FLOOD INSURANCE STUDY

VOLUME 1 OF 3

MONTEREY COUNTY, CALIFORNIA
AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
CARMEL-BY-THE-SEA, CITY OF	060196
DEL REY OAKS, CITY OF	060197
GONZALES, CITY OF	060198
GREENFIELD, CITY OF	060446
KING CITY, CITY OF	060199
MARINA, CITY OF	060727
MONTEREY, CITY OF	060200
MONTEREY COUNTY (UNINCORPORATED AREAS)	060195
PACIFIC GROVE, CITY OF	060201
SALINAS, CITY OF	060202
SAND CITY, CITY OF	060435
SEASIDE, CITY OF	060203
SOLEDAD, CITY OF	060204

EFFECTIVE:
APRIL 2, 2009

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
06053CV001A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways and cross sections). In addition, former flood hazard zone designations have been changed as follows.

Old Zones	New Zone
A1 through A30	AE
V1 through V30	VE
B	X
C	X

Initial Countywide FIS Effective Date: April 2, 2009

Revised Countywide FIS Date:

TABLE OF CONTENTS – Volume 1

TABLE OF CONTENTS – Volume 1 - continued

Page

FIGURES

TABLES

TABLE OF CONTENTS – continued – Volume 2

EXHIBITS

TABLE OF CONTENTS – continued – Volume 3

EXHIBITS - continued

FLOOD INSURANCE STUDY
MONTEREY COUNTY, CALIFORNIA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FISs/Flood Insurance Rate Maps (FIRMs) for the geographic area of Monterey County, California, including: the Cities of Del Rey Oaks, Gonzales, King City, Marina, Monterey, Salinas, Sand City, and Seaside, and the unincorporated areas of Monterey County (hereinafter referred to collectively as Monterey County).

This FIS aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This FIS has developed flood risk data for various areas of the county that will be used to establish actuarial flood insurance rates. This information will also be used by Monterey County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and will also be used by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

This FIS was prepared to include the unincorporated areas of, and incorporated communities within, Monterey County in a countywide format. Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below. The cities of Carmel-by-the-Sea, Greenfield, Pacific Grove, and Soledad did not have FISs.

Del Rey Oaks, City of:	the hydrologic and hydraulic analyses from the FIS report dated May 4, 1981, were performed by George S. Nolte and Associates, for the Federal Insurance Administration (FIA), under Contract No. H-4722. That work, which was completed in July 1980, covered all significant flooding sources affecting the City of Del Rey Oaks.

Gonzales, City of:	the hydrologic and hydraulic analyses from the FIS report dated May 18, 1981, were performed by George S. Nolte and Associates, for the FIA, under Contract No. H-4722. That work, which was completed in August 1980, covered all significant flooding sources affecting the City of Gonzales.
King City, City of:	the hydrologic and hydraulic analyses from the FIS report dated April 15, 1981, were performed by George S. Nolte and Associates, for the FIA, under Contract No. H-4722. That work, which was completed in August 1980, covered all significant flooding sources affecting the City of King City.
Marina, City of:	the hydrologic and hydraulic analyses from the FIS report dated February 3, 1993, were performed by George S. Nolte and Associates, for the Federal Emergency Management Agency (FEMA), under Contract No. H-4722.
Monterey, City of:	the hydrologic and hydraulic analyses from the FIS report dated June 17, 1986, were performed by George S. Nolte and Associates, for FEMA, under Contract No. H-4722. That work was completed in December 1979. The hydrologic and hydraulic analyses for Carmel River were performed by Northwest Hydraulic Consultants for FEMA under Contract No. EMF-2001-CO-0015. The work was completed in March 2006. The hydrologic and hydraulic analyses for Harper and San Benancio were performed by Philip Williams & Associates, Ltd., for FEMA, under Contract No. EMF-2003-CO-0043. The work was completed in May 2005. The hydrologic and hydraulic analyses for Watson, Calera, and El Toro were performed by Northwest Hydraulic Consultants for FEMA under Contract NO. EMF-2001-CO-0015, and completed in April 2005.

Monterey County (Unincorporated Areas): the hydrologic and hydraulic analyses from the FIS report dated September 27, 1991, for most of the original study, were performed by George S. Nolte and Associates, for FEMA, under Contract No. H-4722.

Hydrologic and hydraulic analyses for Pajaro River and Thomasello Creek were performed by Brown and Caldwell, for FEMA, under Contract No. H-4723. That work was completed in December 1982.

The coastal analyses for this revised study were conducted by Ott Water Engineers, Inc., for FEMA, under Contract No. EMW-83-C-1175. That work was completed in August 1984.

Salinas, City of: the hydrologic and hydraulic analyses from the FIS report dated May 4, 1981, were performed by George S. Nolte and Associates, for the FIA, under Contract No. H-4722. That work, which was completed in July 1980, covered all significant flooding sources affecting Salinas.

Sand City, City of: the coastal hazard analyses from the FIS report dated June 3, 1986, were performed by Ott Water Engineers, Inc., for FEMA, under Contract No. EMW-83-C-1175. That work was completed in August 1984.

Seaside, City of: the hydrologic and hydraulic analyses from the FIS report dated August 19, 1986, were performed by George S. Nolte and Associates, for FEMA, under Contract No. H-4722. That work was completed in December 1979.

The coastal analyses for this revised study were conducted by Ott Water Engineers, Inc., for FEMA, under Contract No. EMW-83-C-1175. That work was completed in August 1984.

The hydrologic and hydraulic analyses for portions of this study were performed by Schaaf & Wheeler, for FEMA, under Contract No. EMF-87-C-0282. These analyses were completed in November 1989.

Other portions of this study were revised on February 3, 1993, to incorporate the results of revised hydrologic and hydraulic analyses, including a soils investigation of 11 flood hazard areas shown as approximate Zone A flooding on the Flood Insurance Rate Map (FIRM) for the City of Marina (FEMA, 1988). The revised study was prepared by Ensign & Buckley, Consulting Engineers, the study contractor for FEMA under Contract No. EMW-90-6-3133 and was completed in December 1991.

This study was revised in February 2006 to incorporate an updated analysis of flood hazards along a 19-mile reach of the Carmel River from the San Clemente Dam downstream to the Pacific Ocean. Portions of the revised study area had previously been studied by both detailed and approximate methods.

The hydrologic and hydraulic analyses were performed by Northwest Hydraulic Consultants for FEMA under Contract No. EMF-2001-CO-0015, and completed in March 2006.

This study was revised in November 2006 to incorporate an updated analysis of flood hazards along Calera and Watson Creeks using detailed methods. In addition to these updates, the upper 1,065 feet of El Toro Creek was restudied. This update defines flood hazards using Zone AE, Zone X, and floodway designations. Calera Creek had previously been studied by detailed methods and Watson Creek had previously been studied by approximate methods.

The hydrologic and hydraulic analyses were performed by Northwest Hydraulic Consultants for FEMA under Contract No. EMF-2001-CO-0015, and completed in April 2005.

On selected FIRM panels, planimetric base map information was provided in digital format. These files were compiled at scales of 1:12,000. Additional information was derived from U.S. Geological Survey (USGS) Digital Line Graphs. Additional information may have been derived from other sources. Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

The coordinate system used for the production of this FIRM is Universal Transverse Mercator (UTM), North American Datum of 1927 (NAD 27), Clarke 1866 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the UTM projection, NAD 27. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

1.3 Coordination

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. An initial CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to explain the nature and purpose of a FIS, and to identify the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

The dates of the initial and final CCO meetings held for Monterey County and the incorporated communities within its boundaries are shown in Table 1, "Initial and Final CCO Meetings."

TABLE 1 - INITIAL AND FINAL CCO MEETINGS

Community	For FIS Dated	Initial CCO Date	Final CCO Date
Del Rey Oaks, City of	May 4, 1981	April 20, 1978	October 1, 1979
Gonzales, City of	May 18, 1981	April 1978	July 11, 1980
King City, City of	April 15, 1981	April 1978	July 11, 1980
Marina, City of	February 17, 1988	*	April 1, 1987
	February 3, 1993	July 5, 1990	August 4, 1992
Monterey, City of	July 2, 1981	April 20, 1978	July 9, 1980
	June 17, 1986	May 1983	*
Monterey County	January 30, 1984	July 1978	April 6, 1983
	September 27, 1991	November 1986	February 21, 1990
Salinas, City of	May 4, 1981	April 1978	July 8, 1980
Sand City, City of	June 3, 1986	May 1983	*
Seaside, City of	July 2, 1981	April 20, 1978	July 9, 1980
	August 19, 1986	May 1983	

*Data not available

The initial coordination meeting for the revised detailed study was held in October 2004 and was attended by representatives of FEMA, the study contractor and the Monterey County Water Resources Agency.

For Harper and San Benancio, the initial CCO meeting was held on August 14, 2003, and attended by representatives of FEMA, Monterey County, and the study contractor.

For Watson, Calera, and El Toro, the initial CCO meeting for the revised detailed study was held on October 28, 2003, and was attended by representatives of FEMA, the study contractor, and the Monterey County Water Resources Agency.

On March 25, 2008, the final CCO meeting for Monterey County countywide DFIRM and FIS was held. Attending the meeting were representatives of FEMA Region IX, MAPIX-Mainland (the study contractor), Monterey County, and the City of Soledad.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Monterey County, California.

All or portions of the flooding sources listed in Table 2, "Streams Studied by Detailed Methods," were studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS

Arroyo Seco
Calera Creek
Canyon Del Rey
Carmel River
Carmel River North Overbank
Carmel River South Overbank
Castroville Boulevard Wash
Corncob Canyon Creek
East Branch Gonzalez Slough
Elkhorn Slough
El Estero Lake
El Torro Creek
Gabilan Creek
Gonzales Slough
Harper Creek
Josselyn Canyon Creek
Monterey Bay on the Pacific Ocean
Natividad Creek
Pacific Ocean
Pajaro Creek
Pine Canyon Creek
Reclamation Creek
Reclamation Ditch downstream of Borowdard
Reclamation Ditch upstream of Borowdard
Salinas River
Salinas River Overbank
Salinas River near King City
Salinas River near San Ardo
San Lorenzo Creek
San Miguel Canyon Creek
Santa Rita Creek
Tembladero Slough
Thomasello Creek
Watson Creek

This FIS also incorporates the determinations of Letters of Map Correction issued by FEMA, as shown in Table 3, "Letters of Map Correction."

TABLE 3 - LETTERS OF MAP CORRECTION

Community	Flooding Source(s)/Project Identifier	Date Issued	Type
City of Salinas	Backwater from Carr Lake, East Laurel Drive	February 17, 2004	LOMR
	Carr Lake, Kern Street Parcel	December 28, 1999	LOMR
	Sanborn Creek	September 27, 1995	LOMR
	Reclamation Ditch, W. Rossi Street	September 10, 1992	LOMR
	Gabilan Creek	February 21, 1992	LOMR
City of Salinas	22281 Toro Hills Drive	December 6, 2005	LOMA

TABLE 3 - LETTERS OF MAP CORRECTION - continued

Community	Flooding Source(s)/Project Identifier	Date Issued	Type
City of Salinas	Lots 20-21, Tract No. 1034, Toro Hills Estates	December 6, 2005	LOMR-F
Monterey County (Unincorporated Areas)	Marina Station, Rainfall-Interior Flooding	December 29, 2006	LOMR
	03-373 King Ranch, LLC, Ranchita Creek	June 23, 2006	LOMR
	Basaldua Property, Alisal Creek	September 23, 2005	LOMR
	King Ranch, Ranchita Canyon Creek	May 19, 2005	LOMR
	Coehlo Crossing, Arroyo Seco	March 20, 2003	LOMR
	Moro Cojo Slough	April 8, 1994	LOMR
	Johnson Canyon Creek	February 15, 1993	LOMR
	Gabilan Creek	February 21, 1992	LOMR
Monterey County (Unincorporated Areas)	690 West Blanco – Parcel 1, Tract 2	March 28, 2006	LOMR-FW
Monterey County (Unincorporated Areas)	260 Osborn Road	December 13, 2004	LOMA
Monterey County (Unincorporated Areas)	Tract 445, Carmel Valley Golf and Country Club	January 5, 2005	LOMA
Monterey County (Unincorporated Areas)	Buildings A-F – 15 Salinas Road	January 23, 2007	LOMR-F
City of Marina	Marina Station, Rainfall-Interior Flooding	December 29, 2006	LOMR
	Cypress Knoll, stormwater runoff	August 17, 200?	LOMR
City of Marina	Preston Park Housing	June 27, 2005	LOMR-F
City of Gonzales	Canyon Creek Subdivision	January 14, 2003	LOMR
City of Del Rey		June 19, 1987	LOMR
City of Sand City		May 15, 1987	LOMR

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

All or portions of Canyon Del Rey, Big Sur River, San Lorenzo Creek, San Miguel Canyon Creek, and Tembladero Slough in the county were previously studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Monterey County.

2.2 Community Description

Monterey County is located in west-central California, between Los Angeles and San Francisco, on the Pacific coast. The county is oriented on a northwest-southeast axis, parallel to the Pacific Ocean. The county boundary on the west is formed by the Pacific Ocean, including Monterey Bay and the Big Sur coast. The county encompasses an area of 3,324 square miles, including 1,900 acres of inland water and approximately 100 miles of coastline. Monterey County is essentially the same size as Connecticut, and its area is greater than the combined area of Rhode Island and Delaware. In addition to its coastal resources, the county possesses nearly 1 million acres of rich agricultural land that are almost unparalleled for productiveness. The Salinas Valley has long earned the description "the salad bowl of the nation." Monterey County is bordered by Santa Cruz County to the north; San Luis Obispo County to the south; and San Benito, Kings, and Fresno Counties to the east.

Prehistorically, the region that would ultimately become Monterey County was inhabited by Indians of the Costanoan group. The designation Costanoan is from the Spanish, "Costanos," or "coast people" (A. L. Kroeber, 1967). The descendants of these indigenous peoples preferred the name Ohlone, "people of the west," which was given to them by the Yokuts, the Indian group living to the east in the San Joaquin Valley (City of Santa Cruz Museum, Permanent Display of American Indian Artifacts). The Ohlone lived within the watershed lands from the Carquinez Straits on the north to the Carmel River on the south. Their eastern boundary was the interior chain of the coast ranges, the Mount Diablo Range. Thus, their territory included not only portions of Monterey County, but what is now San Francisco, San Mateo, Contra Costa, Alameda, San Benito, Santa Cruz, and Santa Clara Counties. Probably no more than 10,000 Ohlone were living in this large domain at any one time (A. L. Kroeber, 1967).

The Esselens and Salinans, two other Indian groups, also inhabited portions of Monterey County. The Esselens occupied approximately 25 miles of the Monterey coast, from Point Sur to Point Lopez, extending inland as far as Junipero Serra Peak. They also controlled the upper watersheds of the Carmel and Arroyo Seco Rivers. "The Salinans inhabited the Salinas Valley from an unknown point below Soledad to the Santa Margarita Divide, and on the coast from below Point Lopez to Cayucos..." (Gary S. Breschini, 1972).

Recorded history began in the Monterey County area with the arrival of the Spanish. The earliest account of Monterey County dates back to the year 1542, when Juan Rodriguez Cabrillo, a Portuguese navigator sailing for Spain, briefly visited Monterey Bay and claimed it in the name of God and Phillip II. He also named the small projection at the southern end of the Bay "Punta de los Pinos" (the Point of the Pines).

The next recorded visit was in 1602, when another Spanish ship sailed into Monterey Bay. This time a landing party led by Sebastian Vizcaino came ashore and claimed the land for Spain, naming it after the County of Monterey.

In 1769, Don Gaspar de Portola, a career soldier and governor of the Californias, entered Monterey County by land with a group of conquistadores and padres. Approaching Monterey Bay from the Salinas Valley, at a point near the present King City, Don Gaspar did not recognize it from Vizcaino's description and so he traveled on and discovered San Francisco Bay.

The following year, with more success, Don Gaspar and his foot soldiers met the renowned Franciscan Friar, Father Junipero Serra, who had arrived by sea on the shores of Monterey Bay. Mass was held under the same oak where Vizcaino had knelt 168 years before. Don Gaspar claimed Alta California again for the crown of Spain, and Father Serra formally founded the mission San Carlos Borromeo, second in the chain of 21 missions. With the assistance of the local Costanoan Indians, Father Serra later moved the mission to its present site alongside Carmel Bay.

In 1821, Mexico gained independence—an event with far-reaching consequences for all of California. The missions were secularized and, under Mexican law, private citizens could petition for lands previously belonging to the missions. Hundreds of large land grants were created throughout the territory. American interest in California increased steadily. Mexico had little chance in its dispute with the United States, and with the treaty of Guadalupe Hidalgo in 1848, it surrendered all of the California Territory to the United States.

The City of Salinas, the county seat, was supposedly founded as the result of an accident which occurred in 1856. Deacon Elias Howe was on his way from Monterey to the Natividad stage stop to establish a tavern. His wagon overturned on the banks of the Salinas River. He surveyed the area and the effort involved in repacking his goods and decided to establish his tavern in that location. Thus, Salinas was named after the salt marshes that abound along the edge of the Salinas River (City of Salinas, 1975).

