	18	27	73	90

Source: FEMA

TABLE 3-7
CONTENTS VALUE AS PERCENTAGE OF STRUCTURE REPLACEMENT VALUE

Occupancy Class	Contents Value (%)
Residential	50
Commercial	150
Industrial	150
Agriculture	100

Source: FEMA

TABLE 3-8
IMPROVEMENTS VALUE DISTRIBUTION BY STRUCTURAL TYPE

Percent by Use (Calculated from Tax Assessor's Improvements Inventory (Table 3-5))		**74 Percent Residential, $**	**4 Percent Commercial, $**	**2 Percent Industrial, $**	**20 Percent Agricultural, $**	**0 Percent Utility, $**	**Total, $**
Total Structural Value (Provided by Tax Assessor's Improvements Inventory)		277,757,429	37,417,102	28,322,117	76,884,836	0	**420,381,484**
Structural Value by Structure Type	**One Story Structure (30 Percent)**	83,327,229	11,225,131	8,496,635	23,065,451	0	**126,114,445**
	Two Story Structure (30 Percent)	83,327,229	11,225,131	8,496,635	23,065,451	0	**126,114,445**
	Manufactured Home (40 Percent)	111,102,971	14,966,840	11,328,847	30,753,934	0	**168,152,594**
Total Contents Value (Using Table 3-8)		138,878,715	56,125,653	42,483,176	76,884,836	0	**314,372,379**
Contents Value by Structure Type	**One Story Structure (30 Percent)**	41,663,615	16,837,696	12,744,953	23,065,451	0	**94,311,715**
	Two Story Structure (30 Percent)	41,663,615	16,837,696	12,744,953	23,065,451	0	**94,311,715**
	Manufactured Home (40 Percent)	55,551,486	22,450,261	16,993,270	30,753,934	0	**125,748,951**

The values in Table 3-6 and Table 3-8 were used in calculating the values in Table 3-9. For example, the total structural value of one-story buildings (with no basement) at one-foot depth of flooding is $126,114,445 (given in the last column of Table 3-8). To obtain the total building loss for one-story buildings (with no basements) after one foot depth of flooding, the total structural value of one-story buildings is multiplied by the FEMA percent structure damage to a one-story building (with no basement) for one foot of flooding, 14 percent (given in Table 3-6), and the resultant value of $17,656,022 (provided in Table 3-9).

Based upon this loss estimate, manufactured homes are at the greatest monetary risk and one-story structures are at a greater risk than two-story structures. The elevation of a structure substantially reduces the loss in an event that produces three feet of flooding, by almost $10 million, if all one-story and two-story structures are compared. Losses to residential structures were the greatest compared to all structures.

Flood Hazard Areas Potential Economic Losses

Using the data and information compiled in the previous parts of this section, an estimate is made of the potential losses associated with each of the respective hazard areas. The results of this evaluation are summarized in Table 3-10.

From the evaluation, analyses, and information compiled in this section, it is important to highlight differences with respect to the floodplains delineated for the Flood Hazard Areas. For example, the floodplain for Flood Hazard Area 1, Flood Hazard Area 2, and Flood Hazard Area 4 are the result of levee failure analyses conducted as part of the FEMA FIRM development and consistent with FEMA criteria, and the associated floodplains are largely a regulatory floodplain. On the other hand, the floodplains delineated for Flood Hazard Area 3, Flood Hazard Area 5, and Flood Hazard Area 6 are the result of out-of-bank flow, and its occurrence is less problematic.

The fact that the low in Flood Hazard Area 2 was estimated at 37,500 cfs in the 1997 event, which is significantly greater than the FEMA 100-year flow of 30,300 cfs, demonstrated that the project levees were able to handle the flow without overtopping the levees. Although the flow in Little Chico Creek or Butte Creek downstream of Hamlin Slough were not recorded in the 1997 event, there were no reported problems associated with overbank flooding or overtopping of levees.

Summary

Based upon the risk assessment, a summary of the issues related to flooding are summarized in Table 3-11. Mitigation measures for each of the issues will be addressed in Section 4.0.

TABLE 3-9
POTENTIAL LOSSES WITHIN THE FEMA SFHAs

One Story – No Basement					
Flood Depth, ft	**Building, $**	**Contents, $**			
	All Uses	**Residential**	**Commercial**	**Industrial**	**Agriculture**
1	17,656,022	17,498,718	2,357,278	1,784,293	4,843,745
2	27,745,177	27,497,986	3,704,293	2,803,890	7,611,599
3	34,050,900	33,747,528	4,546,178	3,441,137	9,341,508
Two Story – No Basement					
Flood Depth, ft	**Building, $**	**Contents, $**			
	All Uses	**Residential**	**Commercial**	**Industrial**	**Agriculture**
1	11,350,300	17,498,718	2,357,278	1,784,293	4,843,745
2	16,394,877	27,497,986	3,704,293	2,803,890	7,611,599
3	22,700,600	33,747,528	4,546,178	3,441,137	9,341,508
Manufactured Home					
Flood Depth, ft	Building, $	Contents, $			
	All Uses	Residential	Commercial	Industrial	Agriculture
1	73,987,141	73,327,961	9,878,114	7,477,039	20,297,596
2	105,936,134	99,992,674	13,470,156	10,195,962	27,678,541
3	122,751,394	99,992,674	13,470,156	10,195,962	27,678,541

TABLE 3-10
FLOOD HAZARD AREA ESTIMATED/REPORTED ECONOMIC LOSSES

Flood Hazard Area	Actual or Potential Losses
1	This area includes properties that have reported over $80,000 in damages due to flooding since 1978 (FEMA, NFIP Statistics, 2004 and Butte County DSR Reports, 1997). Potential loss estimated, following FEMA loss estimation procedures, for two feet of flooding in the entire Flood Hazard Area is $1.9 million in structures and $7.5 million in contents ($9.4 million total). No repetitive loss properties in this area.
2	Reported $45,000 in damage due to flooding since 1978. Potential loss estimated, following FEMA loss estimation procedures, for two feet of flooding in the entire Flood Hazard Area is $29.4 million in structures and $42.7 million in contents ($72.1 million total). No repetitive loss properties in the area.
3	Reported $3,000 in damage due to flooding since 1978. Potential loss estimated, following FEMA procedures for loss estimation, for two feet of flooding in the entire Flood Hazard Area is $2.9 million in structures and $4.3 million in contents ($7.2 million total). One repetitive loss property in the area.
4	Flooding at the golf park would cause minimal damage; however, the industrial buildings in the area could be at risk. Reported $100,000 in damage due to flooding since 1978. Two repetitive loss properties in the area. Potential loss estimated, following FEMA procedures for loss estimation, for two feet of flooding in the Flood Hazard Area is $12.3 million in structures and $17.8 million in contents ($30.1 million total).
5	Flooding could pose a risk to new development in the area. Reported $0 in damage due to flooding since 1978. Potential loss estimated for two feet of flooding in the Flood Hazard Area is $81,000 in structures and $118,000 in contents ($200,000 total). No repetitive loss properties in the area.
6	Vegetation in the Little Chico Creek channel reduces the hydraulic capacity of the channel, thereby, increasing the probability of flooding during a storm event. Channel did not overtop in 1997 event, which is determined by the FEMA FIS as a 500-year event, and the FIS submittal as over a 100-year event. Reported $2,000 in damage due to flooding since 1978. Potential loss estimated, following FEMA loss estimation procedures, for two feet of flooding in the Flood Hazard Area is $12.2 million in structures and $60 million in contents ($72.2 million total). No repetitive loss properties in the area.

TABLE 3-11
RISK ASSESSMENT SUMMARY

Butte Creek	FIS Discrepancy Structural Integrity of the Levees Levees Freeboard Deficiencies Bridge Hydraulic Performance Channel Bank Overtopping
Little Chico Creek Diversion Channel	Structural Integrity of the Levees Levee Freeboard Deficiencies
Little Chico Creek	Inadequate Channel Capacity
Butte Creek Watershed	Local Drainage Flooding Emergency Preparedness Development in Floodplains Protected by Levees

SECTION 4.0 MITIGATION MEASURES

This section begins with an overview of the current roles and responsibilities of flood control and flood management in Butte County. This section also identifies and evaluates potential mitigation measures to address the flood protection or flood management deficiencies or issues associated with the Butte Creek watershed. Recommended mitigation measures are identified and presented in Section 6.0, the Action Program.

Roles and Responsibilities

Federal, state, and local agencies identify potential and existing flood hazards and devise preventative structural or nonstructural measures to avoid or minimize losses due to flooding.

FEMA manages the NFIP, produces FIS and FIRMs, and is the main federal agency contact during natural disasters. The FIRM, developed in conjunction with an FIS, allows local governments to identify areas prone to flooding, the location of a specific property in reference to the SFHA, the BFE, the NFIP flood insurance zone designation, and the location of the regulatory floodway, where shown. The NFIP is administered at the local level by cities or counties. FEMA also administers programs such as the PDM, FMA, and HMGP that provide funding for mitigation planning and projects.

The USACOE constructs major flood control facilities, performs hydrologic and hydraulic analyses, develops inundation maps, and can, through federal appropriation, fund investigations, feasibility studies, and construction of flood control projects, similar to the Little Chico Creek-Butte Creek Diversion channel and the levees along Butte Creek.

According to DWR's *Superintendent's Guide to the Operations and Maintenance of California Flood Control Projects Manual*, operation and maintenance of flood control projects that are a feature of the Sacramento River Flood Control Project are governed by the USACOE and the State Reclamation Board, as provided for under provisions of the California Water Code. The USACOE works with other public entities as sponsors of flood control projects (DWR, 1965). The USACOE was directed by Congress in 1917 to study and adopt a major flood control plan for the navigable streams and their tributaries in the Sacramento Valley and San Joaquin Valley, and with constructing facilities to provide flood protection for agricultural land and communities situated on major streams in the Central Valley. Later, the USACOE established rules, codes, and standards for maintaining certain project levees, to be performed by state and local agencies at their expense.

the State Reclamation Board is responsible for flood control along the Sacramento River and San Joaquin River and their tributaries. In addition, the State Reclamation Board is responsible for approving plans, acquiring rights-of-way and flowage easements, providing assurance of local cooperation, enforcing maintenance requirements established by the USACOE, and participating

in federal flood protection projects and designated floodplain management in the Central Valley (DWR, 1965, California Code of Regulations, Title 23, 1996).

The State Reclamation Board has been administratively part of DWR since 1958, but it functions as a separate agency in exercising its original flood management responsibilities. The State Reclamation Board takes lead responsibility for the long-term management of mitigation areas and reviews and approves or denies applications for any alteration or encroachment of any adopted plan of flood control in the Central Valley (DWR, 1965, California Code of Regulations, Title 23, 1996).

Responsibility for operation and maintenance of a maintenance area is assigned to DWR, which may be assigned to a local agency when it has demonstrated the desire and financial ability to meet the obligation. Since 1947, DWR has inspected project facilities semi-annually for compliance with federal, state, and local maintenance requirements. This work is part of the assurances the State Reclamation Board gives the federal government that certain flood control facilities built by the USACOE are properly maintained (DWR, 1965 California Code of Regulations, Title 23, 1996). The levees (not channels) along Butte Creek and part of the Little Chico Creek-Butte Creek Diversion are maintained and patrolled by DWR and are designated Maintenance Area No. 5. This responsibility was accepted soon after the project features were constructed in the 1950's.

DWR's Division of Flood Management assists in public safety for damage due to flooding, facilitates recovery efforts following any natural disaster, provides runoff forecasts, conducts awareness mapping and channel and levee maintenance, and maintains a hydrologic database.

Federal, state, and local agencies and organizations also play a key role in flood hazard mitigation in Butte County. These agencies and a summary of their respective activities as they relate to flood mitigation are provided in Table 4-1.

The flood hazards or issues related to flooding and protecting people, property, and livestock were summarized in Section 3.0. For some issues there are no alternatives, in which case the mitigation may be the selected or preferred measure. Presented below is a summary of the issues and a discussion of the potential mitigation measures associated with each.

TABLE 4-1
MATRIX OF AGENCIES AND MITIGATION ACTIVITIES

Agency	Flood Hazard Data/Maps	Planning Assistance	Prevention	Property Protection	Natural Resource Protection	Emergency Services	Structural Projects	Public Information
Key: F = Agency provides financial assistance. R = Agency regulates or sets regulatory standards. S = Agency performs service directly with its own staff. T = Agency provides technical assistance, information, or reference materials.								
Federal Agencies								
Federal Emergency Management Agency	FST	FST	FRST	FT	T	FST	ST	ST
National Weather Service	T					ST		T
Natural Resources Conservation Service	FST	T	T	ST	FST	FST	FT	T
U.S. Army Corps of Engineers	ST	T	FT	FT	ST	ST	FT	T
U.S. Bureau of Reclamation	TF	TF			R		TF	T
U.S. Fish and Wildlife Service	T				ST			T
U.S. Geological Survey	T							T
State Agencies								
California Department of Fish and Game		T		TSFR				TS
California Department of Forestry	TS	T	T	T	T	T		T
California Department of Water Resources	TSF	TS	TSFR	RTF	TR	TS	STF	TS
California Office of Emergency Services	FST	T	FSRT	T		FSRT		ST
California Reclamation Board	RT							T
California Rivers Assessment	TS	T						T
Butte County Agencies								
Butte County Sheriff						TS		TS
Butte County Fire Department			TSF	TS		TS		TS
Butte County Department of Development Services		TS	RT	RT	T		T	
Butte County Department of Development Services, GIS Division	TS							T
Butte County Department of Planning		TS		T	T			
Butte County Department of Public Works	TS	TSF		T				TS
Butte County Office of Emergency Services	TSF	T	TSFR	T		TSFR		TS
Butte County Resource Conservation District					TSF			TS
Butte County Department of Water and Resource Conservation		T	T		TSF			T
City Agencies								
City of Chico Fire Department			TSF			TSF		TS
Local Associations/Organizations/Chapters								
American Red Cross – Local Chapter						S		ST
Big Chico Creek Watershed Alliance	TS	TS	T	T	TS			TS
Butte County Fire Safe Council	TS	TS	T	T	TS			TS
Butte Creek Watershed Conservancy	TS	TS	T	T	TS			TS
Butte Environmental Council	TS	TS	T	T	TS			TS
California State University at Chico	TSF	TS						
California Waterfowl Association					TSF			TS
Cherokee Watershed Group	TS	TS	T	T	TS			TS
Ducks Unlimited, Inc.					TSF			TS
Little Chico Creek Watershed Group	TS	TS	T	T	TS			TS
Paradise Irrigation District	TS	S				TS		
Salvation Army – Local Chapter						S		ST
Western Canal Water District	TS	TS	T	T	TS			TS

Butte Creek

Issue: *FIS Discrepancy***:** According to the FEMA FIS and FIRMs, the water surface elevations under a 100-year and 500-year storm event would encroach on the freeboard and overtop part of the levees along Butte Creek and flow overbank along Little Chico Creek. However, the recent 1997 event, which exceeded a 100-year flow through Flood Hazard Area 2, did not overtop Butte Creek. Although the flow was not recorded for other hazard areas, no overbank or levee overtopping was reported. The recorded flow of the recent event and the effectiveness of the levee system in this event compared to what is predicted in the FIS, warrants resolution to this discrepancy.

Mitigation: *Update Hydrologic and Hydraulic Analyses:* The discrepancy described can most effectively be addressed by an updated hydrologic and hydraulic analysis of the system with new hydrographic surveys. This would be equivalent to a FEMA FIS.

Issue: *Structural Integrity of the Levees:* The Butte Creek levees were constructed in the 1950's and the condition of the levees at this time, with respect to structural integrity or seepage, is not known.

Mitigation: *Conduct a Geotechnical Investigation:* In view of the deficiencies noted for the Butte Creek levees, it is essential to determine the condition of the existing levees and foundations. The condition of the levees can influence the method by which certification is ultimately achieved. The estimated cost for performing a geotechnical investigation of the Butte Creek levees, including the right levee of the Little Chico Creek-Butte Creek Diversion channel is $680,000 (cost estimates are provided in Appendix F).