From the very beginning, Monterey County's economy has been tied to agriculture. In the 1850s and 1860s, Monterey County was devoted mostly to raising livestock.

The displacement of the wild Spanish cattle by American livestock and dairy cattle brought about significant changes and altered the landscape. Towns emerged along the length of the Salinas Valley and population increased. Large ranchos were divided into smaller farms. Various crops, including hay, barley, and wheat, were grown in great quantities and dairy farms prospered. Salinas, by virtue of its strategic location, became a packing and shipping center as well as a farm implement center supplying the needs of the Salinas Valley.

Agriculture and related activities continue to be dominant factors in the economy of Monterey County. More than 400,000 tons of vegetables are processed annually in processing plants within Salinas. The value of handling, processing, and marketing Salinas Valley products contributes nearly $750 million to Monterey County's economy annually.

Tourism is another of the major elements of the county economy. Starting with the development of the world famous Hotel Del Monte in 1880, thousands of visitors have come to the Monterey area and the Big Sur coastal areas of the county. The Monterey Peninsula area continues to derive much of its revenue from visitors who wish to enjoy the historic and artistic atmosphere of this area of the county.

Educational institutions, such as Monterey Peninsula College and Hartnell College, and military installations, including Fort Ord Military Reservation and Fort Hunter Liggett, also contribute significantly to the local economy. Government is also one of the significant employers within Monterey County. In recent years, particularly in Salinas and some of the other cities in the Salinas Valley, industry has become a growing component of Monterey County's economy.

The pattern of current land uses in Monterey County reflects the changes that have occurred since its founding in 1850. After the founding of the Cities of Monterey and Salinas, the Towns of Castroville, Santa Rita, Soledad, and Gonzales were founded in the late 1880s. From 1850 to 1880, the population continued to increase; by 1880, there were slightly more than 11,000 people in the area that is now Monterey County. Definite patterns of development appeared on the land—quilt work patterns of agriculture in the Salinas Valley and urban-like settlements there and on the Monterey Peninsula. Although by 1880, there were definite signs of growth in Monterey County, a significant increase in population did not occur until the 1920s—an increase that gathered momentum in the 1940s and has continued (Monterey County, 1968).

The population in the county has continued its slow, but regular progress. According to the U.S. Bureau of the Census, in 1971, Monterey County had a population of 252,800. The 1980 population of Monterey County was 290,444. The largest concentration of population in the county is on the Monterey Peninsula. As of 1980, the City of Monterey had a population of 27,558, the City of Seaside had a population of 36,567, the City of Marina had a population of 20,647, and the City of Pacific Grove had a population of 15,755. These Monterey Peninsula cities accounted for 90,527 people of the county's total population. The City of Salinas had a population of 80,479 at that date, and the unincorporated areas of the county had a total population of 84,497 (U.S. Department of Commerce, 1981). According to the U.S. Bureau of the Census, in 2000, Monterey County had a population of 401,762. This represents a 13% increase from 1990 to 2000.

Monterey County is served by an extensive network of highways and major arterials. State Highway 1, the Cabrillo Highway, connects Monterey County with

Santa Cruz County, all points north to San Francisco, San Luis Obispo County, and ultimately Los Angeles to the south. Running parallel to the Cabrillo Highway, through the Salinas Valley, is U.S. Highway 101, which connects the Monterey County communities of Salinas, Chualar, Gonzales, Soledad, Greenfield, and King City. California State Highway 68 connects the City of Monterey with the City of Salinas and communities to the east.

Monterey County is also served by rail and air carriers. The Southern Pacific Railroad mainline runs parallel to the U.S. Highway 101 through the heart of the Salinas Valley. Salinas Valley produce is transported by rail north to San Francisco and south to Los Angeles. The Monterey Peninsula Airport connects Monterey County with San Francisco International Airport, Los Angeles International Airport, and all other national and international airport facilities.

Topography within Monterey County is extremely varied. Elevations range from sea level to 5,844 feet at Junipero Serra Peak, which is located 12 miles inland, in the Santa Lucia range. The county includes the famous Salinas Valley, which is bounded by the Gabilan Mountains to the east and the Santa Lucia Mountains to the west. The valley has approximately 640,000 acres of broad bottom land; it is 10 to 20 miles wide and approximately 130 miles long.

On the coast, Monterey Bay is the most dramatic topographical feature. The entrance to the bay is slightly over 19 miles long and the widest point of the bay is approximately 9 miles. Although the bay is relatively shallow, the largest submarine canyon along the Pacific Coast forms a trench in the floor of the bay and reaches a depth of 3,000 feet at the entrance.

The climate in Monterey County is characterized by warm, dry summers and cool, moist winters. The average temperature is approximately 56 degrees Fahrenheit. Average rainfall in the county varies, but is approximately 15 inches per year, although in some years rainfall in excess of 30 inches has been recorded. Approximately 90 percent of this rainfall occurs between November and April. Measurable precipitation averages 51 days per year, and the average length of the growing season is 235 days. This beneficial environment continues to promote agriculture and tourism in the county.

The soils in Monterey County vary considerably. There are silicon/quartz deposits along the coast (beaches in the Monterey area); to the east, toward Salinas, there are alluvial deposits that form some of the finest farmlands in the nation. Within the county itself, there are rolling hills that are heavily wooded; the soils in these areas are of sedimentary origin, but not particularly suited for agriculture.

The soils in the Salinas Valley area are rich, alluvial deposits for growing numerous crops. Erosion of the Gabilan Mountains to the east and the Santa Lucia Mountains to the west has been the source of the soils that form the alluvial plain upon which Salinas rests.

Meandering creeks that have their headwaters in the surrounding mountains, cross the flat, alluvial portions of Salinas. The soils that have been deposited in the area are from the most recent epoch of geological history, the Pleistocene.

Vegetation in Monterey County is varied. The foothills are covered with a wide range of trees and thick brush cover. The valley floors feature eucalyptus, oaks, and varieties of fruit trees. Numerous cultivated trees and plants (including citrus) flourish throughout the county. Agricultural crops—lettuce, brussel sprouts, sugar beets, artichokes, wheat, hay, barley, and vineyards to cite only a partial list—abound. Reflective of its climate, almost anything can be grown in Monterey County from cypress to palm trees.

The Gabilan and Santa Lucia Mountains are the sources of the principal watercourses in the area. The largest of these, the Salinas River, is 155 miles long. This river roughly bisects the county, running from the Monterey-San Luis Obispo County border to its termination point in Monterey Bay. The principal tributaries to the Salinas River are Arroyo Seco, the Nacimiento River, and the San Antonio River, which catch the high rainfall in the Santa Lucia Mountains, and San Lorenzo Creek, which flows from the Gabilan Mountains.

Drainage patterns in Monterey County have been altered by urbanization; increased runoff poses a greater flood threat than in previous years. To accommodate the increasing runoff, many cities in the county have developed extensive systems of channels and storm drains. The overall drainage pattern in the county is from south to north, the direction of flow of the Salinas River.

The Moss Landing study area occupies the tip of the coastal peninsula, located west of the unincorporated community of Moss Landing. Elkhorn Slough, Moro Cojo Slough, and the Old Salinas River form the northern and eastern perimeters of the site. Due west, the beach faces Monterey Bay, an orientation that exposes the site to southerly and southwesterly storms. A breakwater wall was constructed to the northwest to reduce sedimentation in the entry channel, not for wave-action protection.

The unincorporated community of Moss Landing is industrial, with oil refineries, powerplants, commercial boat repair, and government research providing the major economic base. A couple of residences may be located on the study site. However, the majority of structures are related to marine-commercial or marine-institutional facilities.

The Salinas River Beach study area lies approximately 12,000 feet south of Moss Landing. Bordered on the west by Monterey Bay and on the east by the Old Salinas River, the site exposed to westerly and southwesterly waves and storm events from the Pacific Ocean.

The beach is broad and level and gives rise to a series of recent sand dunes. A pronounced short break in elevation indicates recent erosion of the coastal dune material. Behind the beach is the Monterey Dunes Colony, a private 120-unit residential resort community that has been developed on the coastal dunes (Ott Water Engineers, Inc., 1984).

2.3 Principal Flood Problems

In the City of Del Rey Oaks, excessive rainfall is the principal cause of flooding. Almost all of the city is subject to shallow sheet flow during the 100-year (1-percent annual chance) flood due to limited capacity of the storm drainage system. Floodwaters in excess of the storm-drain capacity will flow down the streets.

From 1911 through 1978, flood damage occurred in portions of Monterey County during March 1911, January 1914, February 1922, November 1926, December 1931, February 1938, March 1941, January 1943, February 1945, January 1952, January 1956, April 1958, February 1962, December 1966, January and February 1969, February 1973, and February 1978. In rural areas, flooding in early years was often viewed as beneficial rather than detrimental. The need for water to irrigate agricultural crops outweighed the damage done by floodwaters. In later years, as development increased, property damage became a more important consideration.

Within the City of Del Rey Oaks, the most significant flood conditions occurred in 1938, 1952, 1958, and 1966. However, there are no historic records for the detailed study area. Therefore, information on the maximum flood of record and frequencies for other significant floods is unavailable.

Following are descriptions of several floods affecting the Del Rey Oaks area. The severity of the floods and the relative development of the area have determined the extent of damage.

The February 1938 storms were some of the most severe in the history of Monterey County.

The following account of flood conditions appeared in the February 11, 1938, issue of the Monterey Peninsula Herald:

> Torrential rains brought nearly 2 inches of precipitation to the Monterey region in the last 24 hours and combined with the rain earlier this week brought about flood conditions in the Carmel Valley and El Estero in Monterey which threatened to add countless thousands of dollars damage to that already caused by the wind.
>
> At El Estero water finally got so high that drain pipes that were installed last year and have been doing noble work all season could no longer carry the load and the water poured out over Del Monte avenue which is closed for several blocks. Fremont Street between upper and lower El Estero is also under water.

> Houses on the Oak Grove side of El Estero are standing in several feet of water, a foot bridge over the lake from Cemetery Road to Oak Grove is inundated and the Lake Road on the Monterey side is also closed.

Extensive agricultural damage was experienced throughout the county and roads to neighboring communities were closed for hours and even days. Flood conditions within the City of Monterey lasted longer than in other areas.

> With receding waters in all sections, highways were reported open to Salinas, Santa Cruz, and the Watsonville/Pajaro region. Carmel River had fallen several feet by this morning and artichoke fields were nearly completely drained of storm waters. Del Monte Avenue in the El Estero region was still under water today but the region was also draining slowly.

The year 1969 was perhaps the most severe flood year for Monterey County. There were two distinct floods, one at the end of January and the second a month later at the end of February; each of these resulted in Monterey County being declared a disaster area. In each flood, both Salinas and Carmel Rivers went on a rampage. Damage from the storms was extremely costly. As noted in the Monterey Peninsula Herald of January 27, 1969: "County officials said they were certain that the $6.5 million flood damage caused along the Salinas River in 1966, of which 4 million was in Monterey County alone, would be exceeded."

Although the City of Monterey received extreme precipitation, over 8.5 inches for the month of January compared to less than 4 inches in a normal year, the City of Monterey itself fared much better than unincorporated areas of the county and some other surrounding communities. Results of the January deluge within the city caused localized flooding of streets, partial flooding of El Estero, and closing for short periods of time of Del Monte Avenue.

As previously noted, the storms of February 1969 also resulted in Monterey County being declared a disaster area. Once again, the Cities of Monterey and Del Rey Oaks were not as seriously affected as other parts of the county. However, localized flooding did occur.

In the City of Gonzales, the severity of floods and the relative development of the area vary from year to year. Accordingly, the damage resulting from these floods reflects the prevailing conditions. Within the Gonzales area, the most significant flood conditions occurred in 1911, 1914, 1941, 1958, 1966, 1969, and 1978.

The headline in the March 11, 1911, issue of the Salinas Valley Rustler described storm conditions in the area graphically: "Most Destructive Storm in the History of the Oldest Inhabitant." The following account in the paper described flood conditions within the general area:

> Many old timers who have talked with the Rustler during the past week personally and over the phone all agree that it was the worst

> storm that ever visited Monterey, San Benito, and San Luis Obispo counties.
>
> Old ravines and gullies were deepened and widened and new ones cut through; the mountain roads were converted into deep gullies through which the waters rushed down to the valleys in a wild race to swell the ever increasing turbulence of the violent Salinas.
>
> The waters are not receding and the storm is over. It will cost $500,000 to $600,000 to repair county bridges in the three adjoining counties mentioned.

The storms of January 1914 did significant damage throughout Monterey County. Damage to county bridges was estimated to exceed $300,000, and damage to properties throughout the county came to over $1 million. The Salinas Daily Index of January 27, 1914, summarized conditions as follows:

> Monterey County has suffered an enormous loss through the damage and destruction of bridges. Passengers arriving from Soledad and Gonzales say private reports received at those places indicate the loss of all the bridges south of Chualar. The Bradley, San Ardo, San Lucas, King City, Soledad bridges are gone. Two spans of the Gonzales bridge have gone out. At Chualar, one end of the bridge has sunk two feet and is one foot out of line. At Gonzales, the people were this morning constructing a cable line over which to send food and supplies on the other side.

In February 1938, Salinas River again flooded. The headline in the Rustler-Herald of Monday, February 14, stated: "Flood Takes Out Soledad Bridge—Continued Rain Starts Salinas River on First Flood in Many Years."

Apparently conditions within Gonzales itself were not severe; however, flood conditions existed both north and south of the city:

> Roaring waters carried away two spans of the steel Soledad Bridge early Friday night and the old wooden bridge across the Salinas River at Chualar.
>
> Streams in the district were setting high water records for many years, some residents declaring that even Friday morning they were higher than at any time since 1916.

The winter of 1940-1941 produced record precipitation in the Gonzales area. As recorded in the March 6, 1941, issue of the Rustler-Herald:

> Clear skies and bright sunshine were welcomed here Wednesday, following a rainstorm which left 3.15 inches of precipitation.

> Water drained into the Soledad underpass Monday at such a rate that the pumping equipment was overtaxed and Highway 101 was flooded to the height of 4 feet at the low point of the underpass. Traffic in both directions was halted for 5 hours and stretched a distance of several miles, until auxiliary pumps cleared the road's surface. Some traffic to King City was diverted over the Metz Road. Streets were flooded at Soledad, and old timers said the water was highest since 1910.

In 1952, there was more significant precipitation in the Gonzales area. In spite of the heavy rainfall, damage in the area was not severe. As noted in the Rustler-Herald of January 17, 1952:

> The turbulent Salinas River, swollen by the heaviest rainfall in 10 years, is flowing bank to bank the length of the Salinas Valley. Through Paso Robles, where the Salinas is about 400 feet across, the river is described as flowing at a furious pace. Some damage has been done to shanties and the river bottom, livestock have been lost and property threatened.
>
> According to rain figures compiled by the Rustler-Herald from L. Ray Milling Company records, this year to date has 8.69 inches. In 1914, the year the King City Bridge went out, 5.72 inches had fallen by January 17. In February of 1938, the year the Soledad Bridge went out twice, 8.49 inches was recorded. This year the total to date is ahead of those record years.

The torrential rains of early April 1958 brought flood conditions to numerous counties in northern California. Monterey County was no exception. As recorded in the Rustler-Herald of April 10, 1958, the Gonzales area was threatened by high water levels:

> Residents of SoMoCo were enjoying the first real run of sunshine in nearly a month this week following a series of damaging storms. Rainfall, which approached the all-time high of 1940-41, raised all streams in the area to flood levels.

Flood conditions along the length of Salinas River caused extensive damage during the storms of January 1966. Most of this damage was to agricultural crops. Over 32,000 acres were inundated at an estimated damage of $6,572,000. The Rustler of December 8, 1966, carried the following account of conditions in the area:

> Valley residents, still staggering from one of the worst storms in history, were bracing themselves for another blast which forecasters say will hit here sometime tonight or tomorrow. Damage from the current storm is expected to be in the hundreds of thousands of dollars. Hardest hit in the South County was the Arroyo Seco area where the rampaging Arroyo Seco tore out

> cabins, house trailers, fences, and dug into valuable farm land washing out crossings before cresting shortly after noon Tuesday.

The City of Gonzalez was spared significant flooding as the water receded without leaving the banks of Salinas River near the city.

Perhaps the most severe flood year in Monterey County was 1969. There were two floods, one at the end of January and the second at the end of February. Each or these resulted in Monterey County being declared a disaster area. Damage from the storms was extremely costly. As noted in the Monterey Peninsula Herald of January 27, 1969:

> County officials said they were certain that the 6.5 million flood damage caused along the Salinas River in 1966, of which 4 million was in Monterey County alone, would be exceeded.

Conditions within the Gonzales area, though not as severe as in some places, were significant. As described in the Rustler, on January 23, 1969:

> In a county where rain is priceless, SoMoCo folks today were yelling uncle looking hopefully for a respite from the 4-day storm that plummeted the area with anywhere from 3.27 inches (City of King) to 16.04 inches (the Indians) during a 72-hour period from Saturday through Tuesday.