Issue: *Butte Creek Levee Freeboard Deficiencies:* As noted previously, Butte Creek, through Flood Hazard Area 2, contained a flow greater than a 100-year event, confirming that the floodplain from Butte Creek is largely due to the theoretical failing or overtopping of the levees on both sides of Butte Creek. Certification of the levees to afford a minimum 100-year flood protection may require widening, raising, setting back, bypass diversions, or strengthening the levees, depending upon the condition of the existing levees and foundation and relative economics. Various mitigation measures for overcoming the freeboard deficiency are addressed below.

Mitigation: *Levee Raising:* The extent of levee improvements required along Butte Creek to establish three feet of freeboard, according to the FEMA FIS, was evaluated and it was determined that a significant portion of the system requires some

improvement to meet the freeboard requirement. An estimate of the cost to reconstruct the levees for the entire Butte Creek flood protection system to obtain three feet of freeboard and levee certification is approximately $22 million (Table 4-2 below). This does not account for the cost to strengthen the existing levees or to treat seepage problems if they exist.

An evaluation of the potential damages in relation to costs for raising the levees to mitigate the freeboard deficiencies associated with Flood Hazard Area 1 and Flood Hazard Area 2 are presented below:

Flood Hazard Area 1 – Based on Butte County Tax Assessor parcel data (Butte County Tax Assessor's parcel data may not reflect true market values due to Proposition 13 regulations as described in Section 3.0 Assessing Vulnerability: Estimating Potential Losses) for structures and land within the floodplain in Flood Hazard Area 1, the total structures values are approximately $14.5 million and land values are approximately $70 million. There are no repetitive loss properties in this flood hazard area, but it includes properties that have reported over $80,000 in damages due to flooding since 1978 (FEMA NFIP Statistics, 2004 and Butte County DSR Reports, 1997). Utilizing the FEMA guidelines for estimating loss (as performed in Section 3.0 Assessing Vulnerability: Estimating Losses, for structures) due to two feet of flooding, the potential loss in this flood hazard area is approximately $9.4 million; $1.9 million in structures and approximately $7.5 million in contents.

The proposed mitigation measure for this flood hazard area is to obtain levee certification for approximately 7.6 miles, followed by the FEMA CLOMR/LOMR process to revise the effective FEMA FIRMs to change the flood hazard zone designation from Zone AE to Zone X. The total cost for reconstructing and certifying the levees in this flood hazard area is over $11 million, based upon the cost estimate provided in Table 4-2, which is 76% of the total structure value in the floodplains in this flood hazard area. This mitigation measure has a high cost in comparison to the total potential structure loss.

TABLE 4-2
BUTTE CREEK LEVEE SYSTEM
RECONSTRUCTION AND CERTIFICATION
COST ESTIMATE FOR FLOOD HAZARD AREA 1

Components of Work	Amount, $ (rounded to nearest thousand)
Project Management	320,919
Topographic Surveying and Mapping	240,000
Utilities/Infrastructure Coordination	40,000
Geotechnical Investigation/Construction Testing/Levee Certification	678,334
Environmental Compliance/Permitting	202,000.00
Preliminary Engineering/Plans and Specifications	638,000
Land Acquisition/ Flood Easements	210,000
Construction Documents, Bidding and Contract Award	10,000
Utility/Infrastructure Coordination/Relocation	210,000
Construction Cost (See Appendix F)	18,514,626
Construction Contract Administration	925,731
Operations and Maintenance Manual	10,000
Total For Entire Butte Creek Levee System (rounded to the nearest thousand)	**22,000,000**
Total Per Mile	**1,517,000**
Miles – Flood Hazard Area 1	**7.6**
TOTAL FOR FLOOD HAZARD AREA 1	**11,529,000**

Flood Hazard Area 2 – Based upon Butte County Tax Assessor parcel information, there is approximately $82.5 million in structures and $107.7 million in land value in the floodplain in Flood Hazard Area 2. There have been six flood insurance claims in this area resulting in claims of over $45,000 (FEMA NFIP Statistics, 2004 and Butte County DSR Reports, 1997), but there are no repetitive loss properties. Utilizing the FEMA guidelines for estimating loss (as performed in Section 3.0 Assessing Vulnerability: Estimating Losses, for structures) due to two feet of flooding, the potential loss in this flood hazard area is approximately $72.1 million; $29.4 million in structures and approximately $42.7 million in contents.

The proposed mitigation measure for this flood hazard area is to obtain levee certification for approximately 6.9 miles, followed by the FEMA CLOMR/LOMR process to revise the effective FEMA FIRMs to change the flood hazard zone designation from Zone AE to Zone X. Levee improvements for this flood hazard area would cost approximately $10.6 million, based upon the cost estimate in Table 4-3.

Channel Terracing: The reaches of Butte Creek with freeboard deficiencies generally correspond with reaches where setback levees exist. This configuration lends itself to maintaining the existing channel and "terracing" the overbank area between the creek channel and levee. This would remove existing agriculture but would provide the opportunity for habitat enhancement without interfering with the existing channel which has effectively supported restoration of the spring-run Chinook population. This concept was modeled with HEC-RAS and modified the cross-section in the FEMA HEC-2 model. The analysis for this model is presented in Appendix F. Based upon modeling the improvements with the FEMA FIS 100-year flow, it was determined that the water surface elevation could be lowered approximately 4,000 feet upstream of Midway Road to approximately 2,000 feet downstream. The overall impact toward mitigating the freeboard deficiency was small and limited to isolated areas. To accomplish the freeboard improvements upstream and downstream of Midway Road would require excavating approximately three million cubic yards of material. The estimated cost of implementing this measure in the vicinity of Midway Road is $66 million (cost estimates are in Appendix F), which does not account for permitting costs.

TABLE 4-3
BUTTE CREEK LEVEE SYSTEM
RECONSTRUCTION AND CERTIFICATION
COST ESTIMATE FOR FLOOD HAZARD AREA 2

Components of Work	Amount, $ (rounded to nearest thousand)
Project Management	320,919
Topographic Surveying and Mapping	240,000
Utilities/Infrastructure Coordination	40,000
Geotechnical Investigation/Construction Testing/Levee Certification	678,334
Environmental Compliance/Permitting	202,000.00
Preliminary Engineering/Plans and Specifications	638,000
Land Acquisition/ Flood Easements	210,000
Construction Documents, Bidding and Contract Award	10,000
Utility/Infrastructure Coordination/Relocation	210,000
Construction Cost (See Appendix F)	18,514,626
Construction Contract Administration	925,731
Operations and Maintenance Manual	10,000
Total For Entire Butte Creek Levee System (rounded to the nearest thousand)	**22,000,000**
Total Per Mile	**1,517,000**
Miles – Flood Hazard Area 2	**6.9**
TOTAL FOR FLOOD HAZARD AREA 2	**10,467,000**

Setback Levees: The majority of the reaches of Butte Creek with freeboard deficiencies are set back from the main channel and range from 200 to 2,000 feet. Along these reaches the levees could be set back further to achieve the freeboard requirement and overcome structural deficiencies, if determined to exist.

Unlike the Sacramento River or other low gradient meandering streams, Butte Creek, in the upper and middle reaches, is a steeper gradient stream and does not meander. The ground outside of the channel slopes away from the channel upstream of Midway Road. Downstream of Midway Road the levees are already set back 800 to 2,000 feet. This is most clearly demonstrated in the FEMA FIRMs where the floodplain shown, which accounts for levee failure on both sides of Butte Creek, depicts the floodwater flowing away from the channel on both sides. Water leaving the Butte Creek channel does not re-enter Butte Creek until it reaches the southernmost reaches, near the Butte Sink.

Given the cost to raise the existing levees to overcome the freeboard deficiencies, the additional costs of land acquisition, the removal and construction of new levees, and the environmental compliance and permitting costs, the setback levees would be more costly than raising the existing levees. The opportunity for environmental enhancement exists within the existing setback levees. Setting the levees back for environmental enhancement alone does not appear warranted under the circumstances.

Divert flow to Hamlin Slough: In an effort to reduce flow in Butte Creek to achieve the freeboard requirements, the suitability of diverting flow from Butte Creek downstream of Highway 99 to Hamlin Slough was evaluated. During a 100-year storm, determined in the FEMA FIS, a peak flow of 6,427 cfs would need to be diverted to meet the FEMA requirement for three feet of freeboard for the Butte Creek levees, according to the FEMA FIS. The topography and existing development represent constraints to developing the diversion channel parallel to Highway 99. The 100-year water surface elevation in Butte Creek downstream of Highway 99 is at El. 216. In some locations, the ground along the downstream face of Highway 99 is as high as El. 231.7, according to the FIS and topographic maps. A significant cut would be required to construct the diversion and detention pond parallel to Highway 99. Additionally, the existing capacity of Hamlin Slough is approximately 2,300 cfs and the timing of local runoff is not considered coincident with Butte Creek. To attenuate the diverted flow from Butte Creek to meet the channel capacity constraints of Hamlin Slough, a detention facility would be required. Based upon aerial photography available, configuring the required storage volume and diversion reaches does not seem feasible and would require considerable land acquisition for the detention basin and channel improvement. Any water storage in this location would face

challenges and require adherence to environmental regulations and policies (hydraulic analyses are provided in Appendix F).

Issue: *Bridge Hydraulic Performance:* Many bridges along Butte Creek are deteriorated and lack the conveyance capacity and foundation to withstand high flow events.

Mitigation: *Bridge Replacement/Modification:* Additional hydraulic analyses were conducted as part of the Butte Creek Watershed FMP to evaluate the adequacy of the bridges on Butte Creek, propose more efficient hydraulic design, identify pier protection measures, and perform preliminary cost estimates. The results of these analyses are presented in Appendix G. To build on the bridge design analyses already completed in the Butte Creek Watershed FMP, the Butte County Department of Development Services, the Butte County Department of Public Works, or the County OES could conduct a comprehensive inventory of bridges needing repair/replacement; redesign and reconstruct Butte County bridges to accommodate reasonably anticipated water depths and flow; and provide planning, design, and cost analysis and guidance in the Butte County General Plan, as an element in a Butte County Flood Mitigation Plan or a Local Hazard Mitigation Plan, and as a component of the Butte County Website for public and private access. The design, cost analysis, and guidance provided in the bridge analyses presented in Appendix G could be used as a basis of this work. The public involvement process, as part of the development of the Butte Creek Watershed FMP, indicated that the bridges in the watershed are of increasing concern.

Issue: *Channel Bank Overtopping:* The floodplain between Honey Run Road and Skyway, Flood Hazard Area 3, is the result of overbank flooding. Homes have been built in the FEMA designated 100-year floodplain. Although the houses near the right bank of Butte Creek have been built on raised pads, the residences are still at risk of flooding.

Mitigation: *Floodproofing:* Based upon a review of the parcel files at the Butte County Office of Development Services, Building Division, many of the buildings in Flood Hazard Area 3 are pre-FIRM but have obtained elevation certificates to confirm elevations one foot above the BFE (or at BFE if constructed or improved before the floodplain ordinance revision in 2000).

Based upon Butte County Tax Assessor parcel information, there are approximately $8.3 million in structures and $3.6 million in land value in the floodplain in Flood Hazard Area 3. However within this area there is one repetitive loss property, which has claimed $3,000 since 1978 (FEMA NFIP Statistics, 2004). Utilizing the FEMA guidelines for estimating loss (as

performed in Section 3.0 Assessing Vulnerability: Estimating Losses, for structures) due to two feet of flooding, the potential loss in this flood hazard area is approximately $7.2 million; $2.9 million in structures and approximately $4.3 million in contents.

Floodproofing existing structures, elevating, relocating, acquiring, and avoiding new development in the floodplain continue to be appropriate floodplain management activities for this area.

Little Chico Creek-Butte Creek Diversion Channel

Issue: *Structural Integrity of the Levees:* The levees along the Little Chico Creek-Butte Creek Diversion channel were constructed in 1957. The condition of the levee and its foundation are not known, thus the floodplain shown on the FEMA FIRM, designated as Flood Hazard Area 4 in this Plan, reflects an inadequate levee in relation to the out-of-bank flooding that can occur from Butte Creek upstream in Flood Hazard Area 3.

Mitigation: *Conduct a Geotechnical Investigation:* This mitigation measure is similar to that identified for the Butte Creek levees. The cost depends upon the findings of the initial geotechnical investigations. The proposed mitigation for this Flood Hazard Area is to conduct a preliminary geotechnical investigation of the levee for close to one mile of one bank. The cost for the geotechnical investigation is estimated at $50,000 as a stand-alone effort. If included as part of the geotechnical investigation for the Butte Creek levees, the cost would be less. The cost to raise and strengthen the levee may be in the order of $ 1 million. This cost, in relation to the $30.1 million potential loss estimated for Flood Hazard Area 4, is very reasonable.

Issue: *Levee Freeboard Deficiencies:* The floodplain resulting from the Little Chico Creek Diversion channel is from overbank flow or encroachment into the levee or bank freeboard.

Mitigation: *Raising and Certifying the Levees:* A prerequisite to pursuing this mitigation measure is the completion of an updated hydrologic and hydraulic analysis identified for Butte Creek, which includes the entire system (Butte Creek, Little Chico Creek-Butte Creek Diversion channel, and Little Chico Creek). Pending the results of this analysis and the above-mentioned structural integrity analysis of the levees, constructing or raising the existing levees could be considered.

With respect to the potential damages that could be mitigated, an evaluation was made in relation to Flood Hazard Area 4 and Flood Hazard Area 5, as summarized below:

Flood Hazard Area 4 – Based upon Butte County Tax Assessor parcel data, the total structure value is approximately $34.5 million and the total land value is approximately $17 million within the floodplain, in Flood Hazard Area 4. There are two repetitive loss properties and two additional properties that have made flood insurance claims in this flood hazard area, of over $100,000 combined, since 1978 (FEMA NFIP Statistics, 2004). Utilizing the FEMA guidelines for estimating loss (as performed in Section 3.0 Assessing Vulnerability: Estimating Losses, for structures) due to two feet of flooding, the potential loss in this flood hazard area is approximately $30.1 million; $12.3 million in structures and approximately $17.8 million in contents.

The total cost for reconstruction and certification of the levees in this flood hazard area, approximately one mile of one bank, is approximately $715,000.

Flood Hazard Area 5 – Based upon Butte County Tax Assessor parcel data, the total structure value is approximately $228,000 and the total land value is approximately $4 million within the floodplain, in Flood Hazard Area 5; however, development is currently underway in the area adjacent to the floodplain (to the north) with plans for additional development in the floodplain. Should this take place, the structure estimates will be significantly higher than the current $228,000. There are no repetitive loss properties in this flood hazard area or FEMA-reported flood insurance claims. Utilizing the FEMA guidelines for estimating loss (as performed in Section 3.0 Assessing Vulnerability: Estimating Losses, for structures) due to two feet of flooding, the potential loss in this flood hazard area is approximately $200,000; $82,000 in structures and approximately $118,000 in contents.

The total cost for construction and certification of a levee in Flood Hazard Area 5 is approximately $208,000 (Table 4-4).

TABLE 4-4
BUTTE CREEK LEVEE SYSTEM
RECONSTRUCTION AND CERTIFICATION
COST ESTIMATE FOR FLOOD HAZARD AREA 5

Components of Work	Amount, $ (rounded to nearest thousand)
Project Management	321,000
Topographic Surveying And Mapping	240,000
Hydraulic and Hydrologic Modeling	15,000
Utilities/Infrastructure Coordination	40,000
Geotechnical Investigation/Construction Testing/Levee Certification	678,000
Environmental Compliance/Permitting	200,000
Preliminary Engineering/Plans And Specifications	638,000
Land Acquisition/ Flood Easements	210,000
Construction Documents, Bidding And Contract Award	10,000
Utility/Infrastructure Coordination/Relocation	210,000
Construction (see Appendix F)	18,788,000
Construction Contract Administration	926,000
Operations And Maintenance Manual	10,000
Total For Entire Butte Creek Levee System	**22,286,000**
Total Per Mile	**1,537,000**
Total Per Mile Per Bank	**1,537,000/2=769,000**
Miles – Flood Hazard Area 5	**0.27**
TOTAL FOR FLOOD HAZARD AREA 5	**208,000**

Little Chico Creek

Issue: *Inadequate Channel Capacity:* The hydraulic capacity of Little Chico Creek is substantially less than the estimated 100-year flow. With urban encroachment, structural measures along Little Chico Creek are problematic. Consideration could be given to diverting increased flow to California Park, Teichert Pond, or Butte Creek.

Mitigation: *Increasing System Storage at California Park:* Previous existing conditions analyses defining drainage affecting the California Park Dam, the downstream area, and potential alternatives for reconfiguration of California Park Dam to maximize flood control benefits downstream along Little Chico Creek were evaluated. This alternative would only be implemented with the consent/agreement of the private owners overseeing the lake and dam. Currently the lake is kept full year-round for recreational features and is supplemented by groundwater pumping to keep it full. The only impact the lake has on flooding is the volume above the spillway crest that slightly dampens downstream peak flow. According to the design engineer and the California Division of Safety of Dams (DSOD), there is minimal technical feasibility in retrofitting the California Park Lakes for improved flood control downstream in Dead Horse Slough and Little Chico Creek. If the California Park Lakes are completely drained and reconfigured to maintain the ponds at a storage capacity available for the peak portion of the 100-year storm event, as defined in the FEMA FIS, it would not be enough storage to reduce the flow in Little Chico Creek within existing channel capacities. According to the analysis, the maximum 100-year peak flow reduction would be approximately 700 cfs (hydraulic analyses are provided in Appendix F).

Increasing System Storage at Teichert Pond: An existing conditions analysis evaluated the current storage volume within the Teichert Pond area and the potential alternatives for reconfiguring the Teichert Pond to maximize downstream flood control benefits along Little Chico Creek. Based upon site evaluations, the existing storage within the Teichert Pond could reduce the maximum peak flow in Little Chico Creek by approximately 300 to 500 cfs. To achieve this reduction, a flood control levee between Little Chico Creek and the pond area would need to be constructed with a spillway weir to "chop off" the peak flow in Little Chico Creek and temporarily store it. This construction would change the character of the pond visibility from the park on the north side of the creek and from the south vantage point as well. It was assumed that the Teichert Pond could be reconfigured in reasonable ways to achieve maximum flood control benefit, including partial draining of the pond to preserve flood control storage capacity as well as constructing the inlet/outlet structures to make it an effective flood control operation. Any implemented alternative would require the

consent/agreement of the community and would have to undergo rigorous environmental approvals. Currently, the only impact the pond has on flooding is a slight decline in peak flow as the flooding spreads into the pond. The definition of the existing available storage was approximated from the aerial photograph and topography from the FIS study. This information was used to approximate the volume/elevation relationship for this area without additional volume excavation. The surface area of the pond was estimated at approximately 40 acres. Based upon discussions with Butte County, the Teichert Pond would only provide minimal storage and is considered an ecological zone that is highly regarded in the community. Considering the level of modification it would require to separate the Teichert Pond area from Little Chico Creek to be able to control the pond for flood control access, it was determined a remotely feasible alternative at best, to gain approval. A control levee structure would have to be constructed on the south side of Little Chico Creek with a spilling weir structure at the upstream (easterly) end of the pond, as well as an outlet structure near the Highway 99 crossing. The Teichert Pond, when utilized as a stand-alone flood control feature, cannot effectively be reconfigured to utilize existing storage to reduce the peak flow in Little Chico Creek to within channel capacity limitations unless perimeter levees and flood control inlet/outlet structures are constructed. This hydrologic and hydraulic analysis showed that the perimeter levee and inlet/outlet structures would result in a reduction of only 300 cfs to 500 cfs, in the Little Chico Creek flow during the 100-year, according to the FEMA FIS model (hydraulic analyses are included in Appendix F).

Increasing Diversion to Butte Creek: Improvements were evaluated to contain the 100-year flow, according to the FEMA FIS, in the Little Chico Creek channel through the City limits. The results of the hydrologic and hydraulic modeling indicate that once vegetation clearing has been implemented, the diversion structure at the Little Chico-Butte diversion would have to be modified so all but 100 cfs is diverted out of Little Chico Creek, to maintain the 100-year floodplain as delineated on the FEMA FIRMs. Allowing more than 100 cfs to pass downstream of the Little Chico Creek-Butte Creek Diversion would exceed the channel capacity in a 100-year event as determined by the current FEMA FIS, due to inflow from Dead Horse Slough and local drainage, resulting in out-of-bank flooding. Reducing the vegetation levels within the Little Chico Creek channel to a reasonable level would still result in a larger floodplain for Little Chico Creek than is provided on the current FEMA FIRMs. If vegetation clearing is conducted in conjunction with reducing the flow to Little Chico Creek at the Little Chico Creek-Butte Creek Diversion to a maximum of 100 cfs, so that the Little Chico Creek could accommodate the remaining flow from Dead Horse Slough (1,775 cfs) and local drainage (325 cfs), the flow of Little Chico Creek through the City of Chico urban area is reduced to the design flow of 2,200 cfs. This would

provide channel capacity to accommodate flow from a 100-year event as determined by FEMA and reduce the floodplain to within the channel boundary (hydraulic analyses are provided in Appendix F).

Adopting this mitigation measure to include the diversion of all but 100 cfs of the Little Chico Creek flow would increase the 100-year flow in the Little Chico Creek-Butte Creek Diversion channel and eventually in Butte Creek downstream of the confluence of the Little Chico Creek-Butte Creek Diversion channel and Butte Creek. To accommodate the increased flow from the Little Chico Creek-Butte Creek Diversion into Butte Creek, according to the FEMA FIS, these levees would have to be raised as high as three feet in some locations to overcome the existing deficiencies to accommodate he 100-year flow. Increasing the diverted flow, from 3,100 cfs to 5,464 cfs, the levees on Butte Creek between Highway 99 and Midway would require raising the levees an additional 0.4 feet to accommodate an increase in the 100-year flow from 29,952 cfs to 31,718 cfs. The levees between Midway and the Butte County line would have to be raised an additional 0.3 feet. Due to the potential environmental consequences of limiting flow to 100 cfs from the Little Chico Creek-Butte Creek Diversion channel to Dead Horse Slough, as well as the potential additional costs of raising the levees in a large portion of the Butte Creek levee system, this alternative is not feasible at this time. This measure has the potential for mitigating the flood hazards associated with Flood Hazard Area 6; however, it requires improvements to the entire project levees that were constructed in the 1950's.

Based upon Butte County Tax Assessor parcel data, the total structure value in the Little Chico Creek FEMA SFHA, previously designated as Flood Hazard Area 6, is approximately $116 million. Although there are no FEMA-reported repetitive loss properties in this flood hazard area and one property has claimed approximately $2,000 in flood insurance since 1978 (FEMA NFIP Statistics, 2004), the urban area is particularly vulnerable to bank overtopping in Little Chico Creek. Utilizing the FEMA guidelines for estimating loss (as performed in Section 3.0 Assessing Vulnerability: Estimating Losses, for structures) due to two feet of flooding, the potential loss in this flood hazard area is approximately $72.2 million; $12.2 million in structures and approximately $60 million in contents.

The potential loss in relation to the $22 million estimate to improve the existing flood control project for the Butte Creek system indicates an economically favorable project.

Channel Maintenance Program: The current channel capacity of Little Chico Creek is estimated at 1,800 cfs with the current vegetation levels, compared to 2,350 cfs in the FEMA FIS. Reducing the density of the vegetation would result

in an increase in channel conveyance capacity. Channel maintenance responsibilities for the Butte Creek levee system and the Little Chico Creek channels are distributed between DWR's Maintenance Area No. 5, the City of Chico, and Butte County. A vegetation clearing and channel maintenance program would increase the channel capacity of Little Chico Creek, facilitate interagency coordination, and initiate active participation from the public. The maintenance program could be developed with continued involvement from other local agencies, organizations, watershed groups, and the public.

The estimated cost for clearing vegetation is approximately $38,000 per stream mile. The estimated miles of the Little Chico Creek channel through Flood Hazard Area 6 is approximately four miles, resulting in an estimated $152,000 for the initial clearing. Maintenance would be required on an on-going basis following the initial clearing.

Butte Creek Watershed

Issue: *Local Drainage Flooding:* Older storm water systems, typically designed to convey a 10-year storm or less, become inadequate as additional watershed development and associated runoff increases. Storm water systems, ditches, and other waterways can be blocked by debris, resulting in ponding storm water prior to the storm water system clearing. Many roads not in the FEMA-designated floodplain have undergone damage in the past due to flooding.

Mitigation: *Butte County Drainage Criteria and City of Chico Storm Drainage Master Plan Update:* Flooding due to local drainage for existing and future development can be reduced or eliminated by revising the Butte County drainage criteria and updating the City of Chico's Storm Drainage Master Plan. Revisions would require additional study and modeling to reconfigure the existing drainage systems. A provision could be incorporated into the design to accommodate the routing of flow greater than the storm drain capacity overland without causing damage. This mitigation measure could accommodate the requirements for drainage for existing and future conditions. The cost to update the storm drainage criteria and to prepare the storm drainage master plans for communities within the valley portion of the Butte Creek watershed could range from $100,000 to $600,000 depending upon the communities involved and the extent of topographic mapping and infrastructure plans available.

Issue: *Emergency Preparedness:* Butte County currently lacks a comprehensive emergency response and evacuation plan, to protect people, property, and livestock, in a high flow event, levee breach, or dam failure scenario.

Mitigation: *Emergency Preparedness and Evacuation Plan:* Ample advance warning to Butte County and city agencies provides communities time for evacuation and rescue. An evacuation plan should be adopted, coordinated, and regularly updated by the County OES as land use, data, and technology change. Elements would include flood threat recognition, flood response, and post-disaster recovery and mitigation. An Emergency Preparedness and Evacuation Plan would facilitate coordination between all levels of government and the public and would ensure the safety of the residents in Butte County in the event of a flood.

Issue: *Land Use Planning:* According to the relatively minimal reported damage and loss of life attributed to flooding over the past 25 years in Butte County, the current land use management practices have proven effective. However, increasing development and population growth will require disciplined land use management practices to ensure that development does not occur behind the levee system, in areas prone to repeated flooding, or exacerbate the affects of flooding in other areas.

Mitigation: *General Plan Update:* The following elements could be incorporated into the Butte County General Plan and the area plans of incorporated cities:

- Restrict or limit development protected by levees.
- Determine future drainage and flood control needs by performing hydraulic and hydrologic modeling that reflects future development and projects that may have an impact upon the floodplains. This could be done similar to the City of Redding's current mapping program, which incorporates future conditions modeling.
- Introduce floodproofing measures into the Butte County General Plan or the area plans such as barriers, dry floodproofing, wet floodproofing, and sewer back-up protection.
- Implement building standards that exceed the FEMA NFIP standards and current Butte County standards for all improved, repaired, or new buildings.

Exceeding the NFIP requirements not only assists Butte County residents in obtaining reduced flood insurance premiums under FEMA's CRS program, it also ensures additional protection. Butte County has not incurred substantial monetary damage due to flooding in the past, due to the fact that development is minimal; however, to ensure that additional damages do not occur in the future in the event of a flood, these changes to the General Plan would be relatively minimal and would assist in incorporating flood hazards in accounting for land use planning.

Summary

Various measures have been evaluated to mitigate or reduce the risk associated with flooding in the Butte Creek watershed. Based upon the risk assessment and application of FEMA's methodology for estimating potential losses in floodplains, mitigating the flood hazards for Flood Hazard Area 2, Flood Hazard Area 4, Flood Hazard Area 5, and Flood Hazard Area 6 appears economically feasible. On the other hand, actual damage encountered are low even in areas not protected by levees. Accordingly, preventing the recurrence of actual damages does not justify the cost of the hazard mitigation projects. The feasibility of implementing flood hazard mitigation measures can also be viewed from the standpoint of eliminating the cost of flood insurance premiums. Although the data did not facilitate breaking the premiums paid into the six flood hazard areas, assuming that 100 percent of the premiums reported in Table 3-5 for the City of Chico of $226,000 and the Butte County unincorporated areas of $716,000 are allocated to rehabilitation of the Butte Creek Flood Control Project, the benefits in terms of premium reductions would amount to approximately $6 million using a discount rate of six percent. Based upon accrued damages, or reductions in flood insurance premiums, it would not be feasible to implement the flood hazard mitigation measures if the existing levees required reconstruction. Nevertheless, as a result of the evaluation presented in this section, several measures are determined to be worthy and appropriate for implementation at this time. Information that would be obtained from implementing certain measures would facilitate an informed review or assessment of the various flood hazard mitigation projects for enhancing flood protection within the watershed. Noted in Table 4-5 are the respective flood hazard issues and associated mitigation measures that are recommended for inclusion into an Action Program of the Butte Creek Watershed FMP.

TABLE 4-5
FLOOD HAZARD AND MITIGATION SUMMARY

Resource	Issue	Recommended Mitigation Measure
Butte Creek	FIS Discrepancy	Updated Hydrologic and Hydraulic Analyses
	Structural Integrity of the Levees	Geotechnical Investigation
	Levees Freeboard Deficiencies	No Mitigation Recommended at This Time
	Bridge Hydraulic Performance	Bridge Replacement/Modification
	Channel Bank Overtopping	No Mitigation Recommended at This Time
Little Chico Creek Diversion	Structural Integrity of the Levees	Geotechnical Investigation
	Levee Freeboard Deficiencies	No Mitigation Recommended at This Time
Little Chico Creek	Inadequate Channel Capacity	Channel Maintenance Program
Butte Creek Watershed	Local Drainage Flooding	Update Storm Drainage Master Plans
	Emergency Preparedness	Emergency Preparedness and Evacuation Plan
	Development in Floodplains Protected by Levees	Land Use Planning

SECTION 5.0 FEDERAL, STATE, AND LOCAL REQUIREMENTS

Environmental compliance and historic preservation are essential components of the mitigation project planning and approval process. These requirements apply to projects that affect streams and rivers, land development, land use, public works, or other construction and mitigation programs. The following are some of the federal, state, and local laws and executive orders that might apply to the proposed mitigation measures in this Butte Creek Watershed FMP.

Federal:

- Anadromous Fish Conservation Act of 1965
- Wild and Scenic Rivers Act
- Clean Water Act (Section 401 and 404)
- Endangered Species Act
- Executive Order 1190 Wetland Protection
- Executive Order 11988 Floodplain Management
- Executive Order 12898 Environmental Justice
- Farmland Protection Act
- Federal Water Pollution Control Act of 1972
- National Environmental Policy Act (NEPA)
- National Flood Insurance Act of 1968
- National Historic Preservation Act
- Rivers and Harbors Act, Section 10 from the USACOE
- River and Harbors Act of 1899

State:

- California Environmental Quality Act (CEQA) of 1970
- California Riparian Habitat Conservation Act of 1992
- California Water Code
- Central Valley Project Improvement Act of 1992
- Clean Water Act, Section 401 Water Quality Certification or Waiver from the California
- Decree No. 19817, Superior Court of the State of California (1942 Adjudicated Rights)
- Efficient Water Management Practices Act of 1990
- Fish and Game Code 1606 – Plans for Timber Harvesting
- Fish and Game Code 5650 – Water Pollution
- Groundwater Management Act of 1992
- Lake/Streambed Alteration Agreement (Fish and Game Code Sections 1601 and 1603)
- Natural Community Conservation Act of 1991

- Regional Water Quality Control Boards
- State Lands Commission Public Trust Doctrine
- The State Reclamation Board

Local:

- Butte County Municipal Code, Chapter 9
- Butte County Municipal Code, Chapter 26, Article IV

Potential Permit Requirements:

- Air quality permits from the Air Resources Control Board
- Encroachment permits from CALTRANS
- Encroachment permits from The State Reclamation Board
- Leases and permits from the California Lands Commission
- Clean Water Act 404 permit from the USACOE

Additional information on relevant federal and state laws can be found on the websites listed in Table 5-1.