On January 30, 1969, the Rustler summarized conditions in the area as follows:

> Flood damage in the County, when all figures are in, is expected to top the $10 million mark. Road Commissioner Bruce McLain set damage to County roads and bridges at $985,000. Damage to the county-owned sewage facility at Chualar is expected to send this figure over $1 million. City Manager Karel Swanson (King City) estimated damage to City property at $35,000. Hardest hit was the golf course where three holes were flooded and two bridges washed out. There was also extensive damage to city-owned sewage settling ponds near the San Lorenzo Creek and the road to the ponds was washed out. Swanson said an effort will be made to secure State and Federal funds for repair of City facilities.
>
> Damage to farmlands and crops is expected to be in the millions of dollars. Hundreds of acres of land along the Salinas River and the South County were flooded and there are reports of pumps inundated by flood waters. Gonzales' sewer system was also hard hit by the flood and preliminary estimate of damage was set at $125,000 by City Manager Irvin Goldman.

In the City of King City, the headline in the March 11, 1911, issue of the Salinas Valley Rustler described storm conditions in the area graphically, "Most Destructive Storm in the History of the Oldest Inhabitant."

> Many old timers who have talked with the Rustler during the past week personally and over the phone all agree that it was the worst storm that ever visited Monterey, San Benito, and San Luis Obispo Counties.
>
> Old ravines and gullies were deepened and widened and new ones cut through; the mountain roads were converted into deep gullies through which the waters rushed down to the valleys in a wild race to swell the ever increasing turbulence of the violent Salinas. Tuesday morning it was found that the San Lorenzo Wagon Bridge was gone and a great slice of Charles Bischof's and Bruce Douglass' town property was carried away.
>
> Thompson's Gulch guided the mountain torrent that took out the bridge of the county road that crosses the gulch near the Salinas River, so it has been impossible without an airplane to go north for nearly a week.
>
> Reports from contiguous territory east are still very meager, but the fact that telephone lines are down and roads washed out is sufficient warrant for fearing the worst. It is hoped that the loss, when it becomes known, may not prove so great as all seem to fear.
>
> The waters are now receding and the storm is over. It will cost $500,000 to $600,000 to repair county bridges in the three adjoining counties mentioned.

The storms of January 1914 did significant damage throughout Monterey County. Bridges in King City, Soledad, Gonzales, Chualar, San Ardo, and Nacimiento were all washed out by raging floodwaters. Damage to these bridges was estimated to exceed $300,000, and damage to properties throughout the county came to over $1,000,000. Within King City, flood conditions were significant. The following account appeared in the January 29, 1914, issue of the Salinas Valley Rustler:

> The storm Friday and Saturday two weeks ago, which gave 5.05 inches of rain to this valley, probably precipitated several times that amount of rainfall on the Salinas Valley watershed, which is the largest in the world for the length of the valley. The springs, feeder streams and all watersheds were filled to overflowing when the next big storm came last Saturday, which started the Salinas River and larger streams and watercourses connecting with it on the wildest rampage known in the life of the oldest settler.
>
> At this point, the temporary approach to the Salinas River Bridge, built after the previous flood, was washed away together with 60 feet of the bank for a couple of hundred yards. The river was bank-full, over 20 feet deep and half a mile wide—a seething torrent

> with a roar that could be heard for miles, which carried out jetties and in some places carried off the houses, barns and lands of farmers.

In December 1931, the King City area received record precipitation. However, this rain was welcome in the area and did not cause flood conditions. The headlines in the Salinas Valley Rustler of January 1, 1932, noted: "Downpour Breaks December Record in King City, With Total for Month Registering 5.67 Inches."

Other areas of the county suffered much more from these December storms.

> Conditions in general were better about this district, with practically no damage reported. From the south and Peninsula districts, reports of thousands of dollars worth of damage amassed, and it will be several days before an estimate can be made of the exact amount.

In February 1938, Salinas River again flooded. The headline in the Rustler-Herald of Monday, February 14, stated: "Flood Takes Out Soledad Bridge—Continued Rain Starts Salinas River on First Flood in Many Years."

Conditions within the city itself were not severe; however, flood conditions existed very near the corporate limits.

> Roaring waters carried away two spans of the steel Soledad Bridge early Friday night and the old wooden bridge across the Salinas River at Chualar.
>
> Streams in the district were setting high water records for many years, some residents declaring that even Friday morning they were higher than at any time since 1916.
>
> As tributaries of the Salinas River poured turbulent waters into the main channel, that stream was nearing flood stage Friday morning with the entire east channel here in King City full and before noon it started running down the entire west channel as well. Thursday night the Arroyo Seco River was already at flood stages and had inflicted severe damages to resorts and ranches along the stream.
>
> Many ranchers throughout the area were said to be stranded at home by washed out and impassible roads. Among them was Mrs. Peter Duckworth, reported marooned Friday by rising waters in Chalone Creek Canyon near Metz without an adequate supply of food.
>
> Friday morning the San Lorenzo was roaring bank to bank and before the crest reached here was flooding portions of the Bengard orchard just west of the San Lorenzo Highway Bridge.

The winter of 1940-1941 produced record precipitation in the King City area, as recorded in the March 6, 1941, issue of the Rustler-Herald.

> Clear skies and bright sunshine were welcomed here Wednesday, following a rainstorm which left 3.15 inches of precipitation.
>
> This brings the total for the 1940-41 season to 19.35 inches at King City. Not since in the 1890s has so much rain fallen here. Previous record rainfall for any one season locally was 17.21 inches recorded in 1910-11.
>
> Water drained into the Soledad underpass Monday at such a rate that the pumping equipment was overtaxed and Highway 101 was flooded to the height of 4 feet at the low point of the underpass. Traffic in both directions was halted for 5 hours and stretched a distance of several miles, until auxiliary pumps cleared the road's surface. Some traffic to King City was diverted over the Metz Road. Streets were flooded at Soledad, and old timers said the water was highest since 1910.

Another year of significant precipitation in the King City area was 1952. In spite of the heavy rainfall, damage in the area was not severe. As noted in the Rustler-Herald of January 17, 1952:

> The San Lorenzo River was a regular torrent early this week and, according to Geraldine McCoy, of Metz, Chalone Creek is flowing for the first time since 1941. Water was in Monroe Canyon for the first time in 10 years.
>
> King City and vicinity has little time to wring itself out between storms as the region is being pelted with the heaviest rainfall in 10 years. Already the total to date has surpassed the season total for last year and is ahead of the wettest year on record since 1909.
>
> According to rain figures compiled by the Rustler-Herald from L. Ray Milling Company records, this year to date has 8.69 inches. In 1914, the year the King City Bridge went out, 5.72 inches had fallen by January 17. In February of 1938, the year the Soledad Bridge went out twice, 8.49 inches was recorded. This year the total to date is ahead of those record years.

The torrential rains of early April 1958 brought flood conditions to numerous counties in northern California. Monterey County was no exception. As recorded in the Rustler-Herald of April 10, 1958, King City received its share of flood damage.

> Residents of SoMoCo were enjoying the first real run of sunshine in nearly a month this week following a series of damaging storms.

> Rainfall, which approached the all-time high of 1940-41, raised all streams in the area to flood levels. In King City, where the season total reached 21.81 inches, the San Lorenzo Creek overran its banks and inflicted heavy damage on the golf course and Tulio Bacciarini's adjacent field. The sixth and seventh holes are still unplayable and Bacciarini will have to replant seven of his ten acres which were in sugar beets. At the North Hatchery, 23,000 two-week old chicks were drowned April 2. Mr. and Mrs. Harlo Orr who operate the hatchery, estimated damage at approximately $9,500.

Flood conditions along the length of Salinas River caused extensive damage during the January 1966 storms. Most of this damage was to agricultural crops; over 32,000 acres were inundated, and damage was estimated at $6,572,000. King City experienced some flooding and damage, although the rural areas and agricultural production were affected most. As noted in the Rustler of December 8, 1966:

> Yards and yards of fill dirt were swept away as the San Lorenzo Creek climbed over its banks and flooded large portions of the King City golf course Tuesday. Most of the sixth and all of the seventh fairway were inundated as was much of Tulio Bacciarini's adjoining farmland. Portions of the eighth and ninth fairways were also flooded.

Conditions within King City although not as severe as in some other areas, were significant. As described in the Rustler, January 23, 1969:

> Ironically, King City with the lightest rainfall in the area, was probably the hardest hit by the storm. Flood waters from the raging San Lorenzo Creek poured over the sixth, seventh, and eighth fairways at the King City Golf Course taking out the bridge at the sixth and stripping another at the seventh. Receding waters left tons of silt and debris on the fairways and greens.
>
> Heavy damage was also reported at Stephens' Repair Shop east of the railway tracks where flood waters ripped away large areas of the fence, ruined several motor cars, and actually carried away a complete 1957 Plymouth sedan and a Volkswagen. "They are probably on their way to the Pacific Ocean," reported Buck Stephens, co-owner of the business.
>
> The rampant San Lorenzo left untold damage in its wake, taking out a footbridge in the vicinity of Joaquin Murietta Labor Camp on Bitterwater Road and overflowing into several farm fields east of King City. The Salinas River was also flowing bank to bank with the Highway 101 bridges in King City and took on additional force downstream when joined by the raging Arroyo Seco near Soledad.

One week later, on January 30, 1969, the Rustler summarized conditions in the area as follows:

> Flood damage in the County, when all figures are in is expected to top the $10 million mark. Road Commissioner Bruce McLain set damage to County roads and bridges at $985,000. Damage to the county-owned sewage facility at Chualar is expected to send this figure over $1 million. City Manager Karel Swanson (King City) estimated damage to City property at $35,000. Hardest hit was the golf course where three holes were flooded and two bridges washed out. There was also extensive damage to city-owned sewage settling ponds near the San Lorenzo Creek and the road to the ponds was washed out. Swanson said an effort will be made to secure State and Federal funds for repair of City facilities.
>
> Villa Way through the new Bengard subdivision in King City, was covered with flood water when San Lorenzo Creek, at its all-time high, poured over its banks and an adjacent manmade levee.
>
> Damage to farmlands and crops is expected to be in the millions of dollars. Hundreds of acres of land along the Salinas River and the South County were flooded and there are reports of pumps inundated by flood waters. Gonzales' sewer system was also hard hit by the flood and preliminary estimate of damage was set at $125,000 by City Manager Irvin Goldman.

The winter of 1972-1973 again brought flood conditions to the King City area, as recorded in the Rustler of February 15, 1973.

> City crewmen and a handful of volunteers made an attempt to save the King City Golf Course from flood damage Saturday afternoon as the raging San Lorenzo Creek lapped onto the fairway just off the sixth green. However, heavy rains through the night pushed the creek level ever higher and Sunday morning water poured over and around the sandbag barricade, inundating the green and portions of the fairway.

In 1978, flood conditions once more occurred in the King City area. As noted in the Rustler of February 16, 1978:

> The Salinas River as seen from the old San Lucas Bridge, looked like the muddy Mississippi last weekend as it stretched bank to bank. At the Allen Giudici Ranch just north of the bridge, the river overflowed its east bank flooding about 40 acres of farmland. Considerable flooding was also reported from the Mission District north.

The article stated that flood damage in King City proper was minimal. The rural areas along Salinas River received the brunt of the storm runoff. The Salinas Californian summarized conditions in the valley as follows:

> Pounding weekend rains have left Salinas Valley farmers looking at an estimated $20,000,000 in flood damages today. Damage was concentrated along the banks of the Salinas River from San Ardo out to the sea.
>
> More than 20,000 of the valley's 200,000 irrigated acres of land were covered with overflow waters from the Salinas River at some point Saturday or yesterday. As much as 1,000 acres of the valley's prime farmlands could be flooded beyond agricultural use this year.
>
> The assessment of damages, exceeding those of even the valley's 1969 flood, comes today from Flood Control Engineer Loran Bunte and Agricultural Commissioner Richard Nutter.
>
> Bunte said the $20,000,000 estimated is based upon his staff's assessment of damages as extensive but perhaps not quite as severe as those of 1969, placed at about $16,000,000. Allowing for inflation, that puts the new flood at about $20,000,000 he said. Damage would have been far more severe if not for the flood control capacities of both Nacimiento and San Antonio Dams, Bunte said. Two dams, almost bone dry just two months ago, were holding 290,000 acre feet of water at Nacimiento and 137,500 acre feet at San Antonio this afternoon. That puts Nacimiento at peak holding capacities already, and with some waters being released over the weekend to leave required flood control storage reserves.

In the City of Marina, sources of flooding come from the Salinas River, tsunami (sea waves generated from oceanic earthquakes, submarine landslides, and volcanic eruptions) runup, Pacific Ocean storms which hit the coast, and blocked storm drains.

The Salinas River has a history of flooding dating back to 1911. In March of 1911, the Salinas River was said to have flooded from its source to its mouth at the Pacific Ocean. The Salinas Valley flooded again in January 1914, February 1938, and in January 1952.

The January 1952 flood was reported in the Salinas Californian as the highest since the 1911 flood. The Salinas River also flooded in April 1958, January 1966, January and February 1969, and February 1978 (FEMA, 1986).

Flooding along the coast is typically associated with the simultaneous occurrence of very high tides, large waves, and storm swells during the winter. Oceanfront development has been hampered by the natural instability of the shoreline and the intense winter weather conditions. The winter of 1983 brought an unusual series of high tides, storm surges, and storm waves (Ott Water Engineers, Inc., 1984).

Tsunami create some of the most destructive natural water waves. As tsunami waves approach shallow coastal water, wave refraction, shoaling, and bay resonance amplify the wave heights.

All of the preceding situations individually can cause flood problems in the City of Marina. During any of these events, blockage of storm drains can occur and can cause local flooding.

In the City of Monterey, the El Estero area was again victimized by the March floods of 1941. The March 3 issue of the Monterey Peninsula Herald carried the following description of flood conditions in this area:

> El Estero swept over its banks Saturday and threatened to assume even more damaging proportions today as local rain gauges ticked off a record precipitation of nearly 3-1/2 inches of continuous rainfall in the past four days…
>
> Del Monte Avenue has been completely closed since Saturday, with traffic detoured around Fremont Street, as El Estero flood waters made a canal of the first aerial out of Monterey.
>
> Roads around El Estero are navigable only by submarine and basements and first floors in Oak Grove are inundated.

A dramatic storm hit the Monterey Peninsula in January 1943. The City of Monterey itself was more fortunate than some surrounding areas. Local street flooding was experienced in the city at the height of the downpour, but it did not create lingering flood conditions. However, precipitation that occurred nearby was especially dramatic. The following description appeared in the January 22 issue of the Monterey Peninsula Herald:

> A downpour of cloudburst proportions flooded upper reaches of the Carmel Valley during Monterey Peninsula's worst storm in a quarter century, it was revealed as reports began coming in from the outlying regions today. While counting the storm damage continued to occupy local residents, it was reported that 5.40 inches of rain had fallen at San Clemente Dam in the 48-hour period ending at 9 a.m. today. During most of yesterday, over 6 feet of water was thundering over the spillway at the rate of 8,000 cubic feet per second (cfs), enough to fill the dam 7 times each day. It is estimated by water company engineers that enough water passed over the spillway during the storm to supply the Monterey Peninsula for the next four years.

The traditional areas of the city that were flood prone again experienced severe conditions in 1952. As noted in the January 15 issue of the Monterey Peninsula Herald:

> Monterey police barricaded Del Monte Avenue below El Estero at 9 a.m. today after El Estero overflowed its banks on two sides. Traffic later was closed over the Pear Street Extension and the two bridges across El Estero when flood waters completely inundated Camino Aguajito near Third Street. Fremont remained the one road north off the Peninsula, and pumps were keeping portions of Fremont open where the runoff from Iris Canyon and other streams overflowed their normal drainage...
>
> City Manager Walter Hahn, Jr., today warned Monterey motorists to be extremely cautious while driving. The storms have damaged the street system seriously, he said, and it may be weeks before they can be repaired. Hahn said the damage to Monterey streets would amount to between $50,000 and $100,000.

Moderate flood conditions occurred within the City of Monterey in January 1956. The Monterey Peninsula Herald carried the following account on January 26:

> A car stalled on Josselyn Canyon Road near the entrance to Santa Catalina School nearly disappeared under flood waters this morning. The car's owner, Kelsey Williams of 1243 Josselyn Canyon Road, said his brakes failed and the car ran into the lake at about 10:15 a.m. Then the water backed up from a clogged drain was only up to the hubcaps of the car. He went home for his jeep, but when he got back, the water had risen almost to the windows of the car.
>
> Elsewhere in Monterey, gullies on San Bernabe Drive and on Via Paraiso in the Monte Regio area caused bad flooding in low spots on those streets. Isabella Street in the Monte Vista section of Monterey and County Road at the railroad crossing near Pacific Grove were reported seriously washed away by heavy water flow.