TABLE 5-1
FEDERAL AND STATE AGENCY WEBSITES

Agency	Website
Federal Emergency Management Agency	www.fema.gov
Environmental Protection Agency	www.epa.gov
United States Fire Administration	www.usfa.fema.gov
National Fire Protection Association	www.nfpa.org
U.S. Army Corps of Engineers	www.usace.army.mil
U.S. Geological Survey	www.usgs.gov
U.S. Department of Agriculture Natural Resources Conservation Service	www.nrcs.usda.gov
ESRI/FEMA Hazards Awareness Site	www.esri.com/hazards
California Department of Fish and Game	www.dfg.ca.gov
California Law	www.leginfo.ca.gov
California Governor's Office of Planning and Research	www.opr.ca.gov
California Governor's Office of Emergency Services	www.oes.ca.gov
California Department of Water Resources	www.dwr.ca.gov
California Department of Forestry-Fire and Resource Assessment Program	http://frap.cdf.ca.gov/

SECTION 6.0 ACTION PROGRAM

Summarized in Section 4.0 are the mitigation measures recommended for inclusion into an Action Program to advance floodplain management within the Butte Creek watershed. The recommended mitigation measures are identified as Action Items and are presented as stand-alone projects to facilitate implementation (Table 6-1). In addition, based upon information gleaned during the course of preparing this Butte Creek Watershed FMP, additional items are identified for inclusion in the Action Program. These are included as Action Items H and I, which provide for an on-going effort to continue public education and awareness of flood-related issues and to provide for implementing, monitoring, and evaluating the Butte Creek Watershed FMP. Each Action Item is described in the following section in terms of scope of work, budget, and schedule.

TABLE 6-1
BUTTE CREEK WATERSHED FMP
RECOMMENDED ACTION ITEMS

Action Item A – Updated Hydraulic and Hydrologic Analyses
Action Item B – Butte Creek Levee System Geotechnical Study
Action Item C – Channel Maintenance Program for Little Chico Creek
Action Item D – Butte County Drainage Criteria and City of Chico Storm Drainage Master Plan Update
Action Item E – Bridge Replacement/Modification
Action Item F – Emergency Preparedness
Action Item G – Land Use Planning
Action Item H – Public Education and Awareness
Action Item I – Establish an Implementation Committee

Action Item A. Updated Hydrologic and Hydraulic Analyses

Purpose:

According to the Federal Emergency Management Agency's (FEMA) Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs), the water surface elevations in a 100-year and 500-year event would exceed the channel banks in many locations in Butte Creek and Little Chico Creek. However, the recent 1997 event, which exceeded a 100-year event as determined by FEMA, did not overtop the Butte Creek or Little Chico Creek channel banks. With the benefit of the 1997 flood event, which exceeded the 100-year peak flow for the FEMA Special Flood Hazard Areas (SFHAs), and did not overtop the levees as indicated it should in the FIS, it appears that the channel configuration is different and has greater capacity. This discrepancy, in addition to the fact that two high flow events (1995 and 1997) occurred since the FIS was preformed in 1992, warrants updating both the hydrologic and hydraulic analyses using updated hydrographic surveys.

Project Description:

Perform hydrographic surveys on the Butte Creek and Little Chico Creek system and update the FEMA FIS.

Scope of Work:

Guidance for a general scope of work can be derived from Chapter 26 of the 2002 U.S. Army Corps of Engineers, Engineering and Design - Hydrographic Surveying Manual (USACOE, 2002), or from FEMA's June 2003 *Guidelines and Specifications for Flood Hazard Mapping Partners*.

Responsible Agency/Organization:

The Butte Creek Watershed Conservancy could coordinate with the Butte County Department of Public Works, Butte County Department of Development Services, and possibly FEMA to determine the study area limits, survey intervals, and other details necessary for project implementation.

Schedule:

This work can be performed as early as funding permits, to reconcile the discrepancies and to provide the community with an updated assessment of the flood hazard associated with the Butte Creek and Little Chico Creek system.

Cost Estimate/Resource:

This cost for the surveys and hydrologic and hydraulic analyses are estimated to be approximately $600,000. The costs for this work could be funded through FEMA's National Flood Insurance Program (NFIP) or a combination of local funds for cost-sharing.

Action Item B. Butte Creek Levee System Geotechnical Study

Purpose:

The floodplain of Butte Creek, as shown on the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps (FIRMs), is largely due to an analysis with the levees failed on both sides of Butte Creek, consistent with FEMA mapping guidelines. This is due to the fact that the levees are deficient hydraulically and assumed to be structurally deficient as well. To reduce the flow in Little Chico Creek through the City of Chico, additional flow would have to be diverted to Butte Creek, which would increase the flow in Butte Creek, raising the water surface elevation.

Project Description:

Conduct a geotechnical study on the Little Chico Creek and Butte Creek levee system to determine the extent to which reconstruction or modification would be made to obtain certification for the levees.

Scope of Work:

Guidance for a general scope of work can be derived from the 2001 U.S. Army Corps of Engineer's (USACOE), Engineering and Design – Geotechnical Investigations Manual (USACOE, 2001).

Responsible Agency/Organization:

The Butte Creek Watershed Conservancy and Butte County Department of Public Works.

Schedule:

This work could be performed as early as funding permits to provide a basis for reevaluating the costs associated with ensuring the structural integrity of the levees system and removing the freeboard deficiencies to achieve levee certification.

Cost Estimate/Resource:

The cost for conducting a geotechnical study for the entire levee system was estimated at approximately $700,000.

Action Item C. Channel Maintenance Program for Little Chico Creek

Purpose:

Heavy vegetation in the Little Chico Creek channel in the reach that flows through the City of Chico urban area has reduced channel capacity, added flow from Dead Horse Slough, and runoff from the City of Chico urban area, which increases the probability of flooding during a storm event. According to the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS), the 100-year flow in Little Chico Creek at Highway 99 is 3,700 cfs. A hydraulic analysis for the Little Chico Creek channel showed that its existing capacity is as low as 1,800 cfs due to heavy vegetation.

Project Description:

Vegetation density has increased significantly since the FEMA FIRM was produced for the Little Chico Creek floodplain. The current channel capacity is estimated at 1,800 cfs, with the current vegetation levels, compared to 2,350 cfs in the FEMA FIS. Reducing the density of the vegetation to a level would result in an increase in flow to approximately 2,900 cfs. Channel and maintenance responsibilities for the Butte Creek levee system and the Little Chico Creek channels are distributed between the California Department of Water Resources' (DWR) Maintenance Area No. 5, the City of Chico, and Butte County. A vegetation clearing and channel maintenance program should be implemented to increase the channel capacity of Little Chico Creek. A state or local agency, such as DWR, NRCS, or a county or city department should sponsor the establishment and implementation of an operation and maintenance program for Little Chico Creek, which would include vegetation clearing. The maintenance program should be developed with continued involvement from other local agencies, organizations, watershed groups, and public input.

Scope of Work:

The Little Chico Creek Maintenance Program should be developed with continued involvement from other local agencies, organizations, watershed groups, and public input and designed to provide long-term guidance to the City of Chico and the DWR to implement routine cost-effective and environmentally sensitive creek maintenance projects to meet the flood protection goals of Little Chico Creek. The main goals of preparing a Little Chico Creek Maintenance Program would be to maintain Little Chico Creek so that it meets the original flood protection design, coordinates the various aspects of routine creek maintenance to better achieve this goal, and assists in obtaining multi-year permits. The objectives of the Little Chico Creek Maintenance Program (derived from the Santa Clara Valley Water District Stream Maintenance Program, 2004) could include:

1. Standardizing practices and protocols for routine sediment removal, vegetation management, and bank protection in and around the creek and related facilities within the City of Chico.
2. Identifying cost-effective routine creek maintenance practices and protocols.
3. Ensuring routine creek maintenance activities that reflect the City of Chico and state policies of environmental protection and stewardship.
4. Avoiding or minimizing adverse environmental effects and encouraging preservation and restoration to the extent practical.
5. Establishing effective and economical compensatory mitigation for environmental impacts from routine creek maintenance activities.
6. Establishing practices and protocols that optimize operational flexibility and allow the integration of lessons learned and improvements in Best Management Practices.

Responsible Agency/Organization:

The City of Chico and DWR.

Schedule:

The initial level of effort to clear the Little Chico Creek channel that runs through the City of Chico would require approximately three months. The on-going maintenance and Little Chico Creek Maintenance Program schedule would be determined once a Little Chico Creek Maintenance Program is established.

Cost Estimate/Resource:

The cost for developing the maintenance plan is variable, and depends upon the amount of agency and public participation. This cost could be shared between the City of Chico and DWR. The estimated cost for initial vegetation clearing is approximately $38,000 per stream mile. The estimated miles for the reach that runs through the City of Chico is approximately four miles so, at minimum, the cost could be approximately $152,000. Costs could be reduced by enlisting the support of the California Conservation Corps, who could not only conduct the initial clearing, but maintain vegetation control once standards have been established.

Action Item D. Butte County Drainage Criteria and City of Chico Storm Drainage Master Plan Update

Purpose:

Several issues cause drainage problems that lead to flooding in the watershed. Ditches and storm water systems are needed to convey storm water away from developed areas; however in some areas the topography prevents surface water from draining quickly to a ditch, stream, or storm drain. Typically, storm water systems are designed to handle storm runoff for events smaller than the 100-year event, such as a 10-year event. Older storm water systems, typically designed to convey the 10-year storm or less, may become inadequate as additional watershed development and associated runoff increases. Storm water systems, ditches, and other waterways can be blocked by debris, resulting in ponding storm water prior to the storm water system clearing. Many roads not in the Federal Emergency Management Agency (FEMA) designated floodplain have undergone damage in the past due to flooding.

Project Description:

Flooding due to local drainage from new development could be reduced or eliminated by revising and implementing the Butte County drainage criteria and updating the City of Chico's Storm Drainage Master Plan. Revisions would require additional study and modeling to reconfigure the existing drainage systems. A provision should be incorporated into the design to accommodate the routing of overland flow, i.e., flow greater than the underground storm drain system can handle.

Scope of Work:

The Butte County drainage criteria could be studied and revised by the Butte County Department of Public Works, Land Development Division, during the development or before the Butte County Storm Water Management Program report, which would be submitted to the California Regional Water Quality Control Board, Central Valley Region every five years. Following the Butte County drainage criteria update, the City of Chico Storm Drainage Master Plan could be updated by the City of Chico Department of Public Works, during the development of the City of Chico Storm Water Management Program report, which would be submitted to the California Regional Water Quality Control Board, Central Valley Region annually.

Responsible Agency/Organization:

The Butte County Department of Public Works would be responsible for coordinating, scheduling, and performing the required study and modeling to reconfigure and update the drainage criteria and update the Butte County drainage criteria. The City of Chico Planning Department would be responsible for updating the City of Chico Storm Drainage Master Plan.

Schedule:

The required study and design for the Butte County drainage criteria update could be scheduled before the next submittal of the Butte County Storm Water Management Program, which is approximately September 2008. This project is long-term.

The required study and design for the City of Chico Storm Drainage Master Plan could be scheduled before the next submittal of the City of Chico Storm Water Management Program, which is approximately July 2005 or the following year, July 2006. This project is short-term.

Cost Estimate/Resources:

The cost for the study and modeling required to update the drainage design criteria and drainage master plans would vary depending upon the extent of the study, the availability of topographic mapping and infrastructure plans, and modeling required, but could be in the range of $200,000 to $500,000.

Action Item E. Bridge Replacement/Modification

Purpose:

During high flow events, bridges over waterways and bridge foundations are particularly vulnerable to damage and blockage due to high velocity water and debris. Bridge replacement should provide adequate clearance, proper design, and debris walls, where needed, to reduce damage caused by tree logs and excessive debris accumulation. Many bridges in the Butte Creek watershed are deteriorated and lack the conveyance capacity to convey high flow and are prone to obstruct emergency response and evacuation routes. The substructure of many bridges in the watershed is such that it encourages blockage.

Project Description:

Additional hydraulic analyses were conducted as part of the Butte Creek Watershed FMP to evaluate the adequacy of the bridges on Butte Creek, propose more efficient hydraulic design, identify pier protection measures, and perform preliminary cost estimates. The results of these analyses are presented in Appendix G. To build on the bridge design analyses already completed in the Butte Creek Watershed Floodplain Management Plan (Butte Creek Watershed FMP), the Butte County Department of Development Services, the Butte County Department of Public Works, or the Butte County Office of Emergency Services (County OES) should conduct a comprehensive inventory of bridges needing repair/replacement; redesign and reconstruct Butte County bridges to accommodate reasonably anticipated water depths and flow; and provide planning, design, and cost analysis and guidance in the Butte County General Plan, as an element in a Butte County Flood Mitigation Plan or a Local Hazard Mitigation Plan, and/or on the Butte County Website for public and private access. The design, cost analysis, and guidance provided in the bridge analyses presented in Appendix G could be used as a basis of this work.

Responsible Agency/Organization:

The Butte County Department of Development Services or the Butte County Department of Public Works would be responsible for coordinating, scheduling, and performing bridge design and cost analysis.

Scope of Work:

The Butte County Department of Development Services or the Butte County Department of Public Works should conduct an inventory of bridges needing repair/replacement; redesign and reconstruct Butte County bridges to accommodate reasonably anticipated water depths and flow; and provide planning, design, and cost analysis and guidance in the Butte County General Plan, as an element in a Butte County Floodplain Management Plan or a Local Hazard Mitigation Plan, and/or on the Butte County Website for public and private access.

Schedule:

The schedule for conducting an inventory of bridges in Butte County, determining design needs, updating the Butte County General Plan, developing a Butte County Floodplain Management Plan or Local Hazard Mitigation Plan, and/or updating the Butte County Website would be contingent upon internal factors such as staff and funding resources. This project could be implemented over time.

Cost Estimate/Resources:

As provided in the bridge analyses in Appendix G, according to the January 2002 Caltrans Comparative Bridge Costs, the cost range for bridge replacement using a CIP/PS box bridge is approximately \$80-150/ft^2 and \$150-\$215/ft^2 for a steel I-Girder bridge for the Southern Pacific Railroad (SPRR). The cost for removing a box girder structure is approximately \$15-\$20/ft^2. The above cost/ft^2 estimates include costs for mobilization at 10 percent and contingency at 25 percent. For a more conservative estimate and to account for adjustment to 2005 dollars, this cost estimate is based upon a total of \$170/ft^2 for the Nelson, Midway, and Durham-Dayton bridges (\$150/ft^2 for construction and \$20/ft^2 for removing the existing structure) and \$235/ft^2 for the SPRR bridge replacement (\$215/ft^2 for construction and \$20/ft^2 for removing the existing structure). The cost for replacing the SPRR Bridge does not account for realigning the Kinder-Morgan 8-inch-diameter petroleum pipeline. Additionally, debris control and bridge pier protection measures could be adopted for the existing or proposed bridges. As previously mentioned, examples of these products are the MOAB and the Bridgeshark from Debris Free, Inc. The cost of these products and the installation were included in the cost estimates to show how the cost of such pier protection and debris control methods factor into the overall cost estimate. The resources to rebuild or modify each bridge could be shared through Caltrans and Butte County, or as a project funded under a hazard mitigation grant, as submitted by the County OES.