The torrential rains of early April 1958 brought flood conditions to numerous counties in northern California. Monterey County was no exception. The following account in the Monterey Peninsula Herald on April 3 gives a vivid pictures of conditions in the City of Monterey:

> The Monterey Peninsula's worst storm of modern times smashed the area yesterday and last night and caused untold thousands of dollars of damage...
>
> Hardest hit of the Peninsula communities was Monterey. El Estero spilled out onto Del Monte Avenue, closing the thoroughfare...

> Streets were broken in several spots in the Monte Vista and Monte Regio areas. In addition, virtually every street in the two hilly areas this morning was covered with remnants of debris and mud that were spilled onto them during the intense storm. At Pearl and Houston Streets, the pavement broke over a storm drain and exposed a hole about four feet wide and four feet deep. A motorist told police his car ran into the hole, but bounced in and out of it.
>
> Of a somewhat humorous note was the fact that the Chamber of Commerce office at El Estero was flooded out this morning and could not be opened for business. As a result, records of past rainfalls kept in the office were inaccessible...
>
> The basement of Larket House, state monument at Jefferson and Calle Principal, was flooded.

The raging waters on city streets nearly caused a tragedy involving a public employee who was trying to keep the culverts clear of debris.

> A Monterey public works department employee narrowly escaped death during last night's torrential rains when he accidentally was swept into a culvert. The man, William Scopell, 46, of 230 Foam Street, Monterey, was carried about 40 feet through the culvert. He was rescued by Monterey Police Captain Robert Trenner. Trenner said Scopell jetted out of the lower end of the 30-inch pipe 'like a bullet.'

As the storm subsided, estimates of damage were calculated. As noted in the April 7 issue of the Monterey Peninsula Herald, "City Manager Alfred D. Coons guessed that total flood damage in Monterey alone might amount to between $300,000 and $400,000."

Although not as serious as the 1958 flooding (or that to come in 1969), flood conditions did exist within the City of Monterey in December 1966. As chronicled in the December 6 issue of the Monterey Peninsula Herald:

> Highway warning signs tell the story at several spots along Fremont in both Seaside and Monterey this morning. Lanes of traffic were closed at El Estero in Monterey and other intersections in Seaside.
>
> The flood conditions also affected other areas of the city: In Monterey, the most serious flooding problem occurred during the night in the Fremont-Perry Land area where water entered the basements of several businesses and houses.

Perhaps the most severe flood year for Monterey County was 1969. There were two distinct floods, one at the end of January and one at the end of February; each of these resulted in Monterey County being declared a disaster area. In each flood, both the Salinas and Carmel Rivers went on a rampage. Damage from the storms was extremely costly. As noted in the Monterey Peninsula Herald on January 27: "County officials said they were certain that the $6.5 million flood damage caused along the Salinas River in 1966, of which 4 million was in Monterey County alone, would be exceeded."

Although the City of Monterey received extreme precipitation, over 8.5 inches for January compared to less than 4 inches in an average year, the city itself fared much better than unincorporated areas of the county and some other surrounding communities. Results of the January deluge within the city caused localized flooding of streets, partial flooding of El Estero, and closing of Del Monte Avenue for short periods of time.

Although the storms of February 1969 resulted in Monterey County being declared a disaster area, the city was not as seriously affected as other parts of the county. However, localized flooding did occur.

In February 1978, moderate flood conditions again occurred in Monterey. This precipitation produced moderate flooding in downtown streets, which cleared within 1 or 2 hours.

Flooding along the coast in Monterey is typically associated with simultaneous occurrence of very high tides, large waves, and storm swells during the winter. As a result, beachfront development has not been compatible with the natural instability of the shoreline and the intense winter weather conditions.

Tsunami (sea waves generated from oceanic earthquakes, submarine landslides, and volcanic eruptions) create some of the most destructive natural water waves. As tsunami waves approach shallow coastal waters, wave refraction, shoaling, and bay resonance amplify the wave heights.

Storm centers from the southwest produce the type of storm pattern most commonly responsible for the majority of the serious coastal flooding. The strong winds and high tides that create storm surges are also accompanied by heavy rains. In some instances, high tides back up riverflows, which causes flooding at the river mouths.

The most severe storms to hit the California coast occurred in 1978 and 1983, when high water levels were accompanied by very large storm waves. Significant storms and associated damage strike the Monterey Bay communities with a frequency of one large storm every 3 to 4 years (Ott Water Engineers, Inc., 1984).

In Monterey County, investigation of flooding from 1911 through 1978 indicates that flood conditions and flood damage were experienced in portions of the county in March 1911, January 1914, February 1922, November 1926, December 1931, February 1937, February 1938, March 1941, January 1943, February 1945, January 1952, December 1955, January 1956, April 1958, February 1962, December 1966, January and February 1969, February 1973, and February 1978. In rural areas, flooding in early years was often viewed as an asset rather than a liability. The need for water to irrigate agricultural crops outweighed the damage done by floodwaters. In later years, as development increased, flood damage became a more important consideration.

Following are descriptions of the flood years in Monterey County. The severity of the floods, and the relative development of the area, vary from year to year. Accordingly, the damage resulting from these floods reflects the prevailing conditions. Within the county, the most significant flood conditions occurred in 1911, 1914, 1938, 1941, 1952, 1958, 1966, 1969, and 1978.

The headline in the March 8, 1911, issue of the Salinas Daily Index described storm conditions in the area graphically: "Disastrous effects of the storm in the Salinas Valley is unprecedented." The following account in the paper described the flood conditions within the general area:

> This storm was the most disastrous in the history of Monterey County and the damaged property is unprecedented. It is reported that more than 2,000 acres of valuable farming land has been destroyed along the course of the Salinas River by the cutting away of the banks of that stream, which is now a raging torrent, freighted with debris, from its source to its mouth on the Bay of Monterey, near Moss Landing... At 10 o'clock the river was said to be higher than at any time since the winter of 1862.

Flood conditions in the Spreckels area were representative of many sections of the county, as described in the Salinas Daily Index.

> At Spreckels, all the lowlands are flooded and the water comes to within thirty feet of the end of the factory, which is protected by a heavy rock embankment. The river is nearly a mile wide at some points there.
>
> The electric light plant and the pumping plant, as well as two large oil tanks near the factory, are half submerged. The No. 2 tank has been torn loose... Barns and outbuildings and farmhouses all along the river bottom south of Spreckels are under water, and tops of a few being all that remain. Everything not securely anchored has been swept away.

The storms of January 1914 did significant damage throughout Monterey County. The following account appeared in the January 26th issue of the Salinas Daily Index:

> Flood conditions prevailed today everywhere throughout the Salinas Valley. Bridges have been carried away, railroad trains tied up, telephone and telegraph service interrupted, and inestimable damage done as a result of the torrential rains of Saturday night and Sunday. Salinas has been isolated as far as

> communications south to Soledad and north to Castroville is concerned...

Damage to bridges in the county was staggering. On January 27th, the Salinas Daily Index described conditions as follows:

> Monterey County has suffered an enormous loss through the damage and destruction of bridges. Passengers arriving from Soledad and Gonzales say private resorts received at those places indicate the loss of all the bridges south of Chualar. The Bradley, San Ardo, San Lucas, King City, Soledad bridges are gone. Two spans of the Gonzales bridge have gone out. At Chualar, one end of the bridge has sunk two feet and is one foot out of line. At Gonzales, the people were this morning constructing a cable line over which to send food and supplies on the other side.

Damage to these bridges was estimated to exceed $300,000, and damage to properties throughout the county came to over $1 million.

A Christmas storm in 1931 brought flood conditions to many portions of Monterey County. Precipitation was dramatic; on the Carmel River, the San Clemente Dam overflowed capacity. As noted in a December issue of the Monterey Peninsula Herald: "Fed by storm swollen streams, San Clemente Dam staged the most sensational rise in history last night, climbing 25 feet in 15 hours." The storm continued for 5 days, bringing damage to Carmel Valley, Big Sur, and the Monterey area.

In February 1938, the Salinas River again flooded. The headline in the Salinas Index-Journal of February 12th stated: "No, not the Mississippi—just the Salinas River." Conditions in the county were serious.

> Going out with a roar that was hardly heard above the driving rain and lashing flood waters of the Salinas River, 208 feet (2 spans) of the Soledad bridge on U.S. Highway 101 was swept downstream at 9:15 p.m. Friday night, adding wreckage to the swollen river which by Saturday afternoon appeared to have reached the peak of one of the severest floods in the valley in years.
>
> At a dozen points along the 70-mile river front from King City to the coast, the churning waters brought to an unprecedented high by the heavy rains in the mountains and valley, brought damage to bridges, crops and roads, halted traffic and marooned an estimated 60 families along the River Road on the west side of the river.

The winter of 1940-41 produced flood conditions within several areas of Monterey County, as recorded in the March 4, 1941, issue of the Salinas Index-Journal.

> The River Road a half-mile south of Spreckels was flooded and motorists were advised not to attempt to negotiate it as it also was under water at other points southward. The Arroyo Seco Road is closed to traffic as is the Pinnacles route out of Soledad. A washout also has blocked the Jamesburg Road in the upper Carmel Valley. Both the piers and the foundations of the approaches to the Toro Creek bridge have been washed out by flood waters, making the span unsafe for traffic.
>
> Streets were flooded at Soledad, and old-timers said that the water was the highest since 1910. At the Trescony Ranch in the San Lucas district, 23 inches of rain has fallen this year to make it the wettest sustained period in history and the largest amount of rainfall for any season since 1890.

A dramatic storm hit Monterey County in February 1945. However, due to the prevailing dry conditions, no appreciable damage resulted from this downpour. The following account appeared in the Salinas Californian on February 2:

> Heavy rains which drenched Salinas and Monterey County yesterday and last night brought a total of 1.69 inches of rainfall in a 36-hour period...
>
> The heavy rainfall was general all over the county, including the southern section of the county, with a report from San Lucas of 3.82 inches for the entire storm. The downpour ended one of the driest spells on record for this time of year and was welcomed by farmers and cattlemen all through the state.
>
> Little damage was reported in this locality, all creeks were up but there were no floods.

As noted in the Salinas Californian of January 16, 1952, was another of the significant flood years within Monterey County.

> The rampaging Salinas River, swelled by 6 days of heavy rain, today had left its banks, flooded Spreckels Junction and forced evacuation by boat of several families in that area and also in Salinas on East John Street. The Salinas-Monterey Highway was closed at Spreckels Junction bridge and probably will not be opened until tomorrow...
>
> Old-timers said the river was the highest it has been since the 1911 flood, and reports this morning from King City said that the stream in that area was rough and high. A crest of the river was expected today when water from yesterday's rain in the mountains reaches this area...

The Salinas area of the county was threatened with potential flood conditions in January 1956. However, conditions never reached a critical stage as described in the Salinas Californian of January 26th.

> Rainfall in the Salinas Valley yesterday and this morning has raised the level of the Salinas River to an all-time high. The crest passed Spreckels about 10:30 a.m. and forced the closing of the Hilltown bridge early this afternoon...
>
> There was more water in the river now than was the case in the pre-Christmas storms (1955). However, the water is flowing faster this time, principally because most of the brush and leaves in the channel were washed away during the Christmas rains.

The torrential rains of early April 1958 brought flood conditions to numerous counties in northern California. Monterey County was no exception, as outlined in the Salinas Californian on April 3rd.

> Flood waters swept through Monterey County today as streams in the Salinas and Carmel Valley watersheds overflowed their banks, closed roads, endangering residents, drowning poultry, and damaging homes. The disaster proclaimed through the state yesterday by Governor Goodwin Knight became a reality early this morning after a near record cloudburst slashed across the county, accompanied by high winds. This was the overall picture today, even as the weatherman warned that additional heavy rain squalls are expected tonight:
>
> 1. The Carmel River has gone over its banks flooding numerous home tracks bordering the river the length of the valley.
>
> 2. The Nacimiento Dam was reported filled and water is being released slowly to take off the peak.
>
> 3. Nearly 3-1/2 inches of rain in 24 hours in the Arroyo Seco has turned the placid stream into a raging torrent ripping through summer cabin sites on its way to the already swollen Salinas River. In the Greenfield area, a marooned family was rescued by Army helicopters.
>
> 4. The Salinas River has overflowed its banks in numerous places, causing the closing of the River and East Garrison Roads. Water may overflow the Salinas-Monterey Highway as a result of the record flow in the Arroyo Seco River.
>
> 5. San Lorenzo Creek overflowed its banks in King City and spread through a chicken ranch, drowning 23,000 birds.

6. Coast Highway 1 to the Big Sur area was closed to automobile traffic by numerous slides.

The two largest floods on the Pajaro River occurred in 1955 and 1958. The associated discharges on the Pajaro River for these events were 24,000 cfs and 23,500 cfs, respectively, at the Chittenden gage. The estimated return periods for these floods are 27 years and 26 years, respectively.

The Salinas Californian carried the following account of flood conditions on February 9, 1962:

> Heavy rains fell on Monterey County last night and this morning, leaving more than an inch of water throughout the Salinas Valley…
>
> In Salinas, there was some flooding along South Abbott Street, in front of the California Rodeo grounds, on North Main Street, along Nacional Street and Pacific Park and at the end of Palma Drive in Serra Park.

The Salinas River did not leave its banks and the flooding described above was the result of localized drainage problems. Flood conditions along the length of the Salinas River caused extensive damage during the storm of January 1966. Most of this damage was to agricultural crops; over 32,000 acres were inundated, at an estimated loss of $6,572,000. The cities in the county experienced some flooding and damage, although the rural areas and agricultural production were the most affected. As noted in the Salinas Californian on December 7th:

> The Salinas River came booming down its bed during the early morning hours today, and by 9:00 a.m. was flowing from abutment to abutment under the new bridge on the Monterey-Salinas Highway.
>
> The river peaked at Bradley at 4:30 a.m. this morning, some three feet above the level reached in the 1958 floods. The crest is expected to hit Salinas about 11 o'clock tonight according to Loran Bunte of the Monterey County Flood Control and Water Conservation District.
>
> The mouth of the river is free, however, Bunte said, and flooding if any, will be minor.

Conditions within the county were described as follows in the Salinas Californian on January 27th:

> The Salinas River cut a multi-million dollar swath of damage through the Salinas Valley from Bradley to the Pacific Ocean today. The valley has been awash in what County Water Engineer

> Loran Bunte calls the 1-percent annual chance flood since Saturday evening. A flood crest only slightly lower than that which passed Spreckels at 40,000 cfs early this morning, is rolling up river from King City this afternoon. The Monterey County Flood Control and Water Conservation District office and the USACE say flooding will continue through Wednesday.
>
> Monterey County Administrator and Civil Defense Director Walter Mansfield declared the county a disaster area Sunday. His declaration triggers the mechanism through which the county may be compensated with federal funds for public facilities damaged by the flood.
>
> Salinas Valley agriculture, which sustained a $3,755,000 loss in the 1966 flood, will almost certainly be hit harder this year.

One month later, the Salinas River again flooded. Once more, much damage occurred, as noted in the Salinas Californian on February 26th:

> The Salinas River, fast, deep and a mile wide, flowed at flood crest through the Salinas Valley this morning, cutting a swath of muddy destruction.
>
> Route 1 was closed at 10:30 a.m. at Twin Bridges near Nashua Road as the river's crest surged toward the ocean, overflowing the highway and drowning the artichoke field delta around Mulligan Hill.
>
> The City of Salinas, which underwent some anxious moments fretting about the possibility of urban flooding last night, remained high and dry as the crest passed. City and county officials had feared a breakthrough by the river in the old Alisal Slough near the Firestone Tire & Rubber Company plant south of town, and the possible intrusion of flood water into the city's industrial area. But it didn't come, although lake-like ponds of surface water now ring the entire Salinas area.

Flood conditions occurred again in the Salinas area and other portions of the county in February 1973, as noted in the Salinas Californian on February 13th:

> A fifth straight day of rain in the Salinas Valley created power failures, closed some Monterey County schools, and added to the mounting alarm of local farmers who face substantial revenue losses from the delay in planting spring crops…
>
> The principal flooding problem in Salinas has occurred on Williams Road near Alisal High School, according to Tom Wong, of the City Public Works Department. The water has been channeled down Williams Road from the foothills and nearby

> farmland, Wong said. But so far the flooding within the city hasn't been serious.

In 1978, flood conditions again occurred in many areas of Monterey County, as noted in the Salinas Californian on February 13th:

> Pounding weekend rains have left Salinas Valley farmers looking at an estimated $20,000,000 in flood damages today. Damage was concentrated along the banks of the Salinas River from San Ardo out to the sea.
>
> More than 20,000 of the valley's 200,000 irrigated acres of land were covered with overflow waters from the Salinas River at some point Saturday or yesterday. As much as 1,000 acres of the valley's prime farmlands could be flooded beyond agricultural use this year.
>
> The assessment of damages, exceeding those of even the valley's 1969 flood, comes today from Flood Control Engineer Loran Bunte and Agricultural Commissioner Richard Nutter.
>
> Bunte said the $20,000,000 estimate is based upon his staff's assessment of damages as extensive but perhaps not quite as severe as those of 1969, placed at about $16,000,000. Allowing for inflation, that puts the new flood at about $20,000,000 he said. Damage would have been far more severe if not for the flood control capacities of both Nacimiento and San Antonio damns, Bunte said. Two dams, almost bone dry just two months ago, were holding 290,000 acre feet of water at Nacimiento and 137,500 acre feet at San Antonio this afternoon. That puts Nacimiento at peak holding capacities already, and with some waters being released over the weekend to leave required flood control storage reserves.