Action Item F. Emergency Preparedness

Purpose:

Butte County currently lacks a comprehensive emergency response and evacuation plan, which is important to mitigate loss of life and property damage during periods of high flow or unexpected levee or dam failures. This project would adopt, implement, and maintain an Emergency Preparedness and Evacuation Plan (EPEP) that contributes to the protection of life and property, including livestock, during a flood hazard event.

Project Description:

Ample advance warning to Butte County and city agencies provides communities time for evacuation and rescue. An evacuation plan was developed using the results of two hypothetical levee failure scenarios and dam failure analyses at Paradise and Magalia reservoirs. The evacuation plan should be adopted, coordinated, and regularly updated by the Butte County Office of Emergency Services (County OES) as land use, data, and technology change. The EPEP involves installing a Flood Automated Local Evaluation in Real Time (ALERT) Network and coordinating flood response activities with critical facilities.

Responsible Agency/Organization:

The County OES would be responsible for coordinating, scheduling, and performing work to adopt and maintain the EPEP. The Butte Creek Watershed Conservancy (BCWC) could work as a partner to ensure that data remains current and modifications to the EPEP are made to accommodate changing conditions.

Scope of Work:

An extensive levee system protects a large portion of Butte Creek and part of the Little Chico Creek-Butte Creek Diversion channel from flooding. Levee systems could be breached or overtopped due to high flow or ineffective levee design and maintenance. The evacuation plan was developed using the results of two hypothetical levee failure scenarios and the failure of Paradise and Magalia reservoirs. For the purpose of understanding the evacuation process, it is important to distinguish between catastrophic and non-catastrophic flooding. Catastrophic flooding occurs with very little or no warning, as in the case of an unexpected levee break. Non-catastrophic flooding provides advance warning, such as during storm events when floodwater rises over hours or days. Evacuation routes and warning systems provided in this Action Plan address non-catastrophic flooding.

An effective evacuation plan is a tool for preventing the loss of life in a flood event. For determining responsibilities in a flood emergency, a distinction of time is made between a rescue

effort and an evacuation effort. An area where people would be endangered within a couple of hours from the time an event occurs would be targeted for a rescue effort. An area where people would be endangered more than two hours after a flood event would be targeted for an evacuation effort. Elements of this evacuation plan involve:

- Flood Threat Recognition
- Flood Response
- Post-Disaster Recovery and Mitigation

F.1 Flood Threat Recognition

Planning, early warning, and decision-making are important components of an effective evacuation plan. Ample advance warning to Butte County and city agencies provides communities time for evacuation and rescue. A flood forecasting/monitoring system (ALERT System) would give occupants of the flood hazard areas along Butte Creek and its tributaries advance warning of pending floods. A similar system is used in Sacramento County and Santa Barbara County.

The Flood ALERT Network could be established, monitored, maintained, and operated by the County OES and the Butte County Department of Public Works. The Flood ALERT Network would be a network of remote sensors that record and remotely transmit data such as rainfall, stream flow, reservoir elevations, dam gate openings, wind speed, and direction readings. It is possible to use the climate and stream gaging stations currently in use in Butte County (station locations are numbered and provided on Map F-1 with numbers that correspond to Table F-1).

Some of the stream flow and precipitation stations that are presently operating and would be appropriate for a Flood ALERT Network are presented in Table F-2 and Table F-3 (Map F-1 shows the locations of the proposed Flood ALERT Network stations and are numbered to Tables F-2 and F-3).

The remotely transmitted information from the Flood ALERT Network stations could be compiled in a central computer system, located either in the Butte County OES or Department of Public Works office. Data could be accessed, analyzed, and evaluated and used for flood warning and for input into a flood warning computer model to forecast river flow.

Access to the Flood ALERT Network could also be added as an expansion to the BCWC's Website as part of the Flood Information Link, which currently directs the user to the stream gage stations in the California Data Exchange Website and is included as a link on the Butte County Website.

TABLE F-1
BUTTE COUNTY PRECIPITATION AND FLOW STATIONS 2004 INDEX

*Highlighted Stations are Discontinued

Number on Map	Agency	Site Number	Site Name	Latitude	Longitude	Period of Record	Northing	Easting
1	USGS	11384000	BIG CHICO C NR CHICO CA	39°46'35"	121°45'10"	1930-1997	14447062	1990853
2	USGS	11384350	MUD C NR CHICO CA	39°47'02"	121°53'06"	1965-1974	14449303	1953667
3	USGS	11389720	BUTTE C BL DIV DAM NR STIRLING CITY	39°58'53"	121°35'15"	1986-2002	14522402	2036113
4	USGS	11389740	BUTTE C BL FKS OF BUTTE DIV DAM NR DE SALBA CA	39°54'05"	121°37'24"	1992-Present	14493113	2026524
5	USGS	11389747	FORKS OF BUTTE PP NR PARADISE CA	39°52'17"	121°37'57"	1992-Present	14482149	2024120
6	USGS	11389750	DE SABLA PH NR PARADISE CA	39°52'10"	121°37'51"	1979-Present	14481448	2024599
7	USGS	11389775	CENTERVILLE PH NR PARADISE CA	39°47'20"	121°39'23"	1979-Present	14452006	2017869
8	USGS	11389780	BUTTE C BL CENTERVILLE DIV DAM NR PARADISE CA	39°52'01"	121°37'58"	1985-Present	14480529	2024067
9	USGS	11389800	TOADTOWN CN AB BUTTE CAN NR STIRLING CITY CA	39°53'09"	121°36'35"	1984-Present	14487507	2030430
10	USGS	11389950	LITTLE BUTTE C NR MAGALIA CA	39°48'38"	121°35'00"	1968-1985	14460212	2038268
11	USGS	11390000	BUTTE C NR CHICO CA	39°43'34"	121°42'28"	1930-Present	14428933	2003762
12	USGS	11390010	BUTTE C NR DURHAM CA	39°40'36"	121°46'42"	1959-1973	14410651	1984168
13	USGS	11390200	GOLD RUN TRIB NR NELSON CA	39°35'21"	121°41'15"	1960-1973	14379151	2010193
14	USGS	11390210	DRY CR N NELSON CA	39°34'54"	121°41'54"	1970-1974	14376375	2007180
15	USGS	11396000	LOST C NR CLIPPER MILLS CA	39°34'25"	121°08'26"	1927-Present	14376205	2164411
16	USGS	11406910	SUTTER BUTTE CN A INTAKE NR OROVILLE CA	39°27'02"	121°39'26"	1967-Present	14328805	2019476

TABLE F-1
BUTTE COUNTY PRECIPITATION AND FLOW STATIONS 2004 INDEX

*Highlighted Stations are Discontinued

Number on Map	Agency	Site Number	Site Name	Latitude	Longitude	Period of Record	Northing	Easting
17	USGS	11394500	MF FEATHER R NR MERRIMAC CA	39°42'30"	121°16'10"	1937-1986	14424538	2127143
18	USGS	11395500	OROVILLE WYANDOTTE CN NR CLIPPER MILLS CA	39°33'15"	121°11'31"	1927-Present	14368829	2150071
19	USGS	11396090	WOODLEAF PH NR WOODLEAF CA	39°33'18"	121°12'11"	1972-Present	14369070	2146933
20	USGS	11396200	SF FEATHER R BL FORBESTOWN DAM CA	39°33'05"	121°12'30"	1962-Present	14367726	2145472
21	USGS	11396290	FORBESTOWN PH NR FORBESTOWN CA	39°33'00"	121°16'36"	1972-Present	14366843	2126218
22	USGS	11396300	SF FEATHER R NR FORBESTOWN CA	39°33'08"	121°16'49"	1957-1961	14367633	2125184
23	USGS	11396310	MINERS RANCH CN BL PONDEROSA DAM NR FORBESTOWN CA	39°33'00"	121°18'20"	1962-Present	14366689	2118073
24	USGS	11396329	KELLY RIDGE PH NR OROVILLE CA	39°31'56"	121°29'25"	1972-Present	14359288	2066107
25	USGS	11396330	BANGOR CN BL MINERS RANCH RES NR OROVILLE CA	39°30'17"	121°27'17"	1963-Present	14349444	2076305
26	USGS	11396350	SF FEATHER R A PONDEROSA DAM CA	39°32'52"	121°18'11"	1962-1997	14365893	2118793
27	USGS	11396395	SUCKER RUN A KANAKA DIV NR FEATHER FALLS CA	39°33'44"	121°16'46"	1989-Present	14371279	2125349
28	USGS	11396396	KANAKA PH NR FEATHER FALLS CA	39°33'44"	121°16'46"	1989-2000	14371279	2125349
29	USGS	11396397	COMBINED FLOW OF 11396395 + 11396396 CA	39°33'44"	121°16'46"	1989-2000	14371279	2125349

TABLE F-1
BUTTE COUNTY PRECIPITATION AND FLOW STATIONS 2004 INDEX

*Highlighted Stations are Discontinued

Number on Map	Agency	Site Number	Site Name	Latitude	Longitude	Period of Record	Northing	Easting
30	USGS	11396400	SUCKER RUN NR FORBESTOWN CA	39°33'12"	121°18'04"	1965-2001	14367926	2119303
31	USGS	11396500	PALERMO CN A ENTERPRISE CA	39°32'05"	121°20'40"	1911-1965	14360921	2107213
32	USGS	11397000	SF FEATHER R A ENTERPRISE CA	39°32'15"	121°20'45"	1911-1966	14361926	2106802
33	USGS	11397500	FEATHER R A BIDWELL BAR CA	39°33'15"	121°26'15"	1911-1964	14367533	2080851
34	USGS	11404330	NF FEATHER R BL GRIZZLY C CA	39°51'09"	121°23'29"	1981-Present	14476397	2091900
35	USGS	11404360	CRESTA PH NR PULGA CA	39°49'35"	121°24'30"	1980-Present	14466804	2087313
36	USGS	11404380	CAMP C NR PULGA CA	39°49'46"	121°25'23"	1992-Present	14467843	2083160
37	USGS	11404400	NF FEATHER R BL POE DAM CA	39°48'25"	121°26'05"	1975-1998	14459592	2080028
38	USGS	11404500	NF FEATHER R A PULGA CA	39°47'39"	121°27'03"	1911-Present	14454861	2075583
39	USGS	11404900	POE PH BL POE DAM NR JARBO GAP CA	39°43'23"	121°28'06"	1967-Present	14428881	2071110
40	USGS	11404901	COMBINED FLOW N F FEATHER R PULGA + POE PP CA	39°43'23"	121°28'06"	1967-1983	14428881	2071110
41	USGS	11405000	NF FEATHER R A BIG BEND CA	39°42'52"	121°28'05"	1905-1910	14425747	2071242
42	USGS	11405085	WB FEATHER R BL SNAG LK NR JONESVILLE CA	40°04'24"	121°27'08"	1993-Present	14556513	2073430
43	USGS	11405120	PHILBROOK C BL PHILBROOK DAM NR BUTTE MEADOWS CA	40°01'48"	121°28'36"	1989-Present	14540615	2066861

TABLE F-1
BUTTE COUNTY PRECIPITATION AND FLOW STATIONS 2004 INDEX

*Highlighted Stations are Discontinued

Number on Map	Agency	Site Number	Site Name	Latitude	Longitude	Period of Record	Northing	Easting
44	USGS	11405200	WB FEATHER R BL HENDRICKS DIV DAM CA	39°56'03"	121°31'43"	1986-Present	14505473	2052895
45	USGS	11405220	LONG RAVINE BL DIV DAM A STIRLING CITY CA	39°54'25"	121°32'28"	1995-Present	14495502	2049553
46	USGS	11405300	WB FEATHER R NR PARADISE CA	39°47'12"	121°33'42"	1957-1986	14451610	2044492
47	USGS	11405500	SPRING VALLEY D NR YANKEE HILL CA	39°45'48"	121°31'42"	1925-1952	14443266	2053997
48	USGS	11406000	CONCOW C NR YANKEE HILL CA	39°45'45"	121°31'35"	1927-1952	14442971	2054548
49	USGS	11406500	WB FEATHER R NR YANKEE HILL CA	39°41'55"	121°33'38"	1930-1963	14419551	2045320
50	USGS	11406799	COMPUTED INFLOW TO LK OROVILLE CA	39°32'06"	121°28'26"	1967-1974	14360377	2070711
51	USGS	11406810	PALERMO CN A OROVILLE DAM CA	39°31'59"	121°28'55"	1968-Present	14359631	2068452
52	USGS	11406818	HYATT PH POWER RELEASE NR OROVILLE	39°32'08"	121°28'27"	1974-Present	14360578	2070630
53	USGS	11406819	HYATT PH PUMPBACK NR OROVILLE CA	39°32'08"	121°28'27"	1974-Present	14360578	2070630
54	USGS	11406820	HYATT PH NR OROVILLE CA	39°32'08"	121°28'27"	1970-Present	14360578	2070630
55	USGS	11406848	THERMALITO POWER RELEASE NR OROVILLE CA	39°30'53"	121°37'43"	1974-Present	14352291	2027197
56	USGS	11406849	THERMALITO PH PUMPBACK NR OROVILLE CA	39°30'53"	121°37'43"	1974-Present	14352291	2027197
57	USGS	11406850	THERMALITO PH NR OROVILLE CA	39°30'53"	121°37'43"	1970-Present	14352291	2027197

TABLE F-1
BUTTE COUNTY PRECIPITATION AND FLOW STATIONS 2004 INDEX

*Highlighted Stations are Discontinued

Number on Map	Agency	Site Number	Site Name	Latitude	Longitude	Period of Record	Northing	Easting
58	USGS	11406880	WESTERN CN A INTAKE NR OROVILLE CA	39°30'19"	121°41'06"	1967-Present	14348615	2011343
59	USGS	11406890	RICHVALE CN A INTAKE NR OROVILLE CA	39°30'19"	121°41'06"	1968-Present	14348615	2011343
60	USGS	11406900	PG&E LATERAL A INTAKE NR OROVILLE CA	39°29'22"	121°41'12"	1968-Present	14342843	2010957
61	USGS	11406920	THERMALITO AFTERBAY RELEASE TO FEATHER R CA	39°27'23"	121°38'10"	1967-Present	14331019	2025404
62	USGS	11406930	DIV TO FEATHER R FISH HATCHERY NR OROVILLE CA	39°31'13"	121°32'48"	1973-Present	14354677	2050277
63	USGS	11406999	FEATHER R A OROVILLE R ONLY CA	39°31'13"	121°32'48"	1973-Present	14354677	2050277
64	USGS	11407000	FEATHER R A OROVILLE CA	39°31'13"	121°32'48"	1901-Present	14354677	2050277
65	USGS	11407150	FEATHER R NR GRIDLEY CA	39°22'00"	121°38'46"	1964-1998	14298307	2023071
66	USGS	11407300	N HONCUT C NR BANGOR CA	39°20'32"	121°29'25"	1960-1981	14290104	2067265
67	USGS	11407500	S HONCUT C NR BANGOR CA	39°22'04"	121°22'16"	1950-1997	14299995	2100792
68	USGS	11411500	N YUBA R A GOODYEARS BAR CA	39°32'28"	120°53'06"	1911-1931	14365962	2236712
69	USGS	392144121492301	MAIN DRAINAGE CANAL A GRIDLEY RD NR GRIDLEY CA	39°21'44"	121°49'23"	2002-2002	14295988	1973080
70	CA DWR	BBD	BUTTE CREEK NEAR DE SABLA	39.9010°N	121.6230°W	1999-Present	14492973	2026620
71	CA DWR	BBW	BW-12 IMPORT TO BUTTE CREEK	39.8850°N	121.5970°W	1997-Present	14487260	2034004
72	CA DWR	BCD	BUTTE CREEK NR DURHAM	39.6780°N	121.7770°W	1997-Present	14411142	1984536