Heavy rains caused extensive flooding and erosion on March 3, 1983, in the Salinas River Valley. Farmland and roadways were damaged, and Monterey County was declared a disaster area. The unofficial peak discharge at the Spreckels gage was 63,172 cfs, close to a 50-year (2-percent annual chance) flood. (The USGS has not verified the Spreckels gage discharge.) The San Antonio and Nacimiento Dams and associated reservoirs aided in attenuating the flows that occurred in the valley.

Flooding along the coast of Monterey County is typically associated with the simultaneous occurrence of very high tides, large waves, and storm swells during the winter. As a result, ocean-front development has not been compatible with the natural instability of the shoreline and the intense winter weather conditions.

2.4 Flood Protection Measures

In the City of Del Rey Oaks, no Federal flood-control facilities exist on the streams affecting the city. However, local interests have provided drainage and improvement projects that affect flood damages within the city. These improvements are generally not adequate to contain the 1-percent annual chance flood flows.

In the City of Gonzales, no Federal flood-control facilities exist on the streams affecting the city. However, local interests have provided drainage and improvement projects that affect flood damage within the city. These improvements are generally not adequate to contain the 1-percent annual chance flood flows.

In the City of King City, several existing projects provide some measure of flood protection along Salinas River. These projects are described in detail in the following discussion. No major flood-control projects have been constructed on San Lorenzo Creek.

There are no flood protection projects located within the City of Marina.

In the City of Monterey, no Federal flood-control facilities exist on the streams affecting the city. However, local interests have provided drainage and improvement projects that affect flood damage within the city. However, these improvements are generally not adequate to contain the 1-percent annual chance flood flows.

Flooding from Josselyn Canyon Creek upstream of State Highway 1 is not included in this study. A storm drain under construction will eliminate all flooding from Josselyn Canyon Creek upstream of the highway.

In Monterey County, there are two significant dams on the Carmel River: Los Padres Dam and San Clemente Dam. These structures were constructed and are operated by the California American Water Company of Monterey, California. Both dams provide water supply for the Carmel-Monterey area. No flood-control storage is allocated in either reservoir, although some flood-control benefits may be attributable to the dams early in the flood season when storage space is available as a result of summer drawdown for water supply. The dams have little effect on reducing peak discharges downstream late in the flood season once they have become full. Los Padres Dam, located in the upper reaches of the basin, is operated in a manner to maintain as much water as possible in San Clemente Dam. After the flood season has passed, flashboards are installed at San Clemente Dam to raise the spillway crest elevation by 12 feet. The flashboards are removed on approximately October 1 of each year, prior to the flood season. Water-supply releases are made from San Clemente Dam, by pipeline, to a downstream treatment plant.

San Antonio Dam is located approximately 7 miles southwest of Bradley on the San Antonio River in Monterey County and intercepts runoff from a drainage area of 330 square miles. It was constructed by the County in 1965. Almost 2,050 cfs were discharged through the outlet works on March 4, 1971, and two spills have since occurred: one in April 1982 (negligible discharge) and one in March 1983 (1,300 cfs). The dam impounds 350,000 acre-feet below its spillway crest, as does Lake Nacimiento; however, San Antonio Reservoir has 300,000 acre-feet of storage for water conservation, including 20,000 acre-feet of dead storage and 50,000 acre-feet storage for flood control. The flood-control storage is equivalent to 2.89 inches of runoff. Like Lake Nacimiento, San Antonio Reservoir was constructed for the purpose of releasing water during the summer to recharge the ground-water supply when the demand for agricultural water is at its peak. Both San Antonio Dam and Nacimiento Dam have a significant effect on the 1- and 500-year (0.2-percent annual chance) flood flows.

Levees have been constructed by private interests on the Carmel River from State Highway 1 upstream approximately 4,000 feet on the north bank, and from 3,000 feet upstream of the mouth to 10,000 feet upstream of the mouth on the south bank. These levees are not adequate to hold the 1-percent annual chance flood.

Low-lying levees located along lower Elkhorn Slough were built privately; they are not maintained and have no effect on the 1-percent annual chance flood.

Levees were completed along the Pajaro River by the USACE in 1949. Levees along the north bank begin just upstream of the mouth at the Pacific Ocean and continue to approximately River Mile 11.8 (Murphy Road); levees along the south bank begin just upstream of the mouth and continue to River Mile 10.6. The levees increased the capacity of the Pajaro River to 22,000 cfs downstream of Salsipuedes Creek, equivalent to a 25-year (4-percent annual chance) flood.

In 1963, the USACE performed additional studies and recommended that the levees along the Pajaro River be modified to provide additional protection (USACE, June 1973). Construction was authorized in The Flood Control Act of 1966, and the project proceeded to the advanced stages of design; but, support in Watsonville was withdrawn and the project was placed in a deferred status (USACE, 1978; USACE, 1974).

There are two ordinances that regulate floodplains in Monterey County. The countywide floodplain ordinance, located in Chapter 16.16 of the Monterey County Code, includes the minimum FEMA requirements for participation in the regular phase of the National Flood Insurance Program (NFIP). Chapter 21.64.130 of the zoning ordinance provides additional floodplain regulation for the Carmel Valley.

In the City of Salinas, two flood protection projects have been completed: Reclamation Ditch, constructed by local interests to replace Alisal Slough, which meandered through the city; and channel improvements for Santa Rita Creek between U.S. Highway 101 and Russell Road, including concrete lining of the channel between U.S. Highway 101 and Santa Rita Street. The concrete lining on

Santa Rita Creek has the effect of confining the 1- and 0.2-percent annual chance flow along the channel between U.S. Highway 101 and Santa Rita Street.

In the City of Sand City, no structural or nonstructural floodplain management measures are in effect.

In the City of Seaside, no Federal flood-control facilities exist on the principal stream affecting the city. Local interests have provided drainage and improvement projects that affect flood damage within the city. However, these improvements are generally not adequate to contain the 1-percent annual chance flood flows.

On May 21, 1981, the City Council adopted Ordinance No. 581, which was incorporated into the City of Seaside Municipal Code as Section 15.28. The ordinance was designed to minimize flood damage in the city.

Salinas Dam, located on Salinas River near Santa Margarita in San Luis Obispo County, was completed in 1942 as a water-supply facility for Camp San Luis Obispo. The dam is approximately 2 miles upstream from Pilitas Creek and 7.5 miles northwest of the Town of Pozo, and intercepts runoff from a drainage area of 112 square miles. The reservoir, Lake Santa Margarita, is operated for water-conservation purposes only and has an estimated average annual yield of 14,000 acre-feet. The dam impounds a usable water-supply capacity of approximately 26,000 acre-feet to its spillway crest and has a maximum capacity of 44,500 acre-feet to the dam crest. The only dependable storage for flood control is spillway surcharge. The effect of reservoir operation on the discharge hydrograph near King City is negligible.

Nacimiento Dam is located approximately 15 miles northwest of El Paso de Robles in San Luis Obispo County and is situated on the Nacimiento River, a major tributary of the Salinas River. The dam was constructed in 1957 by Monterey County and intercepts runoff from a drainage area of 319 square miles. The reservoir impounds 350,000 acre-feet, 150,000 acre-feet of which is for flood control. Ten thousand acre-feet of dead storage lies below the outlet works invert level. The 150,000 acre-foot flood-control storage is equivalent to 8.76 inches of runoff. A total of 200,000 acre-feet (including the 10,000 acre-feet dead storage) are for water conservation and recreation. The water is stored during dry periods. Most of the released water percolates into the gravelly streambed and goes into underground storage in the Salinas Valley, from which it is pumped primarily for irrigation. Storage greater than 200,000 acre-feet occurs in the reservoir only during and just after major storms. Following a flood, the reservoir is drawn down to the 200,000 acre-foot level to provide storage for subsequent flood flows. Lake Nacimiento has spilled three times since its construction: in April 1958, February 1969, and April 1983. The largest spill (3,000 cfs) occurred on February 25, 1969, concurrent with a discharge of 3,770 cfs through the outlet works, for a total discharge of 6,770 cfs. On April 29, 1983, 1,100 cfs overtopped the dam due to high inflow.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this FIS. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 2-, 1-, or 0.2-percent annual chance (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 2-, 1-, or 0.2-percent annual chance floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 1-percent chance of annual exceedence in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of this FIS. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each riverine flooding source studied by detailed methods affecting the community.

For each community within Monterey County that had a previously printed FIS report, the hydrologic analyses described in those reports have been compiled and are summarized below.

Precountywide Analyses

Information on the methods used to determine peak discharge-frequency relationships for the streams restudied as part of this countywide FIS is shown below.

In the City of Del Rey Oaks, flood hydrographs and peak discharges for the 10-, 2-, 1-, and 0.2-percent annual chance floods for Arroyo del Rey were based on statistical analyses of stream gage records and rainfall-runoff computations. For streams with sufficiently long gage records for analysis, discharges are based on statistical analysis directly. For ungaged streams, or gaged streams with insufficient flow records, discharges are based on rainfall-runoff calculations calibrated at a nearby gaged basin. A stream gage is located on Arroyo Del Rey (1967-1978), in Del Rey Park. Due to the short record and the large number of small events in the record, it was not considered adequate for the log-Pearson Type III analysis.

Flood hydrographs were generated based on the U.S. Soil Conservation Service rainfall-runoff procedure. It uses the basin area, unit hydrograph, soil type, ground cover, antecedent moisture conditions, and a storm rainfall depth and time distribution to develop a runoff hydrograph (U.S. Department of Agriculture, 1972).

To ensure the validity of the procedure assumptions for the region, the runoff hydrograph was reconstituted for the February 10-11, 1973, storm at the El Toro Creek stream gage. The basin above the gage was divided into smaller subbasins and unit hydrographs were derived using the S-hydrograph techniques. The soil types were taken from the U.S. Soil Conservation Service soil survey for Monterey County (U.S. Department of Agriculture, 1978). The rainfall depth and time distribution from the Monterey County Flood Control and Water Conservation District rainfall gage at Mount Toro were used. Due to the pervious nature of the soil in the basin, it was necessary to modify the basic U.S. Soil Conservation Service procedure by the incorporation of a minimum infiltration rate. Estimates of minimum infiltration rates for each soil type were based on data from the county soil survey (U.S. Department of Agriculture, 1978). The modified procedure produced a reasonable reconstitution of the 1973 hydrograph.

Peak discharges for other basins were based on the U.S. Soil Conservation Service procedure. The storm pattern from the storm of December 1955 was used to develop hydrographs for floods of the selected recurrence intervals. The storm depths for each subbasin were based on the mean annual precipitation (USACE, Isohyetal Map, 50-year Normal Annual Precipitation, 1906-1956) and a regression equation derived from precipitation stations within the region. Separate regression equations were used for the 10-, 2-, 1-, and 0.2-percent annual chance storms. Basin type and land use factors were selected as described previously for El Toro Creek. Antecedent moisture conditions for each recurrence interval were calibrated based on the results of the analysis of the El Toro Creek stream gage.

The effects of channel and valley (overbank) storage on flood flow rates were determined by developing storage-discharge relationships for reaches of each stream. The storage-discharge relationships were developed by computing a series of water-surface profiles for various flow rates and determining the storage in the reach for each outflow rate. Flood hydrographs from the smaller subbasins were combined and routed downstream using the Modified Puls routing procedure. For areas outside the limits of detailed study, routings were based on the Muskingum Method with velocity of flow estimated.

Capacities of bridges, culverts, and stream channels were considered in developing the final flow rates. Flows in excess of capacity were routed overland and recombined with channel flows where appropriate.

In the City of Gonzales, because Gonzales Slough and East Branch Gonzales Slough are ungaged, peak discharges were calculated using the U.S. Soil Conservation Service rainfall runoff procedure (U.S. Department of Agriculture, 1972). This procedure uses the basin area, unit hydrograph, soil type, ground cover, antecedent moisture conditions, and a storm rainfall depth and time distribution to develop a runoff hydrograph.

The basin above the gage was divided into smaller subbasins, and unit hydrographs were derived using the S-hydrograph technique. The soil types were taken from the U.S. Soil Conservation Service soil survey for Monterey County (U.S. Department of Agriculture, 1978). Due to the pervious nature of the soil in the basin, it was necessary to modify the basic U.S. Soil Conservation Service procedure by incorporating a minimum infiltration rate.

The storm pattern from the storm of December 1955 was used to develop hydrographs for all four recurrence intervals for Gonzales Slough and East Branch Gonzales Slough. The storm depths for each subbasin were based on the mean annual precipitation (USACE, Isohyetal Map, 50-year Normal Annual Precipitation, 1906-1956) and a regression equation derived from precipitation stations within the region. Separate regression equations were used for the 10-, 2-, 1-, and 0.2-percent annual chance storms. Basin type and land use factors were selected as described previously for El Toro Creek.

Antecedent moisture conditions for each recurrence interval were calibrated based on the results of the analysis of the El Toro Creek stream gage.

The effects of channel and valley (overbank) storage on flood flow rates were determined by developing storage-discharge relationships for reaches of Gonzales Slough. The storage-discharge relationships were developed by computing a series of water-surface profiles for various flow rates and determining the storage in the reach for each outflow rate. Flood hydrographs from the smaller subbasins were combined and routed downstream using the Modified Puls routing procedure. For reaches outside of the study area, routings were based on the Muskingum method, with estimated flow velocities.

The capacity of the culverts at the Monterey Vineyard Winery was considered in developing the final flow rates. Flows in excess of capacity were spilled from the pond upstream of the culverts.

In the City of King City, the peak discharges for San Lorenzo Creek were based on log-Pearson Type III analysis (U.S. Water Resources Council, 1977) of the stream-gage records for San Lorenzo Creek below Bitterwater Creek gage (1959-1978).

The peak discharges for Salinas River were based on hydrologic modeling of the basin. A HEC-1 model (USACE, January 1973) was calibrated to fit the frequency-discharge curve for the river prior to the construction of the Nacimiento and San Antonio Dams. This frequency curve was based on Salinas River near Spreckles stream gage (1930-1956) using the log-Pearson Type III analysis including historic adjustment. The flood-control storage-discharge relationships for the dams were added to the model to estimate the regulated discharge for each recurrence interval.

The City of Marina study consisted of the analyses of 22 constructed percolation ponds and natural infiltration areas. Runoff to each of the percolation ponds or natural infiltration areas was determined using the USACE program HEC-1

(USACE, 1973). Watershed areas were defined using the City of Marina topographic mapping with a horizontal scale of 1:2,400 and two-foot contour intervals (Aero-Geodetic Corporation, 1979).

Based on infiltration rates given in the report Soils Study for Permeability Assessment, City of Marina Infiltration Ponds, prepared in conjunction with this revised FIS, it was determined that for most of the percolation basins the outflow rate would equal or exceed the inflows for storm duration beyond 24 hours (Cook, Terry D., 1991). Therefore, a 1-percent annual chance, 24-hour storm was selected for the basin analyses. Runoff from rainfall events of six and ten days were analyzed for basins with significantly lower infiltration rates. The precipitation amounts and distribution were determined by averaging the rainfall statistics for the National Weather Service's Castroville Treatment Plant and Del Monte rainfall gages as determined by the California Department of Water Resources (California Department of Water Resources, 1976). The Monterey County Rainfall Intensities Chart (California Department of Water Resources, 1976), prepared by the County Road Department was also reviewed and compared with the results of the gage statistic analyses.

In the City of Monterey, the storm pattern from the storm of December 1955 was used to develop hydrographs for floods of the selected recurrence intervals for Josselyn Canyon Creek, Del Monte Lake, and El Estero Lake. Antecedent moisture conditions for each recurrence interval were calibrated based on the results of the analysis of the El Toro Creek stream gage.

The outflows from El Estero Lake were based on the maximum pumping capacity of the pump station that drains the lake. The pump station was assumed to be in operation during the entire storm for each recurrence interval.

In Monterey County, peak discharges for San Lorenzo Creek, El Toro Creek, Arroyo Seco, and the Carmel River were based on a log-Pearson Type III analysis of the stream gage records (U.S. Water Resources Council, 1976).

For San Lorenzo Creek, the record for the existing gage (1959-1978) located below Bitterwater Creek gage was supplemented with additional data from years during which a gage was present on the creek at a different location (1940-1942 and 1943-1945). The peak discharges for those years were adjusted to account for the differences in drainage area between the various gage locations.

There are two stream gages on Arroyo Seco. The frequency analysis for the gage on Arroyo Seco near Soledad (1906-1978) was used directly. The statistics for the gage on Arroyo Seco near Greenfield (1962-1978) were adjusted based on correlation with the Soledad gage (U.S. Water Resources Council, 1976; USACE, 1962).

Similarly, the frequency analysis for the Carmel River at the San Clemente Dam spillway (1938-1979) was used directly. The statistics for the gage on the Carmel River near Carmel (1963-1978) were adjusted based on the correlation with the record at San Clemente Dam. The gage record for the Carmel River at Robles del

Rio was not used because of difficulties with the record. Inconsistencies between the three gages are described in a 1974 USACE report (USACE, April 1974).