TABLE F-1
BUTTE COUNTY PRECIPITATION AND FLOW STATIONS 2004 INDEX

*Highlighted Stations are Discontinued

Number on Map	Agency	Site Number	Site Name	Latitude	Longitude	Period of Record	Northing	Easting
73	CA DWR	BCG	BUTTE CREEK NEAR GRIDLEY	39.3620°N	121.8920°W	1997-Present	14295661	1953594
74	USGS	BCK	BIG CHICO CREEK NEAR CHICO	39.7680°N	121.7770°W	1997-Present	14443913	1984089
75	CA DWR	BPD	PARROT DIV FROM BUTTE CREEK	39.7090°N	121.7550°W	1997-Present	14422515	1990570
76	CA DWR	BWC	BUTTE CREEK NR WESTERN CANAL	39.5580°N	121.8330°W	1997-Present	14367237	1969346
77	South Feather Water and Power Agency	BNG	BANGOR CANAL	39.5040°N	121.4540°W	1985-Present	14349185	2076513
78	CA DWR	CHC	CHEROKEE CANAL NR RICHVALE	39.4650°N	121.7420°W	1997-Present	14333720	1995470
79	South Feather Water and Power Agency	FBD	FORBESTOWN DITCH (OROV-WYAN CANAL)	39.5500°N	121.1800°W	1995-Present	14367380	2153469
80	Pacific Gas & Electric	FPL	FEATHER NF AT PULGA	39.7940°N	121.4510°W	1911-2002	14454799	2075537
81	CA DWR	FTM	FEATHER MF NR MERRIMAC	39.7080°N	121.2690°W	1907-1970	14424419	2127270
82	CA DWR	FTO	FEATHER RIVER AT OROVILLE	39.5220°N	121.5470°W	1905-Present	14355302	2050173
83	NONE	FTP	FEATHER SF AT PONDEROSA	39.5480°N	121.3030°W	1900-1992	14365974	2118808
84	CA Dept of Water Resources/O & M	GRL	FEATHER RIVER NEAR GRIDLEY	39.3670°N	121.6460°W	1984-Present	14298429	2023101
85	CA Dept of	MER	FEATHER RIVER AT	39.7090°N	121.2700°W	1984-Present	14424778	2126982

TABLE F-1
BUTTE COUNTY PRECIPITATION AND FLOW STATIONS 2004 INDEX

*Highlighted Stations are Discontinued

Number on Map	Agency	Site Number	Site Name	Latitude	Longitude	Period of Record	Northing	Easting
	Water Resources/O & M		MERRIMAC					
86	Pacific Gas & Electric	MIC	MIOCENE CANAL	39.6900°N	121.5600°W	1985-Present	14416417	2045526
87	CA Dept of Water Resources/O & M	ORO	OROVILLE DAM	39.5400°N	121.4930°W	1967-Present	14362107	2065292
88	CA DWR	PLC	PALERMO CANAL	39.5330°N	121.4820°W	1979-Present	14359610	2068437
89	Pacific Gas & Electric	PLG	NORTH FORK FEATHER RIVER AT PULGA	39.7940°N	121.4510°W	1998-Present	14454799	2075537
90	South Feather Water and Power Agency	SLC	SLY CREEK	39.5840°N	121.1160°W	1961-Present	14380132	2171252
91	CA DWR	TAB	THERMALITO AFTERBAY	39.4500°N	121.6330°W	1967-Present	14328706	2026317
92	CA DWR	TFR	THERMALITO FOREBAY	39.5190°N	121.6290°W	1969-Present	14353847	2027064
93	CA DWR	THA	TOTAL RELEASE-FEATHER R BLW THERMALITO	39.4500°N	121.6330°W	1998-Present	14328706	2026317
94	CA DWR	THD	THERMALITO DIVERS POOL	39.5280°N	121.5430°W	1969-Present	14357505	2051266
95	CA DWR	TMT	THERMALITO TOTAL	39.4580°N	121.6380°W	1969-Present	14331597	2024862
96	National Weather Service	PRD	PARADISE FIRE STATION	39.7500°N	121.6170°W	1925-Present	14438013	2029153
97	Pacific Gas & Electric	DSB	DE SABLA (PG&E)	39.8670°N	121.6170°W	1905-Present	14480618	2028494
98	CA Dept of Water Resource	DES	DE SABLA (DWR)	39.8720°N	121.6100°W	1984-Present	14482469	2030430

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BUTTE COUNTY PRECIPITATION AND FLOW STATIONS 2004 INDEX

*Highlighted Stations are Discontinued

Number on Map	Agency	Site Number	Site Name	Latitude	Longitude	Period of Record	Northing	Easting
99	CA Dept of Forestry	CHI	CHICO	39.7120°N	121.7830°W	1988-Present	14423499	1982680
100	CA Dept of Forestry	CAR	CARPENTER RIDGE	40.0690°N	121.5820°W	2000-Present	14554330	2037146
101	CA Dept of Water Resource	BCM	BRUSH CREEK (DWR-2)	39.6940°N	121.3400°W	1995-Present	14418944	2107394
102	US Forest Service	BCR	BRUSH CREEK RS	39.6900°N	121.3400°W	1935-Present	14417487	2107421
103	CA Dept of Forestry	BGR	BANGOR	39.3820°N	121.3830°W	1984-Present	14305113	2097339
104	CA Dept of Water Resource	BRS	BRUSH CREEK (DWR)	39.6920°N	121.3390°W	1986-Present	14418221	2107689
105	CA Dept of Forestry	BTM	BUTTE MEADOWS	40.1000°N	121.5000°W	1984-2000	14565995	2059899
106	National Weather Service	CES	CHICO UNIV FARM	39.7000°N	121.8170°W	1982-Present	14419002	1973175
107	CA Dept of Water Resource	CHR	CHEROKEE CANAL	39.6520°N	121.6430°W	1999-2001	14402216	2022385
108	CA Dept of Forestry	CST	COHASSET	39.9000°N	121.7000°W	1984-Present	14492285	2005029
109	Pacific Gas & Electric	FBS	FORBESTOWN	39.5170°N	121.2660°W	1999-Present	14354885	2129456
110	CA Dept of Forestry	JAR	JARBO GAP	39.7360°N	121.4890°W	2003-Present	14433496	2065219
111	South Feather Water an	KLL	KELLY RIDGE POWER PLANT	39.5330°N	121.4830°W	1993-Present	14359606	2068155
112	National	ORF	OROVILLE FISH HATCH.	39.5170°N	121.5500°W	1989-1994	14353468	2049356

TABLE F-1
BUTTE COUNTY PRECIPITATION AND FLOW STATIONS 2004 INDEX

*Highlighted Stations are Discontinued

Number on Map	Agency	Site Number	Site Name	Latitude	Longitude	Period of Record	Northing	Easting
	Weather Service							
113	CIMIS	#12	DURHAM	39o36'32" N	121o49'22" W	1982-Present	14385804	1971985
114	USGS	11390045	LITTLE CHICO C TRIB A FOREST RANCH CA	39o52'40" N	121o40'25" W	1962-1973	14484302	2012550
115	USGS	11406910	SUTTER BUTTE CN A INTAKE NR OROVILLE CA	39°27'02"	121°39'26"	1967-Present	14328805	2019476
116	USGS	11407400	WYMAN RAVINE TRIB NR PALERMO CA	39°22'57"	121°34'43"	1960-1973	14304365	2042059

TABLE F-2
PROPOSED FLOOD ALERT NETWORK STREAM FLOW STATIONS

Index/Map #	Agency	Site Number	Site Name
11	U.S. Geological Survey	11390000	Butte Creek Near Chico, CA
70	California Department of Water Resources	BBD	Butte Creek Near DeSabla, CA
72	California Department of Water Resources	BCD	Butte Creek Near Durham, CA
78	California Department of Water Resources	CHC	Cherokee Canal Near Richvale, CA

TABLE F-3
PROPOSED FLOOD ALERT NETWORK PRECIPITATION STATIONS

Index/Map #	Agency	Site Number	Site Name
99	California Department of Forestry	CHI	Chico
97	Pacific Gas & Electric Company	DSB	De Sabla (PG&E)
96	National Weather Service	PRD	Paradise Fire Station

During the installation of the Flood ALERT Network, all buildings within the 100-year floodplain within the Butte Creek watershed could be checked against elevation data and owner contact information for these structures, which could be obtained from Butte County and city planning departments, and could be used to create a database that lists the structures in the order of flood vulnerability. Residents vulnerable to damage in a flood event could be alerted prior to flooding.

Notification of a flood emergency should occur through Butte County's Emergency Operations Center, located at the County OES. The USACOE requires patrolling the federal flood control project levees along Butte Creek, considered part of Maintenance Area No. 5 by the California Department of Water Resources (DWR), when river stages exceed warning levels. The superintendent of the levee system could prepare a comprehensive patrol schedule and a plan that is coordinated with the central computer system for the Flood ALERT Network. With the implementation of a Flood ALERT Network and DWR's levee patrols, advance warning of flood hazards could be provided. Once a flood threat has been recognized, the Butte County Emergency Services Officer could disseminate flood warnings as noted on Figure F-1. The Butte County Emergency Services Officer, the police, and fire personnel would notify people in the endangered areas through a combination of press briefings, emergency briefings, local radio, television stations, and door-to-door communication. Emergency response to a flood threat could also be coordinated with the efforts of the California Department of Forestry (CDF) Butte Unit Emergency Command Center, located in Oroville. This Command Center is "…responsible for mutual aid coordination and coordinates all fire mutual aid requests for all jurisdictions within Butte County" (Fire Management Plan, 2003).

The cities of Chico, Oroville, Durham, and the towns of Biggs, Nelson, Richvale, Paradise, and Gridley could prepare flood response plans that are coordinated with the central computer system of the Flood ALERT Network and with the Butte County Emergency Services Officer.

F.2 Flood Response

The Silver Dollar Fairgrounds in Chico and the Butte County Public Works Department have a total of approximately 15,000 sandbags. The Butte County Public Works Department also has a blanket contract for sandbags with the Sacramento Bag Manufacturing Company, located in Sacramento. In the event of a flood emergency, the Butte County Emergency Services Officer must be able to coordinate floodfighting efforts with these entities, as well as the Sheriff's office, Police Department, and Fire Department. A repository for sandbags could be developed so that in the event of an emergency, the sandbags would be located in closer proximity.

FIGURE F-1
FLOOD ALERT NETWORK COMMUNICATIONS CHART

FLOOD ALERT

Flood Alert Network	DWR Maintenance Area No.3 and No.5, Superintendent. (530) 751-8360
National Weather Service, http://weather.gov/alerts/ca.html	California Department Of Forestry And Fire Protection, Butte Unit, (530) 538-6234

CENTRAL COORDINATION

Emergency Services Officer
Butte County Office of Emergency Services
(530) 538-7373

FLOOD RESPONSE

INFORMATION DISSEMINATION

TV Station – KCRA
Channel 3
(916) 444-7316
TV Station – KHSL
Channel 12
530-343-1212
Radio Stations
Newspapers

RESPONSE AND EVACUATION

BUTTE COUNTY DEPARTMENTS	CITY OR TOWN
Fire Department (530) 538-7111 Public Works (530) 538-7681 Sheriff's Department (530) 538-7321 Water and Resource Conservation (530)-538-6265	FIRE DEPARTMENTS POLICE DEPARTMENTS EMERGENCY MEDICAL SERVICES LOCAL VOLUNTEER FIRE DEPARTMENTS RESIDENT DEPUTY SHERIFF City of Chico City of Oroville Town of Durham Town of Biggs Town of Nelson Town of Richvale Town of Paradise Town of Gridley

SHELTERS AND CRITICAL FACILITIES

SHELTERS	CRITICAL FACILITIES[1]
Red Cross (530) 673-1460 Salvation Army (916) 563-3796	Essential Facilities Lifeline Systems Hazardous Materials Facilities Utility Systems Transportation Lifeline Systems

FEDERAL AND STATE ASSISTANCE

California Governor's Office of Emergency Services,
Emergency Alert System
(916) 845-8610

California Department of Water Resources, Hydrology and
Flood Operations Center[2]
(916) 574-2605

California Department of Transportation
http://www.dot.ca.gov/hq/roadinfo/do3map.htm

California Highway Patrol[3]
Chico Dispatch Office
(530) 879-1900
Truckee Dispatch Office
(530) 538-2700

U.S. Army Corps of Engineers
Sacramento District, Emergency Response Mission[2]
(916) 557-6919

[1]Listed in Table 3-1 and shown on Map 12.
[2]Technical assistance DWR and USACOE must be requested through the State OES.
[3]The State and County OES should directly notify the appropriate California Highway Patrol Office.

F.2.1 Shelters and Critical Facilities

Critical facilities comprise essential facilities and systems that include transportation systems, lifeline utility systems, high potential loss facilities, and hazardous material facilities (FEMA, 2001). Protecting critical facilities during a flood is a vital part of the emergency services effort and recognizing the location of the critical facilities in the Butte Creek watershed assists the Butte County Emergency Services Officer in coordinating a comprehensive emergency response. Critical facilities within the Butte Creek watershed are listed in Table 3-3 of the Butte Creek Watershed FMP. The critical facilities list also includes the locations of helicopter landing zones designated by CDF, which could be used during the rescue and evacuation effort.

The American Red Cross Chapter that includes Butte County also includes Colusa, Glenn, Plumas, Sutter, and Yuba counties, as well as Beale Air Force Base. In the event of a disaster, the Disaster Director (or the Disaster Chairman) of the Red Cross deploys the approximate number of needed trained personnel to provide service and/or requests additional support. If shelters are required, the State OES deploys trained Red Cross Social Services teams to open and staff the shelters until replaced by Red Cross Mass Care personnel. In the event of a disaster in Butte County, the Chapter would initially open an operations center at the Chico office (American Red Cross, 2003).

Shelters outside of endangered areas would be established in coordination with the Butte County Emergency Services Officer and determined at the time of the evacuation and rescue process. For a rescue effort, a temporary assembly area for people coming out of the danger area would be established and then transported to a shelter. In an evacuation effort, the locations of shelters are established before they are announced through the information dissemination process. The Red Cross is responsible for operating, staffing, and managing the shelters and their efforts would be coordinated with the Salvation Army, if necessary (American Red Cross, 2003).

In the case of a flood disaster, the Red Cross tracks all evacuees by computer so that families and relatives are able to ascertain their locations. The Red Cross publishes a telephone number for people to call to locate their relocated relatives (American Red Cross, 2003).

F.2.2 Re-entry to Evacuated Area

The Police Department is responsible for securing an evacuated area and controlling access. Mass care facilities and the media would notify the public when evacuated areas are safe again (American Red Cross, 2003).

F.3 Evacuation Plan

Two hypothetical Butte Creek levee failure locations were analyzed to provide a demonstration for the expected propagation of flooding and the evacuation measures to adopt in such an event.

The first levee failure scenario is located at the west bank just above the Durham-Dayton Highway and the second scenario is at the east bank of the creek at the Oroville-Chico Highway (Map 27). Evacuation routes were established for both hypothetical levee failure scenarios.

Dam failure from Paradise and Magalia reservoirs, Oroville Dam, Black Butte Dam, Whiskeytown Dam, and Shasta Dam would also have an impact on flooding in the Butte Creek watershed. The majority of flooding due to dam failure for any of the dams individually or combined, could occur in the lower canyon and valley section of the watershed. Evacuation routes were established for a failure at Paradise and Magalia reservoirs.

To identify evacuation routes, GIS was used to create maps illustrating the locations of the Red Cross shelters, the primary streets and highways leading to them, and defining the distances to these shelters.

For a levee failure, at the Oroville-Chico Highway on the east side of the Butte Creek levee, the evacuation routes (Levee Failure #1, Map F-2) lead to the nearest Red Cross shelters listed in Table G-3. Between the Oroville-Chico Highway and Esquon Road, the area fills to a depth of one-half foot in the first 24 hours. Based upon Census 2000 data, there are close to 2,265 people in the inundation area for Levee Failure #1. If evacuation was necessary and based upon a reasonable assumption that 70 percent of the population would be in need of shelter, accommodation requirements would be for 1,586. The total sleeping capacity for the shelters (listed in Table F-4) is just over 2,500. For this area exclusively, there would be enough shelter capacity for evacuation efforts.