For ungaged streams, or streams without sufficient gage data for statistical analysis, flood hydrographs were generated based on the SCS rainfall-runoff procedure (U.S. Department of Agriculture, 1972). The procedure uses the basin area unit hydrograph, soil type, ground cover, antecedent moisture condition, and a storm rainfall depth and time distribution to develop a runoff hydrograph.

Peak discharges for Canyon Del Rey, Calera Creek, Castroville Boulevard Wash, Elkhorn Slough, Pine Canyon Creek, San Miguel Canyon Creek, and Tembladero Slough were based on the SCS procedure. The storm pattern from the storm of December 1955 was used to develop hydrographs for all four recurrence intervals.

Mean annual precipitation values were based on an isohyetal map (USACE, Isohyetal Map, 50-year Normal Annual Precipitation, 1906-1956. Basin type and land use factors were selected as described previously for El Torro Creek.

Within major basins, the hydrographs from separate subbasins were combined and routed downstream using the Muskingum routing procedure (D. E. Overton, 1966).

Peak flood flows in the Pajaro River basin for the 10-, 2-, 1-, and 0.2-percent annual chance events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE, 1973). Calibration of rainfall-runoff parameters employed in the model was performed using the techniques described in the HEC-1 user documentation (USACE, 1973, HEC-1 Flood Hydrograph Package, User's Manual).

Flood hydrographs on the Pajaro River are influenced by storage and routing conditions in the overbanks. A flood hydrograph for the Pajaro River was obtained from Interim Report for Flood Control – Pajaro River Basin, California (USACE, June 1973). This hydrograph was scaled to give peak flows corresponding to the most recent USACE estimates. These flood flow estimates account for upstream basin characteristics including regulated storage and are, therefore, more acceptable than USGS estimates based solely on gaged flow records.

Flows used in the hydraulic analysis of Thomasello Creek were developed from HEC-1 computer modeling (USACE, 1973). These flows were adjusted to agree with flows developed by the USACE in an unpublished local drainage study for the area within the Pajaro River basin.

Natividad Creek and Santa Rita Creek flows were derived from the SCS rainfall-runoff model (U.S. Department of Agriculture, 1972). Discharges and storage capacities for Carr Lake were determined in a report prepared by the Monterey County Flood Control and Water Conservation District (MCFCWCD) for the Monterey County Master Drainage Plan (MCFCWCD, 1979).

The Reclamation Ditch flows were derived from the SCS rainfall-runoff model and further modified by storage-discharge curves for Heinz and Carr Lakes. Heinz Lake is a dry lake located southeast of Salinas along Reclamation Ditch. As these derived flows were within 10 percent of the flows of the Carr Lake study (Monterey County Flood Control and Water Conservation District, 1979), the flows derived from the SCS model were used. For Gabilan Creek, the SCS model was used on a weighted-average basis along with statistical analysis of the stream gage and regional regression equations.

Discharges on Corncob Canyon Creek were determined using the SCS rainfall-runoff model upstream of Warner Lake; downstream, the discharge of spills from the Pajaro River were used to determine flow rates.

On Canyon Del Rey, inadequate culvert capacity at several road crossings causes a temporary damming effect as water ponds behind the structures. This results in a lower discharge downstream of the affected culvert. This situation also occurs downstream of Elkhorn Road on Corncob Canyon Creek.

On the Salinas River, floodwaters downstream of Salinas River Overbank cross Nashua Road as weir flow. The flow (4,000 cfs) is trapped between Nashua Road and State Highway 183 and flows into Tembladero Slough.

The Reclamation Ditch flows for this reach were taken from the Carr Lake Study (Monterey County Flood Control and Water Conservation District, 1979). Peak discharge-drainage area relationships for the Reclamation Ditch are shown in Summary of Discharges (Table 4). The flow rate of 4,000 cfs was used to analyze the 1-percent annual chance flooding for Tembladero Slough between Nashua Road and the Southern Pacific Railroad.

Cross sections for the backwater analyses of the Reclamation Ditch for the revised detailed study between Tembladero Slough and Boronda Road were obtained from field surveys.

In the City of Seaside, flood hydrographs and peak discharges for the 10-, 2-, 1-, and 0.2-percent annual chance floods for Canyon Del Rey were based on statistical analyses of stream gage records, and on rainfall-runoff computations. A stream gage is located on Canyon Del Rey in Del Rey Park. However, because of the short record (1967 through 1978) and the large number of small events in the record, it was not considered adequate for the log-Pearson Type III analysis.

Revised Countywide Analyses

For this revision, peak flows on the Carmel River were determined from a frequency analysis of flows at USGS Gage 11143200, Carmel River at Robles Del Rio and USGS Gage 11143250, Carmel River near Carmel. A regional skew values was determined from PEAKFQ. Peak 10-, 2-, 1-, and 0.2-percent annual chance discharge values were calculated at the gages, then scaled by drainage area to a series of index points along the study reach. These values are presented in the Summary of Discharges.

For this revision, peak flows on El Toro, Calera, and Watson Creeks were determined from frequency analysis of flows at USGS Gage 11152540, El Toro Creek near Spreckels, located just downstream of the study reach. An appropriate regional skew value was determined from analysis of seven nearby gages. Peak, 10-, 2-, 1-, and 0.2-percent annual chance discharge values were calculated at the gage, then scaled by drainage area to a series of index points along the study reach. These values are presented in the Summary of Discharges.

The 10-, 2-, 2-, and 0.2-percent annual chance flow is estimated by frequency analysis of recorded peak flows for the El Toro Creek stream gage. Peak flows on the San Benacio watershed were estimated by applying the scaling function to these estimated flows. The estimated peak flow of the subwatersheds of San Benancio Gulch and Harper Creek were computed using regional regression equations. Correction factors were developed by comparing the peak flows of the watershed and subwatersheds at the El Toro Creek gage and San Benancio at El Toro Creek. The subwatershed peak flows are corrected by applying these correction factors. The final values are presented in the Summary of Discharges.

The estimated peak flow of the subwatersheds of San Benancio Gulch and Harper Creek were developed using regional regression equations. Correction factors were developed by comparing the peak flows of the watershed and subwatersheds at the El Toro Creek gage and San Benancio at El Toro Creek. The subwatershed peak flows are corrected by applying these correction factors. The final values are presented in Table 4, "Summary of Discharges."

A summary of the drainage area-peak discharge relationships for all the streams studied by detailed methods is shown in Table 4, "Summary of Discharges."

TABLE 4 – SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ARROYO SECO					
At Soledad gage	244	20,500	34,200	40,100	53,700
At Greenfield gage	113	14,900	24,100	28,000	37,100
CALERA CREEK					
At confluence with San Benancio Creek	25.4	464	1,274	1,768	3,305
At confluence with Watson Creek	12.7	249	689	962	1,824

TABLE 4 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ARROYO DEL REY					
At Laguna Del Rey Inflows	14.3	265	480	560	1,130
At Roberts Lake Outflow	14.3	110[1]	310[1]	480[1]	1,020[1]
At Fremont Boulevard	13.1	250[1]	490[1]	675[1]	1,410[1]
At Kolb Avenue	13.1	240[1]	450[1]	525[1]	1,090[1]
At Fort Ord South Boundary Road	10.0	250	565	720	1,450
CANYON DEL REY					
At Blue Larkspur Lane	5.3	120	210	295	990
Downstream of Laguna Seca Ranger Station	2.2	30[1]	230[1]	275[1]	440[1]
At Laguna Seca Ranger Station	2.2	140	300	365	600
CARMEL RIVER					
Pacific Ocean	254	9,800	19,000	23,300	33,500
Below Potrero Creek (USGS Gage near Carmel)	246	9,500	18,500	22,700	32,600
Below Robinson Canyon Creek	228	9,300	17,300	20,900	29,200
Below Los Garzas Creek	210	8,600	16,100	19,400	27,200
Below Hitchcock Creek (USGS Gage Robles Del Rio)	193	8,400	14,900	17,700	24,100
Below Tularcitos Creek	184	8,000	14,300	16,900	23,100
Below San Clemente Dam	125	5,700	10,200	12,100	16,600
CASTROVILLE BOULEVARD WASH					
At Elkhorn Road	3.5	25	80	125	270
CORNCOB CANYON CREEK					
At confluence with Elkhorn Slough	3.0	85	875[2]	970[2]	1,560[2]
At Elkhorn Road (upstream crossing)	2.9	85	1,075[3]	1,350[3]	2,220[3]
At Lewis Road	1.5	10	65	95	190

[1]Reduced or constant flow values due to capacity restriction
[2]Reduction in flow values due to capacity restrictions at roads
[3]Includes discharge from Pajaro River spill

TABLE 4 – SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
DEL MONTE LAKE					
Total inflow	2.9	105	285	340	550
At Josselyn Canyon Creek	1.3	40	110	145	250
At State Highway 68 Canyon	0.8	45	100	120	200
EAST BRANCH GONZALES SLOUGH					
At U.S. Highway 101	2.3	55	135	195	260
EL ESTERO LAKE					
Total inflow	4.2	210	460	550	930
East inflow	2.4	90	220	270	465
West inflow	1.2	60	130	160	270
EL TORO CREEK					
At El Toro Gage (11152540)	31.9	574	1,560	2,160	4,020
ELKHORN SLOUGH					
At State Highway 1	48.7	370[1]	960[1]	1,200[1]	2,330[1]
At Elkhorn Road	34.0	475	1,370	1,740	3,460
At Maher Road	22.0	410	1,200	1,530	3,021
At U.S. Highway 101	4.4	120	325	400	760
GABILAN CREEK					
At Herbert Road	36.7	600	1,500	2,000	3,100
GONZALES SLOUGH					
Below football field	17.6	40[2]	75[2]	230[2]	290[2]
Below 7th Street	17.5	45[2]	150[2]	250[2]	320[2]
Below 1st Street	17.4	65[2]	230[2]	310[2]	420[2]
Below confluence with East Branch Gonzales Slough	17.4	160	300	360	430
Below Monterey Vineyard Culvert	15.1	120[3]	165[4]	165[4]	165[4]
Above Monterey Vineyard Culvert	15.1	120[3]	250[3]	400[3]	690[3]
HARPER CREEK					
At San Benancio Gulch	2.21	50	143	202	390

[1]Reduction in flow values due to overbank storage in tidal flats
[2]Flow values reduced due to channel and overbank storage
[3]Flow values reduced due to upstream diversions
[4]Flow values reduced due to capacity restriction

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
JOSSELYN CANYON CREEK					
At Del Monte Lake	1.3	40	110	145	250
NATIVIDAD CREEK					
At Laurel Drive	10.0	190	560	700	1,330
PAJARO RIVER					
Downstream of confluence with Salsipuedes Creek	1,275.0	14,300	32,500	43,600	76,200
PINE CANYON CREEK					
At Jolon Road	15.6	650	1,200	1,500	2,200
RECLAMATION DITCH					
At confluence with Tembladero Slough	124	*	*	1,300	*
At Espinosa Drain	108	*	*	1,125	*
Downstream of Carr Lake	100	610	910	1,050	1,300
Downstream of Heinz Lake (southeast of City of Salinas)	39	330	430	470	540
SALINAS RIVER					
At Bradley	2,536	35,000	67,000	88,000	124,000
At King City	3,220	35,000[1]	66,000[1]	86,000[1]	123,000[1]
At Spreckels	4,156	35,000[1]	64,000[1]	85,000[1]	121,000[1]
Downstream of Salinas River overbank	4,156	35,000	64,000	81,000[2]	121,000
SAN BENANCIO GULCH					
At El Toro Creek	5.86	132	360	499	936
At Harper Creek	3.25	74	206	289	552
SAN LORENZO CREEK					
At First Street	260	7,090	14,800	18,700	28,800
SAN MIGUEL CANYON CREEK					
At downstream crossing of U.S. Highway 101	12.8	145	490	690	1,460

[1]Constant or reduced flows due to infiltration into riverbed
[2]Reduction in flow due to spill over Nashua Road
*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
SAN MIGUEL CANYON CREEK (continued)					
At upstream crossing of U.S. Highway 101	8.2	90	305	440	940
At State Highway 156	6.0	65	250	300	750
At Echo Valley Pond	1.5	15	50	80	160
SANTA RITA CREEK					
At North Main Street (in City of Salinas)	4.2	160	400	465	810
TEMBLADERO SLOUGH					
At State Highway 1	135	960	1,110	4,000	4,000
THOMASELLO CREEK					
At confluence with Pajaro River	3.6	370	590	850	1,560
WATSON CREEK					
At confluence with Calera Creek	7.5	155	430	604	1,157

The stillwater elevations have been determined for the 10-, 2-, 1-, and 0.2-percent annual chance floods for the flooding sources studied by detailed methods and are summarized in Table 5, "Summary of Stillwater Elevations."

TABLE 5 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD*)			
	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
CARR LAKE				
Northeast of U.S. Highway 101	42.8	45.4	46.6	48.9
EL ESTERO LAKE				
At shoreline	8.3	10.5	11.4	13.8
PACIFIC OCEAN				
At Moss Landing	7.3	7.5	7.6	7.8
At Salinas River Beach	7.3	7.5	7.6	7.8
At Sand City	7.5	7.7	7.8	8.0
At Seaside	7.5	7.7	7.8	8.0
At Monterey	7.4	7.7	7.8	8.0

*North American Vertical Datum of 1988

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Precountywide Analyses

For each community, which had a previously published FIS, within Monterey County, the hydraulic analyses described in those reports have been compiled and are summarized below.

Information on the methods used to determine peak discharge-frequency relationships for the streams restudied as part of this countywide FIS is shown below.

In the City of Del Rey Oaks, flood elevations were computed through the use of the USACE HEC-2 step-backwater computer program (USACE, 1973) and were supplemented by hand calculations where required.

Topographic data for channel cross sections were obtained from existing topographic mapping (Monterey County Flood Control and Water Conservation District, 1977) supplemented with field survey data as necessary.

Cross sections for backwater analysis were located at small intervals upstream and downstream from bridges and culverts and other hydraulically significant features in order to establish the backwater effect of such structures in areas presently urbanized or potentially subject to development. All bridges and culverts were measured to determine channel geometries at flow restrictions.

Some areas in Del Rey Oaks are subject to sheet flow originating from Arroyo Del Rey. Shallow overland flooding is generally less than 3 feet deep, characterized by unpredictable flow paths. The depths of flooding in these areas are essentially independent of those along the adjacent streamway and are affected principally by obstructions in the flooded area. These depths were hand calculated using field inspection and engineering judgment and compared with existing topographic information.

Due to the limited storm drain capacity, the entire City of Del Rey Oaks is subject to shallow flooding averaging less than 1 foot and not associated with the channel.

In the City of Gonzales, water-surface elevations of the 10-, 2-, 1-, and 0.2-percent annual chance floods were computed through use of the USACE HEC-2 step-backwater computer program (USACE, October 1973).

Cross sections for the backwater analyses were obtained from aerial photographs (Harl Pugh & Associates, 1978). All bridges and culverts were surveyed to determine channel geometry at flow restrictions.

Cross sections for Gonzales Slough were taken sufficiently downstream of the corporate limits to ensure that the starting water-surface elevation assumptions would not influence the water-surface profiles within the study reach. Starting water-surface elevations for East Branch Gonzales Slough were set equal to the concurrent water-surface elevations at its mouth in Gonzales Slough. This was done because the peak flows in the two creeks are nearly coincident.

Areas where runoff in excess of storm drain capacity would collect and pond were evaluated as part of a sheet flow flooding investigation. Sheetflow is shallow overland flooding generally less than 3 feet deep and unrelated or not readily associated with channel flooding and flood profiles. The water-surface elevations of sheet flow flooding are essentially independent of those along adjacent stream channels and are affected principally by obstructions in the flooded area.

Areas along Old U.S. Highway 101 and Alta Street were studied for sheet flow flooding downstream of a spill from the pond located on the Monterey Vineyard Winery property near the upper end of Gonzales Slough. Water from the spill caused flooding over 1 foot deep in only one small area and will pond in the area of Alta Street and U.S. Highway 101.

These areas were delineated using surveyed and photogrammetric elevations, field investigations by experienced engineers, and hand calculations based on normal depths.

In the City of King City, the starting water-surface elevations for San Lorenzo Creek were based on critical depth in the constricted section where the creek discharges into the Salinas River floodplain. Starting water-surface elevations for Salinas River were based on normal depth approximately 2 miles downstream.

In the City of Marina, Salinas River stationing was based on the Pacific Southwest Inter-Agency Committee River Mile Index. Correlation was made at certain river mile locations, resulting in some minor distortion between such locations because of scale change and uncertainties in the location of the channel centerline (FEMA, 1986).

The starting water-surface elevation for the Salinas River, which drains into the Pacific Ocean, is near higher high-water.