For a levee failure just above the Durham-Dayton Highway, the evacuation routes (Levee Failure #2, F-3) lead to the nearest Red Cross shelters located at the locations listed in Table F-4 (the same shelters for Levee Failure #1). Flooding of the area rapidly fills to a depth of one foot and extends south of White Drive within seven hours. Based upon Census 2000 data, there are close to 1,300 people in the inundation area for Levee Failure #2. Based upon a reasonable assumption that 70 percent of the population would be in need of shelter, accommodation requirements would be for 910 people. The total sleeping capacity for the shelters (listed in Table F-4) is just over 2,500. For this area exclusively, there would be enough shelter capacity for evacuation efforts.

If both hypothetical levee failures were to occur, shelter accommodation would require approximately 2,500 people (assuming a 70 percent total area population requirement), the total present shelter capacity in that area. Although these particular shelters would reach capacity in the event of both hypothetical levee failures, there are more shelters within Butte County that could accommodate people; the shelters listed are only those within the immediate vicinity of the levee failure point.

TABLE F-4
HYPOTHETICAL LEVEE FAILURE
EVACUATION ROUTE SHELTERS

Name	Address	City	Sleeping	Feeding
Bidwell Junior High School	2376 North Ave.		312	262
Chapman Elementary School	1071 East 16th Street	Chico	58	137
Chico Senior High School	901 Esplanade	Chico	477	299
Citrus Elementary School	1350 Citrus Ave.	Chico	85	117
Craig & Gordon Hall	1400 West 3rd St.	Chico	40	200
Durham Elementary	9420 Putney Drive	Durham	108	0
Fairview High School	102 West 11th St.	Chico	65	100
First Baptist Church	850 Palmetto	Chico	60	120
First Christian Church	295 East Washington	Chico	150	186
Hooker Oak Elementary School	1238 Arbutus Ave.	Chico	83	189
Jay Partridge Elementary School	290 East Ave.	Chico	70	157
John McManus Elementary School	933 East Ave.	Chico	65	151
Little Chico Creek Elementary	2090 Amanda Way	Chico	133	250
Marigold Elementary School	2446 Marigold Ave.	Chico	60	152
Neal Dow Elementary School	1420 Neal Dow Ave.	Chico	64	153
Parkview Elementary School	17770 E. Eight St.	Chico	55	108
Pleasant Valley High School	1475 East Ave.	Chico	518	211
Rosedale Elementary School	100 Oak Street	Chico	57	135
Sierra View Elementary School	1598 Hooker Oak Ave.	Chico	57	135
Salvation Army	1054 Broadway	Chico		
Salvation Army	700 Broadway	Chico		
Salvation Army	1358 East Ave.	Chico		
Salvation Army	6410 Clark Road	Paradise		
Salvation Army	2357 Meyers Street	Oroville		
TOTALS			**2,517**	**3,062**

A dam failure at Paradise and Magalia reservoirs would only allow 15 minutes to two hours to evacuate the area, requiring a rescue effort for many residents. Depth of flooding is not known in the event of a dam failure at these reservoirs, so it is assumed that it would be deep enough to put lives in danger. Evacuation and rescue routes are presented on Map F-4, and a list of the locations of nearby shelters is presented in Table F-5.

If both reservoirs were to fail (Magalia Reservoir is located downstream of Paradise Reservoir and would be vulnerable to failure if Paradise fails), the approximate population that would need to be evacuated (based upon a 70 percent total area population requirement) would be approximately 6,200. The total shelter capacity of the shelters in the area (Table F-5) is close to 7,000; therefore current shelter capacity would be adequate. These shelters do not include those outside of the watershed, such as in Oroville, which would also be accessible and increase shelter capacity Due to the dynamic nature of population densities not only from year to year, but from day to night, the population densities for the evacuation routes were assumed for the higher nighttime, residential density. Although shelter locations listed are current, due to the changes in land use and structure locations, these would need to be updated periodically with the Butte Creek Watershed FMP. Map F-5 and Map F-6 reflect the population and residential densities as they relate to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs).

F.4 Post Disaster Mitigation and Recovery

Post-disaster reconstruction regulation and mitigation planning procedures should be coordinated as part of the post-flood response planning. Preliminary damage assessments should be conducted immediately following a flood to evaluate conditions and to identify appropriate mitigation measures. The federal, state, and local mitigation efforts should evaluate the warning and response activities that were implemented during the disaster.

Measures that could be coordinated and delegated by the Butte County Emergency Services Officer to assist in the repair and recovery process after a disaster include: Regulating reconstruction to ensure it meets all code requirements, including the FEMA National Flood Insurance Program's (NFIP) substantial damage regulations; disseminating public information to advise residents about mitigation measures they could incorporate into their reconstruction work, for example, elevating structures, using waterproof or fireproof materials, elevating utilities above flood level; evaluating damaged public facilities to identify mitigation measures that could be included during repairs; acquiring substantially or repeatedly damaged properties from willing sellers; planning for long-term mitigation activities; and applying for post-disaster mitigation funds.

TABLE F-5
PARADISE AND MAGALIA RESERVOIRS
EVACUATION ROUTE SHELTERS

Name	Address	City	Sleeping	Feeding
Bidwell Junior High School	2376 North Ave.	Chico	312	262
Chapman Elementary School	1071 East 16th Street	Chico	58	137
Chico Junior High School	280 Memorial Way	Chico	0	0
Chico Senior High School	901 Esplanade	Chico	477	299
Citrus Elementary School	1350 Citrus Ave.	Chico	85	117
Craig & Gordon Hall	1400 West 3rd Street	Chico	40	200
Fairview High School	102 West 11th Street	Chico	65	100
First Baptist Church	850 Palmetto	Chico	60	120
First Christian Church	295 East Washington	Chico	150	186
Hooker Oak Elementary School	1238 Arbutus Ave.	Chico	83	189
Jay Partridge Elementary Schoo	290 East Ave.	Chico	70	157
Little Chico Creek Elementary	2090 Amanda Way	Chico	133	250
Neal Dow Elementary School	1420 Neal Dow Ave.	Chico	64	153
Parkview Elementary School	17770 East Eight Street	Chico	55	108
Pleasant Valley High School	1475 East Ave.	Chico	518	211
Rosedale Elementary School	100 Oak Street	Chico	57	135
Sierra View Elementary School	1598 Hooker Oak Ave,	Chico	57	135
John McManus Elementary School	933 East Ave.	Chico	65	151
Marigold Elementary School	2446 Marigold Ave.	Chico	60	152
Durham Elementary	9420 Putney Drive	Durham	108	0
Paradise Pines Community Center	14211 Wycliff Way	Magalia	40	200
Bird Street Elementary	1421 Bird Street	Oroville	40	101
Butte College	3536 Butte Campus Drive	Oroville	635	441
First United Methodist Church	45 Acacia Blvd.	Oroville	0	300
Wyandott Elementary	2800 Wyandott Avenue	Oroville	75	200
First Baptist Church of Paradise	6500 Clark Road	Paradise	225	0
Paradise Pines Elementary	13676 Compton Drive	Paradise	92	250

Ponderosa Elementary	6593 Pentz Road	Paradise	100	250
Paradise Adventist Academy	5699 Academy Drive	Paradise	125	100
Paradise High School	5911 Maxwell Drive	Paradise	977	30
Paradise Intermediate	5657 Recreation Drive	Paradise	190	250
Paradise Lutheran Church	780 Lutheran Drive	Paradise	120	150
Nelson Avenue School	2255 6th Street	Thermalito	68	250
Poplar Avenue School	2075 Poplar Avenue	Thermalito	1125	300
Sierra Avenue School	1050 Sierra Avenue	Thermalito	650	300
Salvation Army	1054 Broadway	Chico		
Salvation Army	700 Broadway	Chico		
Salvation Army	1358 East Avenue	Chico		
Salvation Army	6410 Clark Road	Paradise		
TOTALS			**6,979**	**6,184**

F.5 Additional Hypothetical Levee Failure Analyses

The levee failure scenarios analyzed in the Butte Creek Watershed FMP involved assumptions made for:

> ***Location***: During a Steering Committee meeting in October 2003, Butte County staff proposed several locations on the levee. Locations were selected based upon the scale of damage expected if a levee does fail at a spot due to the presence of populated areas or downstream of that location (Map F-7).
>
> ***Levee Failure Width***: Without performing detailed field-reconnaissance geotechnical analyses and levee failure computer modeling, the width of the levee failure remains an assumption. In this case, the width of the failure was estimated in a process similar to that of a dam failure analysis.
>
> ***Time for Failure***: Due to the same limitations listed under "Levee Failure Width" the time for failure was assumed to be 0.5 hours.

The BCWC or the Butte County OES should initiate additional modeling at the areas of concern along the Butte Creek levee system that would be vulnerable to failure in the event of a 100-year flood. Two of the identified locations were modeled for levee failure; however, additional areas could be modeled to expand the evacuation plan and ensure the maximum safety of the citizens within Butte County and the Butte Creek watershed. Additional locations were selected based upon the scale of damage expected if the levee fails at a spot near populated areas or downstream of those areas.

Schedule:

On-going, but varies depending upon the level of funding and extent of early warning system to be adopted. These projects are long-term.

Cost Estimate/Resources:

Based upon estimates from the Santa Barbara Flood Control and Water Conservation District, the cost for a Flood ALERT Network could range from $300,000 to $500,000. Factors that affect this value include the number of monitors, installation or repair of existing stream gages and precipitation stations, maintenance, the extent of new computer capabilities needed, and staff.

The cost for the setup, implementation, and maintenance of the EPEP varies according to the level of coordination and participation as well as factors such as staff, facilities, and other

necessary resources. Funding for the Flood ALERT Network could be shared between the Butte County Office of Emergency Services, DWR, and other state and local agencies.

Based upon the levee break modeling conducted for the Butte Creek Watershed FMP, the estimated cost for additional modeling for the identified six sites would be approximately $25,000. This cost is dependent upon the level of detail of the modeling conducted and the current available data.

Action Item G. Land Use Planning

Purpose:

The relatively minimal reported damage and loss of life attributed to flooding over the past 25 years in Butte County indicates that the current land use planning practices and the flood protection systems in Butte County have proven effective. However, increasing development and population growth would require disciplined land use planning practices to avoid development in areas protected by levees or areas prone to repeated flooding. Where development does occur it is important that current storm drainage criteria are implemented so as not to exacerbate flooding in other areas.

Project Description:

Butte County and the City of Chico have FEMA FIRMs by which to administer the NFIP within the Butte Creek watershed. Land use policies need to continue to be implemented to avoid increasing the potential risk in areas protected by levees.

Responsible Agency/Organization:

Butte County Department of Development Services, Department of Public Works, Planning Department, and the City of Chico Department of Public Works and Planning Department.

Scope of Work:

Providing the maps online as a link on the Butte County and Butte Creek Watershed Conservancy (BCWC) Websites, incorporating the maps into the BCWC database, and using the maps when determining and implementing flood mitigation measures could be integrated into the Butte County's daily operations and implementation costs would be relatively low. The primary activity related to this task is to avoid increasing the flood hazards by virtue of approving development in the floodplains or areas protected by the levees. As general plans are being updated and amended, the committee recommended in Action Item G should review pertinent material and comment as deemed appropriate so as to not increase risks.

Also, the following elements could be incorporated into the Butte County General Plan and the area plans of incorporated cities:

- Determine future drainage and flood control needs through the update of storm drainage criteria and master plans, as discussed in Action Item D, and develop phasing plans that could be implemented to mitigate adverse impacts from future development and projects in the floodplains.

- Incorporate floodproofing measures into the Butte County General Plan or the local area plans such as barriers, dry floodproofing, wet floodproofing, and sewer back-up protection.

- Incorporate standards into the building code that exceed the NFIP standards and current Butte County standards for all improved, repaired, or new buildings.

- Incorporating these elements into the Butte County General Plan and the incorporated cities' area plans would be a part of the update and review process.

Schedule:

This project would be long-term and would take place as part of the General Plan and community area plan updates.

Cost Estimate/Resources:

This activity would be implemented largely through on-going communication and coordination with both Butte County and the City of Chico Planning Departments and the implementation committee formed as part of this Butte Creek Watershed FMP.

Action Item H. Public Education and Awareness Programs

Purpose:

This project is to develop and implement public education and awareness programs that advise property owners and visitors about flooding hazards, ways to protect people and property from the hazards, and the natural and beneficial functions of floodplains. To ensure effectiveness, these programs must be ongoing.

Project Description:

This project involves increasing public awareness and education through providing updated flood-related mapping and materials (through the Internet and local libraries), initiating outreach and educational programs, providing real estate disclosure, providing technical assistance, and increasing awareness related to flood emergency preparedness and evacuation. The California State University at Chico's (CSUC) Geographical Information Center (GIC) Geographical Information System (GIS) database could be expanded to include a range of land use information in determining flood hazard vulnerability areas, such as elevation certificates, repetitive loss property information, and public infrastructure and critical facilities. All GIS data obtained for the Butte Creek Watershed FMP could be provided to CSUC to add to the existing database of the watershed and Butte County.

Responsible Agency/Organization:

The Butte County Emergency Services Officer or staff designated by the Butte County Emergency Service Officer, or a member of the Butte Creek Watershed Conservancy (BCWC) would be responsible for providing the latest list of flood protection references, government publications, Internet Websites, and instructions on how to order free documents for the public.

The Floodplain Administrator for Butte County and the City of Chico would be responsible for responding to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) inquiries.

The Butte County Floodplain Administrator or the Butte County Emergency Services Officer would be responsible for coordinating, scheduling, and performing outreach projects, educational programs, real estate disclosures, and offering technical assistance to flood-prone residents and businesses.

Scope of Work:

H.1 Map Information

To increase public awareness, the BCWC and/or Butte County could post FEMA FIRMs and related flood information on their Websites. This activity would qualify Butte County for FEMA Community Rating System (CRS) credit (once the Butte Creek Watershed FMP is incorporated into a countywide floodplain management plan and approved by FEMA).

The CSUC GIC currently has existing data for the Butte Creek watershed maps. GIS data obtained in the process of developing the Butte Creek Watershed FMP could be provided to CSUC, as a centralized location for GIS data, to add to the existing database of the Butte Creek watershed and Butte County, and updated regularly as new data is acquired. The Butte County Floodplain Administrator and the Butte County Emergency Services Officer could be liaisons for providing CSUC updated data periodically and to ensure the correctness of the Website information.

H.2 Outreach Projects

The CRS provides credit against flood insurance policies for public information and outreach projects. To receive credit under this activity, a person designated by the BCWC, the Butte County Floodplain Administrator, or the Butte County Emergency Services Officer, could do one or more of the following types of projects:

- Provide flooding and floodplain management information to all properties in the Butte Creek watershed through a newsletter, utility bill, or other widely distributed document.

- Provide a "Flood Safety" section in the Yellow Pages that outlines what a family could do in the event of a flood emergency. Direct flood-prone residents to a step-by-step checklist of action to reduce or prevent flood damage (FEMA's Website: http://www.fema.gov/rrr/displan.shtm).

- Send an annual notice to property owners in flood-prone areas, properties in the FEMA Special Flood Hazard Area (SFHA), and other areas that may be susceptible to flooding. The brochure or notice should discuss the local flood hazard, safety measures, property protection measures, and flood insurance information.

- Insert flyers in local newspapers announcing recent flood news.

- Provide flood information brochures at county, city, and public utility offices.

H.3 Real Estate Disclosure

The Butte County Floodplain Administrator or the Butte County Emergency Services Officer could coordinate with Butte County or BCWC to offer training classes to local realtors on FEMA FIRMs, the NFIP process, and flood hazard disclosure requirements, and conduct a mailing to the members of the Board of Realtors publicizing the map information services provided by Butte County.

H.4 Library

Butte County libraries should be provided with a current list of flood protection references, government publications, relevant Internet Websites, and instructions on how to order flood hazard documents. Butte County libraries are located in Biggs, Chico, Durham, Gridley, and Paradise, and the administrative office is in Oroville. To receive credit under the CRS, publications must be kept and distributed by public libraries. The Butte County Floodplain Administrator or the Butte County Emergency Services Officer could be designated to coordinate with the libraries to maintain updated flood hazard and flood insurance materials. The Oroville branch of the Butte County Library, located at 1820 Mitchell Avenue, would be a good location for the flood hazard material due to its close proximity to other Butte County offices.

H.5 Technical Assistance

The BCWC could set up a "Butte County" or "Watershed" 24-hour telephone line, answered by the Butte County Floodplain Administrator or the Butte County Emergency Services Officer during business hours. This service would offer technical assistance to flood-prone residents and businesses and allow the public to call with questions or concerns. Flood safety and flood hazard information recordings would be available during evenings and on weekends. Credit towards flood insurance reductions could be awarded for providing inquirers with information from the Butte County FIRMs, including whether a property is in a SFHA and providing base flood elevation (BFE) information. Credit depends upon publicizing this service and advising inquirers about the flood insurance purchase requirement.

H.6 Educational Programs

Schools, parks and recreation departments, conservation associations, and youth organizations, such as Boy Scouts and summer camps, could undertake education programs that address flood hazards, flooding causes, and the significance of adopting multi-objective management approaches to flood control that would keep people and structures out of harm's way while protecting the natural and beneficial functions of watersheds and floodplains. The Butte County Floodplain Administrator or the Butte County Emergency Services Officer could also coordinate with schools and organizations for these outreach activities. The Butte County Floodplain

Administrator or the Butte County Emergency Services Officer could coordinate with local television channels to televise FEMA's educational videos and/or local floodplain videos.

Schedule:

This project would be on-going and long-term.

Cost Estimate/Resources:

The cost would vary, depending upon which program or portions of programs are adopted.

Action Item I. Establish an Implementation Committee

Purpose:

To ensure the implementation and maintenance of the Action Program and the Butte Creek Watershed (Butte Creek Watershed FMP), a committee should be established. The Butte Creek Watershed FMP Implementation Committee (IC) would be responsible for coordination efforts among interest groups and agencies related to implementing the Action Program and activities that have the potential for increasing the risk to people, property, and livestock.

Project Description:

The IC would meet to coordinate or promote coordination of activities affecting flood hazards and seek funding for implementing the mitigation measures, reviewing and guiding the implementation of the mitigation measures, and reviewing and commenting on land use planning and policies from the flood hazard mitigation and floodplain management perspective.

Scope of Work:

Once the Butte Creek Watershed FMP is adopted by Butte County and the Butte Creek Watershed Conservancy (BCWC), it is important that the Action Program is implemented. Implementation will require time and effort in times of constrained budgets; however, every effort should be made to contribute to limit or reduce the risk associated with flood hazards. Where funding is limited, the importance of sound land use policies is amplified. The IC should be established with participation from Butte County or the City of Chico Floodplain Administrators, the Butte County Office of Emergency Services (County OES), the BCWC, and the Butte County Resource Conservation District (County RCD). It is suggested that the committee be co-chaired by the County OES and BCWC.

The IC would meet at least quarterly to review progress toward implementing the Action Program. The principal activities of the IC would include the following:

- Seek funding and technical assistance for implementation of the Action Program and regular updates to the Butte Creek Watershed FMP.
- Develop and implement strategy and coordinate the implementation of the Action Items.
- Conduct periodic public awareness events and disseminate pertinent information.
- Keep legislators and congressional legislators updated on activities and potential projects.
- Establish partnerships for implementing programs and projects.
- Monitor maintenance of the California Department of Water Resources (DWR) on Butte Creek and Little Chico Creek.
- Coordinate with other watershed groups on programs of mutual benefit.
- Document flood events and the performance of the flood control system.

- Prepare an annual report and distribute the report to federal, state, and local agencies.
- Prepare a periodic (five-year) update to the Butte Creek Watershed FMP.

Schedule:

The IC should be formed immediately following the adoption of the Butte Creek Watershed FMP. The BCWC and Butte County should continue their leadership in organizing the IC.

Cost Estimate/Resources:

It is anticipated that personnel or representative entities would be allocated time to participate in the IC. Funding would be through agency budgets and funding that could be obtained through federal and state grant programs. Funding for projects should be pursued through DWR, OES, and the U.S. Army Corps of Engineers. An important activity of the IC would be seeking funding.

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ACRONYMS

BCFD	Butte County Fire Department
BCWC	Butte Creek Watershed Conservancy
BFE	Base Flood Elevation
BLM	Bureau of Land Management
CDF	California Department of Forestry
CDFG	California Department of Fish and Game
CDSOD	California Division of Safety of Dams
CFS	Cubic Feet Per Second
CLOMR	Conditional Letter of Map Revision
CRS	Community Rating System
CSUC	California State University, Chico
DMA 2000	Disaster Mitigation Act of 2000
DSR	Damage Survey Report
FBFM	Flood Boundary and Floodway Map
FEMA	Federal Emergency Management Agency
FHBM	Flood Hazard Boundary Maps
FIS	Flood Insurance Study
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FMP	Floodplain Management Plan
GIC	Geographic Information Center
GIS	Geographic Information System
HEC-1	Hydrologic Engineering Center – Model 1
HEC-RAS	Hydrologic Engineering Center River Analysis System
HMGP	Hazard Mitigation Grant Program
IC	Implementation Committee
LHMP	Local Hazard Mitigation Plan
LOMR	Letter of Map Revision
NFIP	National Flood Insurance Program
NRCS	National Resource Conservation Service
PDM	Pre-Disaster Mitigation Plan
PG&E	Pacific Gas and Electric Company
SFHA	Special Flood Hazard Area
USACOE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WAC	Watershed Advisory Committee
WCWD	Western Canal Water District

GLOSSARY

A-Zones – See "Special Flood Hazard Area."

Active Fault – A fault that has moved in recent geologic time and which is likely to move again soon (For geologic purposes, there are no precise limits to recency of movement or probable future movement that define an "active fault." Definitions for planning purposes extend on the order of 10,000 years or more back and 100 years or more forward. The exact time limits for planning purposes are usually defined in relation to contemplated uses and structures).

Alluvial – Pertaining to or composed of alluvium, or deposited by a stream or running water (AGI, 1972).

Alluvial Fan – Area of deposition where steep mountain drainages empty into valley floors, usually in arid regions. Flooding in these areas often includes characteristics that differ from those in riverine or coastal areas (FEMA, 1999).

Alluvial Fan Flooding – Flooding that occurs on the surface of an alluvial fan (or similar landform) that originates at the apex of the fan and is characterized by high-velocity flows; active processes of erosion, sediment transport, and deposition; and unpredictable flow paths (FEMA, 1999).

Alluvium – A general term for clay, silt, sand, gravel or similar unconsolidated detrital material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope (AGI, 1972).

Base Flood – Flood that has a one percent probability of being equaled or exceeded in any given year. Also known as the 100-year flood (FEMA, 1999).

Base Flood Elevation (BFE) – The height of the base flood, usually in feet, in relation to the National Geodetic Vertical Datum of 1929 or other datum as specified. The BFE is determined by statistical analysis for each local area and is designated on the FIRMs. This elevation is the basis of the insurance and floodplain management requirements of the NFIP (FEMA, 1999).

Community – As defined for NFIP purposes, any state, area, or political subdivision; any Indian tribe, authorized tribal organization, or Alaska native village, or authorized native organization that has the authority to adopt and enforce floodplain management ordinances for the area under its jurisdiction. In most cases, a community is an incorporated city, town, township, borough, or village, or an unincorporated area of a County or parish. However, some states have statutory authorities that vary from this description (FEMA Website, 2004).

Critical Facilities – Comprises essential facilities, transportation systems, lifeline utility systems, high potential loss facilities, and hazardous material facilities. Definitions of these are listed in this glossary (FEMA, 2001).

Essential Facilities – Critical facilities that are essential to the health and welfare of the whole population and are especially important following hazard events. The potential consequences of losing them are so great, that they should be carefully inventoried. Be sure to consider not only the structural integrity and content value, but also the effects on the interruption of their functions because the vulnerability is based on the service they provide rather than simply their physical aspects. Essential facilities include hospitals and other medical facilities, police and fires stations, emergency operations centers and evacuation shelters, and schools (FEMA, 2001).

Debris – Materials carried by floodwater, including objects of various sizes and suspended soils (FEMA, 1999).

Development – Any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, minimizing, dredging, filling, grading (except grading in any A-, A-10, A-15, A-20, A-40, A-160 or AI zones for agricultural purposes and which does not increase flood levels upstream or downstream), paving, excavation, drilling operations, or storage of equipment or materials. (44 CFR Ch.1, Subch.B, NFIP, Part 59, Subpart A).

Fault – A surface or zone of rock fracture where there has been displacement, from a few centimeters to a few kilometers in scale (AGI, 1972).

Fault Surface – In a fault, the surface where displacement has occurred (AGI, 1972).

Fault System – Two or more interconnecting fault sets (AGI, 1972).

Fault Zone – A fault zone is expressed as a zone of numerous small fractures or of breccia or fault gouge. A fault zone may be as wide as hundreds of meters (AGI, 1972).

Federal Emergency Management Agency – Independent agency created in 1978 to provide a single point of accountability for all federal activities related to disaster mitigation and emergency preparedness, response, and recovery. FEMA administers NFIP (FEMA, 1999).

Federal Insurance Administration (FIA) – Component of FEMA directly responsible for administering the flood insurance aspects of the NFIP (FEMA, 1999).

Flash Flood – Flood that rises very quickly and usually is characterized by high flow velocities. Flash floods often result from intense rainfall over a small area (FEMA, 1999).

Flood – Under the NFIP, a partial or complete inundation of normally dry land areas from: (1) the overland flow of a lake, river, stream, ditch, etc.; (2) the unusual and rapid accumulation or

runoff of surface waters; and (3) mudflows or the sudden collapse of shoreline land (FEMA, 1999).

Flood Frequency – Probability, expressed as a percentage, that a flood of a given size will be equaled or exceeded in any given year. The flood that has a one percent probability (1 in 100) of being equaled or exceeded in any given year is often referred to as the 100-year flood. Similarly, the floods that have a two percent probability (1 in 50) and a 0.2 percent (1 in 500) of being equaled or exceeded in any year are referred to as the 50-year flood and the 500-year flood, respectively (FEMA, 1999).

Flood Fringe – That portion of the floodplain that is beyond the floodway and serves as a temporary storage area for floodwater during a flood. This section receives water that is more shallow and of lower velocity than floodway water (FEMA, 1999).

Flood Insurance Rate Map (FIRM) – The official map of a community prepared by FEMA that shows the BFE, along with the special flood hazard areas and the risk premium zones for flood insurance purposes. Once it has been accepted, the community is part of the regular phase of the NFIP (FEMA, 1999).

Flood Insurance Study (FIS) – A study performed by any of a variety of agencies and consultants to delineate the special flood hazard areas, base flood elevations, and risk premium zones. The study is funded by FEMA and is based upon detailed site surveys and analysis of the site-specific hydrologic characteristics (FEMA, 1999).

Floodplain – An area susceptible to inundation by water from any source (FEMA, 1999).

Floodplain Management – Program of corrective and preventive measures for reducing flood damage, including flood control projects, floodplain land use regulations, floodproofing or retrofitting of buildings, and emergency preparedness plans (FEMA, 1999).

Floodproofing – Structural or nonstructural changes or adjustments included in the design, construction, or alteration of a building that reduce damage to the building and its contents from flooding and erosion (FEMA, 1999).

Floodway – Portion of the regulatory floodplain that must be kept free of development so that flood elevations will not increase beyond a set limit – a maximum of one foot according to NFIP guidelines. The floodway usually consist of the stream channel and land along its sides. Also known as a regulatory floodway (FEMA, 1999).

Freeboard – Additional amount of height incorporated into the design flood elevation to account for uncertainties in determining flood elevations (FEMA, 1999).

Hazard Mitigation – Action taken to reduce or eliminate long-term risk to people and property from hazards such as floods, earthquakes, and fires (FEMA, 1999).

Hazardous Material Facilities – Facilities housing industrial/hazardous materials, such as corrosives, explosives, flammable materials, radioactive materials, and toxins (FEMA, 2001).

High Potential Loss Facilities – Critical facilities that have a high loss associated with them, such as nuclear power plants, dams, and military installations (FEMA, 2001).

Historic Earthquake – An earthquake, which occurred within the recorded history of man. Approximately 200 years maximum in California for large earthquakes.

Impervious Surfaces – Land surface that resists penetration by water (FEMA, 1999).

Intensity (Earthquake) – A measure of the effects of an earthquake at a particular place on humans and/or structures. The intensity at a point depends not only upon the strength of the earthquake, or the earthquake magnitude, but also upon the distance from the point to the epicenter and the local geology at the point (AGI, 1972).

Levee – Flood barrier constructed of compacted soil (FEMA, 1999).

Lifeline Utility Systems – Critical facilities such as potable water, wastewater, oil, natural gas, electric power, and communication systems (FEMA, 2001).

Liquefaction – Change of water saturated cohesionless soil to liquid, usually from intense ground shaking; soil loses all strength (AGI, 1972).

Lowest Floor – Floor of the lowest enclosed area within the building, including the basement (FEMA, 1999).

Magnitude (Earthquake) – A measure of the strength of an earthquake or the strain energy released by it, as determined by seismographic observations. As defined by Richter, it is the logarithm, to the base 10, of the amplitude in microns of the largest trace deflection that would be observed on a standard torsion seismograph (static magnification = 2800; period = 0.8 sec; damping constant = 0.9) at a distance of 100 kilometers from the epicenter (AGI, 1972).

100-Year Flood – The flood that has a one-percent chance of being equaled or exceeded in any given year. It is also known as the Base Flood (FEMA, 1999).

Regulatory Floodplain – Flood hazard area within which a community regulates development, including new construction, the repair of substantially damaged buildings, and substantial improvements to existing buildings. In communities participating in the NFIP, the regulatory

floodplain must include at least the area inundated by the base flood, also referred to as the SFHA (FEMA, 1999).

Repetitive Loss Structures – Include any currently insured building with two or more flood losses (occurring more than 10 days apart) greater than $1,000 in any 10-year period since 1978 (FEMA, 2001).

Scour – Process by which floodwater removes soil around objects that obstruct flow, such as the foundation walls of a house (FEMA, 1999).

Seiche – A wave that oscillates in lakes, bays, or gulfs as a result of seismic or atmospheric disturbances.

Special Flood Hazard Area – Portion of the floodplain subject to inundation by the base flood, designated Zone A, AE, A1-A30, AH, AO, AR, V, VE, or V1-V30 on a FIRM (FEMA, 1999).

Storm Surge – Rise in the level of the ocean that results from the decrease in atmospheric pressure associated with hurricanes and other storms (FEMA, 1999).

Strike-Slip Fault – A fault, the actual movement of which is parallel to the strike (trend) of the fault (AGI, 1972).

Subsidence – The gradual settling or sinking of an area of land with little or no horizontal motion, due to the decomposition of organic material in the soil, or the withdrawal of groundwater or oil.

Substantial Improvement – Any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the "start of construction." This term includes structures that have incurred "substantial damage," regardless of the actual repair work performed. The term does not, however, include: (1) any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications that have been identified by the local code enforcement official and that are the minimum necessary to ensure safe living conditions, or (2) any alteration of a "historic structure" provided that the alteration would not preclude the structure's continued designation as a "historic structure" (FEMA, 1999).

Transportation Systems – Critical facilities that include airways such as airports, heliports; highways such as bridges, tunnels, roadbeds, overpasses, transfer centers; railways such as trackage, tunnels, bridges, rail yards, depots; and waterways such as canals, locks, seaports, ferries harbors, drydocks, piers (FEMA, 2001).