Channel roughness factors (Manning's "n") for hydraulic computations were assigned on the basis of field inspection of floodplain areas. Roughness factors for the Salinas River were determined by calibration through successive iterations using high-water marks for the January 18-21 and February 23-28, 1969, flooding events and stage-discharge data for the February 8-12, 1978, flood event. The 1969 high-water marks were obtained from a USACE report on the January and February floods (USACE, 1970). The 1978 stage-discharge data were obtained from the USGS (U.S. Department of the Interior, 1978) for the Salinas River stream gages at Bradley and Spreckels.

In the City of Monterey, flood elevations along Josselyn Canyon Creek, Del Monte Lake, and El Estero Lake were determined by hand calculations in conjunction with the drainage-discharge information.

Starting water-surface elevations for Josselyn Canyon Creek were obtained using the mean higher high water at Monterey Bay.

The profiles for Arroyo Del Rey were obtained from the FIS for the City of Seaside (FEMA, 1981).

An area south of the western end of Garden Drive is subject to shallow overland flooding that is generally less than 3 feet deep and is characterized by unpredictable flow paths. The water-surface elevations of flooding in these areas are essentially independent of those along the adjacent streamway and are affected principally by obstructions in the flooded area. These flood elevations were hand calculated by field inspection and engineering judgment and compared with existing topographic information.

The depth of the shallow flooding throughout the city resulting from the limited capacity of the storm drainage system was estimated, using engineering judgment, to be generally less than 1 foot.

In Monterey County, cross sections for the backwater analyses of the Pajaro River and Thomasello Creek were obtained from topographic maps prepared by the USACE, at a scale of 1:1,200 (USACE, 1971) and from topographic maps, developed from aerial surveys, at a scale of 1:4,800 (Spink Corporation, 1978).

Cross sections for the backwater analyses of all the other watercourses were obtained from aerial photographs flown in September 1978, at a negative scale of 1:12,000 in rural areas and 1:6,000 in urbanized areas (Harl Pugh and Associates, 1978).

The starting water-surface elevation for streams draining into the Pacific Ocean is Mean Higher High Water. Those streams are the Pajaro, Salinas, and Carmel Rivers, and Elkhorn Slough. Starting water-surface elevations for Gabilan and Natividad Creeks were based on coincident water-surface elevations from Carr Lake and Reclamation Ditch (Monterey County Flood Control and Water Conservation District, 1979). Starting water-surface elevations for all other streams studied in detail were calculated using the slope/area method. In these cases, the mean water-surface elevations in the streams to which they are tributary were used for starting water-surface elevations.

Substantial levees or mass fill areas exist on the Carmel River on the north side of the low-flow channel from State Highway 1 upstream approximately 4,000 feet. On the south side of the channel, there are manmade levees from approximately 3,000 feet above the mouth upstream 7,000 feet. Because the 1-percent annual chance floodflow cannot be completely contained within the low-flow channel (the channel capacity is approximately a 20- to 25-year flood), 9,000 cfs spill into the north overbank just upstream of the north levee. This water flows parallel to the Carmel River channel on the north side of the levee until it joins with the main channel, downstream of State Highway 1. Whether the south levee will fail during the 1-percent annual chance flood cannot be determined.

The Carmel River from its mouth upstream 10,000 feet was analyzed in three ways because of the uncertainty of the south levee's stability and the variable severity of flooding on each overbank.

The north overbank was analyzed assuming that the south levee remains intact and forces the entire 9,000 cfs to the north overbank as previously described. The path of this flow is shown as "Carmel River North Overbank" on the maps and profiles. The worst set of conditions to be expected in a 1-percent annual chance flood (i.e., highest elevations) is being shown for the north bank.

The south overbank was analyzed assuming that the south levee fails during the 1-percent annual chance flood, and the south bank is therefore inundated. This flow path is shown as "Carmel River South Overbank" on the maps and profiles and represents the worst set of conditions (highest elevations) to be expected in the south overbank. The flow breaks out of the main channel just upstream of the south levee and returns to the channel downstream of the levee.

The main channel of the Carmel River was analyzed assuming that both levees hold, producing higher elevations on the channel between the levees than are shown in the two overbanks. The worst situation to be expected on the main channel is being shown. The main channel elevations are shown on the profiles, with the assumption that both levees remain intact.

Because the Pajaro River levees do not provide 3 feet of freeboard with respect to the 1-percent annual chance flood, water-surface elevations were computed for two cases. In the first case, flood elevations were computed before levee overtopping begins, assuming that the levees remain intact. In the second case, floods were computed after overtopping occurs, assuming that the levees had failed. The worst case is used to establish flood elevations in the channel and in the floodplain area. In this study, water-surface elevations before levee overtopping were always highest for the channel, while the highest elevations for the floodplain area were computed when the levees were assumed to be overtopped. The location of levee failure cannot be predicted during major floods; therefore, it was assumed that all levees fail.

Profiles labeled "Pajaro River" represent channel elevations from the mouth at the Pacific Ocean upstream to the county limits. The extent of this coverage includes flood elevations both downstream and upstream of the levees, as well as channel elevations inside the levees, under the assumption that they are not overtopped.

An elevated right bank on Thomasello Creek causes 100 cfs to be retained in the channel; however, during a 1-percent annual chance flood, the creek flows westerly over its elevated bank and ponds at a lower elevation behind the Pajaro River levee.

Flooding is augmented on Corncob Canyon Creek by spills from the Pajaro River upstream of Salinas Road. Floodwaters enter Corncob Canyon Creek at Warner Lake, just upstream of the Southern Pacific Railroad.

Levees along lower Elkhorn Slough were ignored because they have no effect on the 1-percent annual chance flood.

Salinas River stationing was based on the Pacific Southwest Inter-Agency Committee River Mile Index. Correlations were made at certain river mile locations, resulting in some minor distortion between such locations because of scale change and uncertainties in the location of the channel centerline.

On the Salinas River near King City, a profile baseline is used to show the path taken by 1-percent annual chance flood flows. The natural channel is also shown on the maps to represent the low-flow location of Salinas River drainage.

A bridge constriction at Blanco Road west of the City of Salinas causes 1-percent annual chance floodwaters from the Salinas River to flow over a low ridge east of the main channel. The ridge is inundated by the 1-percent annual chance flood and acts as a weir to convey the flow northward across Blanco Road and parallel to the main channel. Lowlands adjacent to the ridge allow this breakout flow to pond southeast of Blanco Road. The flow, called Salinas River Overbank, rejoins the main channel approximately 4 miles downstream of Blanco Road. A separate flood profile for the Salinas River Overbank has been presented.

Sheetflow is shallow overland flooding generally less than 3 feet deep and unrelated to or not readily associated with channel flooding. Areas in Monterey County subject to sheetflow were analyzed in this study.

Areas where overflow from channels or runoff in excess of storm drain capacity would collect and pond were also evaluated. The water-surface elevations of ponding in these areas were essentially independent of those along adjacent stream channels and were affected principally by obstructions in the flooded area. Shallow flooding areas were delineated using surveyed and photogrammetric elevations, field investigations by experienced engineers, and hand calculations based on normal depths.

Upstream of the City of Salinas, shallow flooding with depths of less than 1 foot occurs on the northern bank of the Salinas River, inundating the overbank up to the Southern Pacific Railroad embankment. This situation prevails downstream as far as the Pacific coast. Areas of this extensive shallow flooding that occur adjacent to Tembladero Slough and Elkhorn Slough originate from the Salinas River.

Areas of shallow sheetflow with 1-foot depths occur on the south overbank of the Pajaro River, adjacent to the levees. This flow would occur as a result of levee breaching during the 1-percent annual chance flood event, as water leaving the channel crosses high ground before reaching lower areas in the overbank.

Streams studied by approximate methods were analyzed using normal-depth calculations.

In the City of Salinas, starting water-surface elevations for Gabilan Creek and Natividad Creek were based on coincident water-surface elevations from Carr Lake determined from the Monterey County Master Drainage Plan report for Carr Lake and Reclamation Ditch (Monterey County, California, 1979). Starting water-surface elevations for Reclamation Ditch and Santa Rita Creek were determined using the slope/area method.

Areas where runoff in excess of storm-drain capacity would collect and pond were evaluated as part of a sheet flow flooding investigation.

Sheet flow is shallow overland flooding generally less than 3 feet deep and unrelated to or not readily associated with channel flooding and flood profiles. The water-surface elevations of sheet flow flooding are essentially independent of those along adjacent stream channels and are affected principally by obstructions in the flooded area.

Downstream of East Alisal Street, Reclamation Ditch overflows the left overbank and becomes ponded along the U.S. Highway 101 embankment and along an area of high ground between Bridge Street and Sherwood Drive.

These areas of shallow flooding and ponding were determined using surveyed and photogrammetric elevations, field investigations by experienced engineers, and hand calculations based on normal depths.

In the City of Seaside, flood elevations for Canyon Del Rey were computed through the use of the USACE HEC-2 step-backwater computer program (USACE, 1973) and were supplemented by hand calculations where required.

Cross sections for backwater analyses were located at small intervals upstream and downstream for bridges and culverts and other hydraulically significant features. This was done to establish the backwater effect of such structures in areas currently urbanized or potentially subject to development. All bridges and culverts were measured to determine channel geometry at flow restrictions.

Starting water-surface elevations for Canyon Del Rey were based on the mean higher high water at Monterey Bay on the Pacific Ocean.

Seaside is subject to shallow flooding that is essentially independent of the flooding along the adjacent stream channel. Using engineering judgment, the depth of the shallow flooding was estimated to be generally less than 1 foot.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the North American Vertical Datum of 1988 (NAVD 88). To obtain up-to-date elevation information on National Geodetic Survey (NGS) benchmarks shown on this map, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov. Map users should seek verification of non-NGS benchmark monument elevations when using these elevations for construction or floodplain management purposes.

Roughness factors (Manning's "n") range from 0.025 in the Reclamation Ditch to 0.040 in Tembladero Slough. Channel roughness values were based on engineering experience, judgment, and field inspection. The starting water-surface elevation was determined from the 1-percent annual chance water-surface profile along Tembladero Slough. The USACE's HEC-2 step-backwater computer program was used for hydraulic analysis (USACE, 1984).

The SCS unit hydrograph option of HEC-1 was used. Losses were determined by the SCS curve number method in accordance with the SCS manual, Hydrology for Small Urban Watersheds-TR55 (U.S. Department of Agriculture, 1986). The SCS curve numbers represent the combined effect of soil type, land treatment and antecedent moisture conditions of the previous portion of the watershed. The percentage of the watershed represented as impervious was based on the land use. Land uses were determined from the available mapping (Aero-Geodetic Corporation, 1979), and field inspection. Soil types were determined from the SCS Soil Survey for Monterey County (U.S. Department of Agriculture, 1978). Soils in the watershed area are predominantly permeable sandy materials classified as Hydrologic Soils Group A by the SCS. Runoff, travel and lag times were estimated based on HEC-1 and TR55 guidelines.

The discharge hydrographs were routed through percolation basins using storage versus elevation ratings tables determined from the available topographic mapping (Aero-Geodetic Corporation, 1979) and supplemental site specific data (Bestor Engineers, Inc., 1979; Neill Engineers, Inc., 1985).

Outflow (infiltration) versus elevation relationships for each pond were developed based on permeability rates estimated in accordance with SCS Guidelines for the types of soils identified in the percolation ponds. The soils types were identified by field inspection and sampling using hand auger and backhoe trenches. Permeability rates were estimated to range from 0.06 inches per hour to over 12 inches per hour. The field investigations are summarized in the report, Soils Study for Permeability Assessment, City of Marina Infiltration Ponds (Cook, Terry D., 1991).

Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and were based on field observations of the streams and floodplain areas. Roughness factors for all streams studied by detailed methods are shown in Table 6, "Manning's "n" Values."

TABLE 6 - MANNING'S "n" VALUES

Stream	Channel "n"	Overbank "n"
Gabian Creek	0.030 – 0.050	0.030 – 0.100
Gonzales Slough	0.015 – 0.045	0.015 – 0.040
East Branch Gonzales Slough	0.015 – 0.040	0.025 – 0.030
Natividad Creek	0.030 – 0.040	0.010 – 0.200
Reclamation Creek	0.030 – 0.040	0.030 – 0.040
Salinas Creek	0.030	0.045
San Lorenzo Creek	0.030	0.045
Santa Rita Creek	0.030 – 0.050	0.020 – 0.060

Revised Countywide Analyses

For this revision, cross sections used in the backwater analyses of the Carmel River revised detailed study were obtained from field surveys and a Triangulated Irregular Network (TIN) derived from Light Detection and Ranging (LiDAR) data.

Roughness coefficients (Manning's "n") along the main stream corridor ranged from 0.040 to 0.075 in the channel and 0.04 to 0.080 on the overbanks. These values were determined from aerial photography, field investigation, and model calibration.

Water-surface profiles were computed using HEC-RAS. At the Carmel River mouth, starting water-surface elevations for the backwater analyses were calculated with the normal depth equation using an energy slope of 0.0017 ft/ft. A frequency analysis of peak annual Carmel River Lagoon stages was also conducted. Within the Lagoon, water-surface profiles were based on the higher of the two analyses.

For this revision, cross sections for the backwater analyses of El Toro, Calera, and Watson Creeks for the revised detailed study were obtained from field surveys and extended with available 2-foot contour topographic mapping.

Roughness coefficients (Manning's "n") along the main stream corridor ranged from 0.025 to 0.08 in the channel and 0.02 to 0.15 on the overbanks. These values were determined from aerial photography and field investigation of the study reach. The starting water-surface elevations for El Toro Creek were taken from the existing

FIS profile, and the starting water-surface elevations for Watson Creek were based on the Calera Creek flow profile.

Channel and overbank roughness factors ("n" values) used in the hydraulic computations were chosen by engineering judgment and were based on field observations of the stream and floodplain areas. The channel "n" values for San Benancio Gulch and Harper Creek ranged from 0.03 to 0.0485, and the overbank "n" values ranged from 0.03 to 0.18. Water-surface elevations for floods of the selected recurrence intervals were computed through use of the USACE HEC-RAS step-backwater computer program (USACE, 2003). Starting water-surface elevations for San Benancio Gulch at the confluence with El Toro Creek were determined from the results of the FIS study of Calera Creek performed by North West Hydraulic Consultants in 2005.

Water-surface elevations for floods of the selected recurrence intervals were computed through use of the USACE HEC-RAS step-backwater computer program (USACE, 2003). Starting water-surface elevations for San Benancio Gulch at the confluence with El Toro Creek were determined from the results of the FIS study of Calera Creek performed by North West Hydraulic Consultants in 2005.

Channel and overbank roughness factors (n-values) used in the hydraulic computations were chosen by engineering judgment and were based on field observations of the stream and floodplain areas. The channel n-values for San Benancio Gulch and Harper Creek ranged from 0.03 to 0.0485, and the overbank n-values ranged from 0.03 to 0.181.

3.3 Coastal Analysis

Swell-wave and wind-wave frequency and magnitude components were determined by a two-step process. The first step defined a stillwater elevation that included effects of astronomical tide, storm surge, and wave setup. The second step determined wave runup above stillwater elevation onto the beach.

Storm surge is the superelevation of the water level above the astronomical tide elevation caused by the low barometric pressure and wind stresses of a storm. Storm surge was evaluated only for definition of the wind-wave component of landfalling storms. Setup is an additional superelevation of the water surface produced by wave action, and the magnitude of wave setup varies with wave characteristics, bathymetry, and beach profile. Because wave setup varies with the characteristics of the waves, different stillwater elevations and magnitude relations were defined for wind waves from the northwest, wind waves from the southwest, swell waves from the northwest, and swell waves from the southwest. Wave runup is the maximum elevation of a wave breaking onto a beach and varies with wave characteristics, bathymetry, and beach profile.

The storm surge for Monterey County was defined by a two-dimensional, finite-element computer model (James R. Pagenkopf, 1976). Applicability of the model had been tested using long-term climatic records for San Francisco (U.S.

Department of Commerce, 1944-1983) to synthesize a long-term record of storm surge hydrographs for San Francisco Bay. The close comparison of synthesized with available tidal records confirmed the usability of the model for California storm conditions. For Monterey County, the model synthesized a record of storm surges from both the northwest and southwest quadrants based on windspeed, wind direction, and barometric pressure data, from 1955 to 1983, determined from North American Surface Weather Maps (U.S. Department of Commerce, 1955-1983).

The effects of storm surge were combined with astronomical tide and wave setup to define the stillwater elevation needed to evaluate the wind-wave setup. Characteristics of astronomical tide for Monterey County could be reliably defined from previous studies (U.S. Department of Commerce, 1945-1983) and were convoluted with storm surge (USACE, 1977). The magnitude of wind-wave setup was calculated by an iterative process coupled with the wave runup calculations.

Runup of wind waves was evaluated by first determining the deepwater wave conditions from both the southwest and northwest quadrants using the 1955-to-1983 climatic data and methods described in the Shore Protection Manual (USACE, 1977). A wave-tracking model (R. S. Dobson, 1967) then transformed the deepwater waves as they traveled toward the shoreline on the basis of bathymetry and beach profiles. Beach transects along the coast provided a generalized representation of the beach profiles that control the magnitude of wave runup. In coastal study areas, beach transects were oriented perpendicular to the shoreline and were strategically located along the shore to represent reaches with similar characteristics. Data were primarily obtained from offshore bathymetry maps supplemented with 1978 USACE survey data (USACE, 1978). The transects used in this study are shown in Figures 1-3, "Transect Location Map." Transect Location (Table 7) provides a listing of the transect locations and Figure 4 presents a sample transect. The wave runup along sloping sandy beaches was computed by Hunt's method (I. J. Hunt, 1959); at obstructions, it was computed by Stoa's method (USACE, July 1978).

The elevation-probability distribution for swell waves followed a similar development. Stillwater was defined only from wave setup convoluted with astronomical tide. The frequency of offshore wave height and wave period from the northwest and southwest quadrants were determined from available data (Meteorology International, Inc., Deep-Water Wave Statistics for the California Coast) and routed shoreward with the wave-tracking model. The runup elevation at each beach transect was calculated using Hunt's and Stoa's methods. Tsunami plus astronomical tide elevations having 1- and 0.2-percent annual chance recurrence intervals have been published (USACE, December 1978; USACE, May 1974; USACE, 1979), and for the analysis of Monterey County, the complete magnitude-frequency relationship was defined from supporting data for those earlier studies.

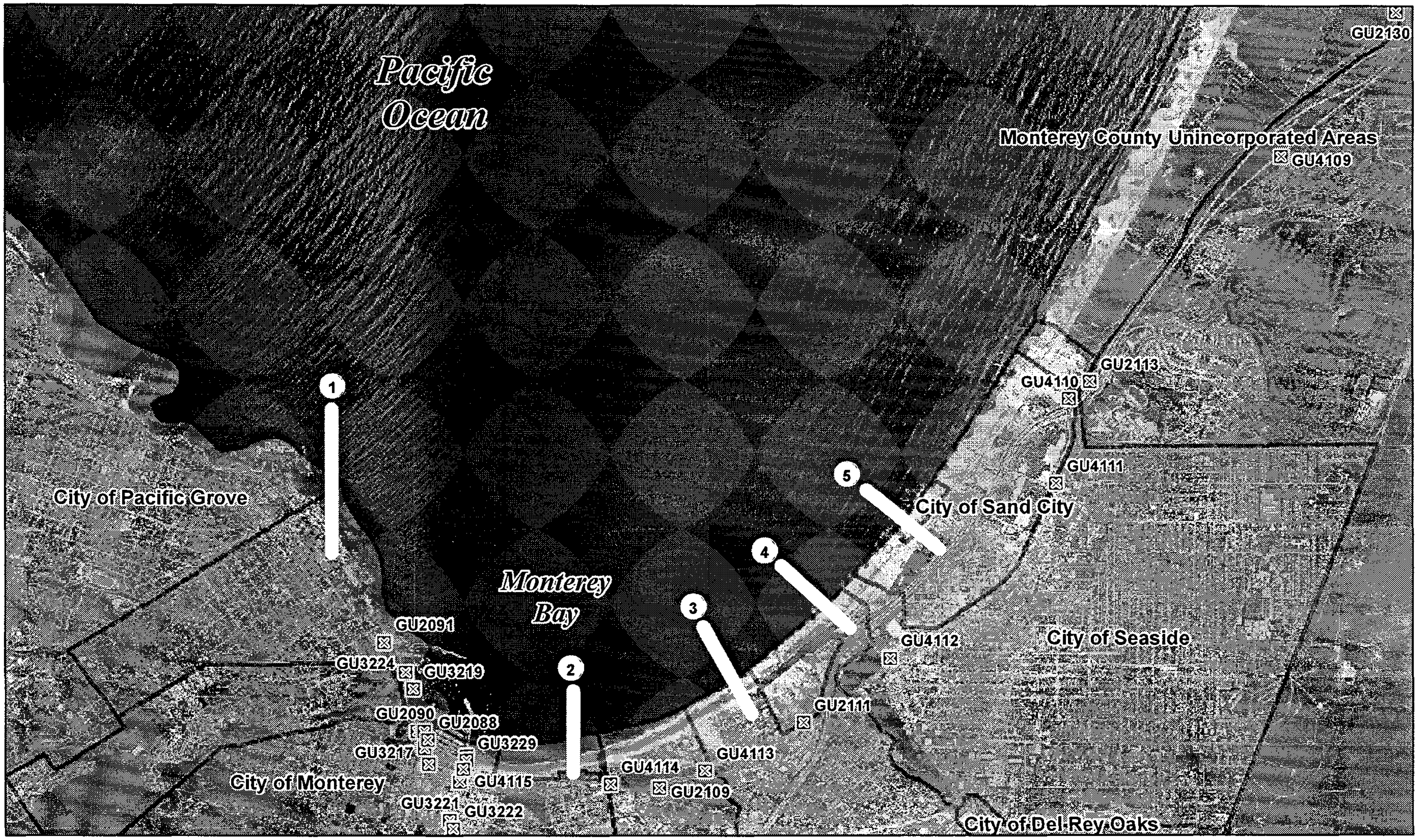


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

2,500 1,250 0 2,500 5,000 7,500 Feet

TRANSECT LOCATION MAP

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

TRANSECT LOCATION MAP

FIGURE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

900 450 0 900 1,800 2,700 Feet

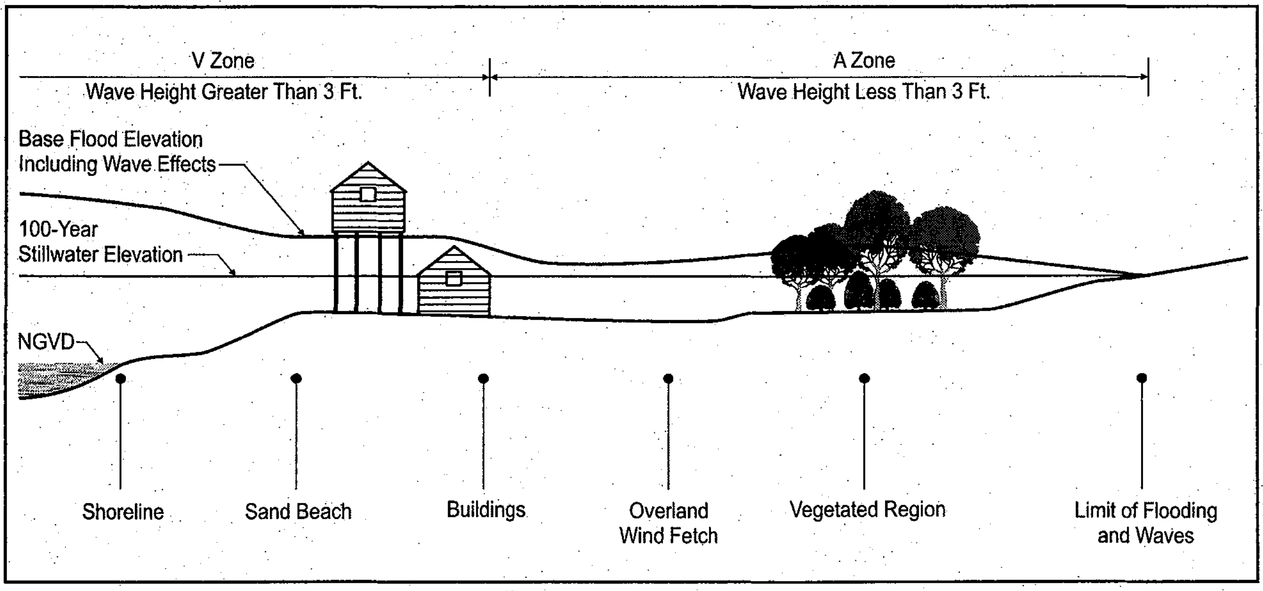
TRANSECT LOCATION MAP

The joint probability of wind waves from the northwest and southwest, swell waves from the northwest and southwest, and of tsunami was defined on the assumption that the events are independent. Results of the analysis are shown in Table 7.

TABLE 7 – TRANSECT LOCATIONS

Transect	Study Area	Location
1		From the water's edge approximately 1,400 feet northwest from the U.S. Coast Guard Wharf Pier and southwest to Cannery Row.
2		From the water's edge, south to La Playa Street, east of Park Avenue.
3		From the coastline, southwest to the intersection of Surf Way and Tide Avenue.
4		From the water's edge southeast across the southwestern side of the Holiday Inn to Sands Dunes Drive.
5*		From the coastline in Sand City, southeast along Bay Street to Sand Dunes Drive.
6	Moss Landing	From the shoreline, east 635 feet to the waterline along the Old Salinas River delta.
7	Moss Landing	From the water's edge, along the south side of the Municipal Pier and southeast to the water's edge at the Old Salinas River.
8	Salinas River Beach	From the water's edge, east 550 feet between buildings 142 and 144 at the Monterey Dunes Colony.
9	Salinas River Beach	At the southern end of the Monterey Dunes Colony, from the coastline east along the northern side of residence No. 288, to the main access road.

*Transect located outside corporate limits



TRANSECT SCHEMATIC Figure 4

For the coastal area between the U.S. Coast Guard Wharf Pier and Municipal Wharf No. 2, tsunami study reports (USACE, December 1978; USACE, May 1974; USACE, 1979) provided the 1- and 0.2-percent annual chance flood data. Assuming a log-normal probability relationship for the tsunami data, a log-normal plot was developed using the 1- and 0.2-percent annual chance flood values and was extrapolated to obtain the 1- and 2-percent annual chance tsunami wave heights. A comparison of the storm tide elevation and the tsunami wave height then determined the higher value to be used in evaluating the coastal flooding hazard. It was found that storm-generated surge dominates the flooding associated with lower frequency (e.g., the 10-percent annual chance event).

Northwest Hydraulic Consultants (nhc) was contracted by FEMA to conduct a FIS along an 18.9-mile reach of the Carmel River from San Clemente Dam downstream to the mouth at the Pacific Ocean. This study involved computing flood inundation limits and water levels for the 10-, 2-, 1-, and 0.2-percent annual chance of occurrence flood events. The Carmel River flows into the Carmel Lagoon as it drains to the Pacific Ocean. Water levels in Carmel Lagoon are influenced by both Carmel River flows and ocean tides.

Monterey Peninsula Water Management District (MPWMD) has measured lagoon water levels at a recording stage gage since November 1987. Records indicate that peak water levels are controlled by a sand dune that forms at the mouth of the lagoon. These extreme lagoon water levels occurred when moderate river flows flowed into the lagoon and were backed up behind the sand dune. Large rainfall runoff events have not caused high lagoon water levels since, the MPWMD typically excavates a channel through the dune prior to the large rainfall runoff events to increase the flow conveyance from the lagoon to the ocean. Extreme tide levels measured at a nearby NOAA tide gage were 5 to 7 feet below extreme lagoon water levels.

The available data suggests that extreme water levels within the lagoon are controlled by riverine processes and backwater due to a naturally forming dune at the mouth of the Carmel River. To better assess the coastal hazards in the Lagoon, nhc recommends that FEMA consider studying the potential for flooding due to wave overtopping and tsunamis as part of a large-scale coastal analysis. The following analyses describe the water level frequency analyses conducted to assess the 10-, 2-, 1-, and 0.2-percent annual chance lagoon water levels.

Methodology

nhc conducted a water level frequency analysis of recorded Carmel Lagoon annual maxima water levels and a frequency analysis of tide water level annual maxima recorded at Monterey Harbor (NOAA Gage 9413450). Annual peak water levels at the gage sites were evaluated using the Corp's flow frequency analysis program HEC-FFA. These analyses used the computed station skew to calculate the frequency curve.

The MPWMD provided graphs of recorded lagoon water levels between 1992 and 2005. Peak water levels were selected for each month between 1992 and 2005. These values are summarized in Table 8, "Peak Monthly Water Levels (NGVD 29) by Calendar Year." Annual peak water levels are shown in Table 9, "Summary of Peak Water Levels (NGVD 29) by Water Year." The MPWMD states that lagoon water levels are controlled by water ponding behind dunes at the mouth of Carmel River. These annual peak lagoon water levels are not directly related to Carmel River peak flows or Pacific Ocean tides. Table 10, "Peak Water Levels During Peak Annual Discharge at Carmel River Near Carmel Lagoon" shows peak lagoon water levels measured near annual peak flows in the Carmel River.

nhc retrieved the Monterey Harbor annual peak tide water level records from the NOAA website (http://co-ops.nos.noaa.gov/data_res.html). These data were converted from the station datum to NGVD 29 vertical datum by subtracting 5.97 feet. Table 10 summarizes the annual peak tide data for the Monterey Harbor gage.

TABLE 8 – PEAK MONTHLY WATER LEVELS (NGVD 29) BY CALENDAR YEAR

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Jan	-	7.0	10.0	6.3	8.9	9.6	7.9	9.4	10.0	11.3	12.04	9.6	7.9	9.6	8.5
Feb	-	9.0	10.0	9.0	8.7	8.6	8.6	9.4	6.8	6.1	7.3	9.0	9.4	9.9	7.9
Mar	-	-	8.9	9.4	8.7	7.4	9.4	6.2	9.0	6.9	9.2	8.9	9.2	8.6	10.2
Apr	-	-	8.1	8.2	5.7	9.8	8.4	6.8	5.3	8.0	7.4	6.4	9.9	8.9	7.4
May	-	7.4	8.2	7.6	7.0	7.2	8.1	9.2	6.5	9.0	8.0	8.2	7.5	7.2	8.6
June	-	-5.7	9.1	6.0	8.0	7.7	6.8	6.1	9.8	8.2	7.1	7.3	8.7	4.8	5.8
July	-	3.6	5.8	3.4	6.0	7.7	4.3	5.3	7.8	5.7	5.3	4.6	5.3	3.5	
Aug	3.6	3.0	4.6	3.0	7.0	3.7	3.5	5.1	3.9	4.0	4.1	3.5	3.5	4.5	
Sept	5.2	5.8	3.8	4.1	7.7	4.3	7.8	7.3	4.8	5.8	5.1	3.8	3.9	4.2	
Oct	4.6	7.3	5.1	4.7	6.7	6.5	6.8	9.8	7.3	6.7	5.6	5.3	5.6	6.0	
Nov	5.1	6.8	6.2	5.3	5.4	6.0	7.9	10.0	6.8	6.5	6.2	8.8	5.0	5.8	
Dec	6.8	6.7	6.8	5.6	9.3	9.7	10.5	8.5	5.7	8.9	10.8	10.8	10.5	10.3	

Water year begins on October 1st and ends September 30th (e.g., Water Year 1992 extends from 10/1/91 to 9/30/92)
All water levels are NGVD 29

TABLE 9 – SUMMARY OF PEAK WATER LEVELS (NGVD 29) BY WATER YEAR

Water Year	Month/Cal Yr.	Water Levels
1992	02/92	9.0
1993	02/93	10.0
1994	03/94	9.4
1995	01/95	8.9
1996	01/96	9.6
1997	12/96	9.7
1998	12/97	10.5
1999	01/99	10.0
2000	01/00	11.3
2001	01/01	12.0
2002	12/01	10.8
2003	04/03	9.9
2004	12/03	10.5
2005	12/04	10.3

Water year begins on October 1st and ends September 30th (e.g., Water Year 1992 extends from 10/1/91 to 9/30/92)
All water levels are NGVD 29

TABLE 10 – PEAK WATER LEVELS DURING PEAK ANNUAL DISCHARGE AT CARMEL RIVER NEAR CARMEL LAGOON

Date	Peak Discharge	Peak Water Level
2/15/92	3,910	6.3
1/14/93	4,940	6.1
2/20/94	636	4.8
3/10/95	16,000	8.8
2/19/96	3,360	6.3
1/29/97	5,170	4.7
2/3/98	14,600	6.6
2/9/99	2,510	5.2
2/14/00	2,450	6.0
3/5/01	2,550	5.8
12/2/01	625	5.5
12/16/02	3,470	10.8
2/25/04	3,380	4.0

Water year begins on October 1st and ends September 30th (e.g., Water Year 1992 extends from 10/1/91 to 9/30/92)
All water levels are NGVD 29

Results

The Carmel Lagoon 10-, 2-, 1-, and 0.2-percent annual chance water level events are significantly greater than the water levels computed at the Monterey Harbor gage. These values are summarized in Table 11, "Water Level Quantiles for the Carmel Lagoon and Monterey Harbor Water Level Gages." nhc compared the Carmel Lagoon water level frequency quantiles to normal depth results from the riverine analysis. The higher of the two stage estimates was used to assess flood hazards in Carmel Lagoon.

TABLE 11 – WATER LEVEL QUANTILES FOR THE CARMEL LAGOON AND MONTEREY HARBOR WATER LEVEL GAGES

Percent Chance Exceedance (Return Period)	Carmel Lagoon Peak Water Level	Monterey Harbor Peak Water Level
0.2 (500-year)	13.4	5.6
1.0 (100-year)	12.6	5.3
2.0 (50-year)	12.2	5.2
10.0 (10-year)	11.3	4.9

Summary

Peak lagoon water levels result from ponding of riverine flows behind the dune at the river mouth. The peak lagoon water levels due to ponding behind the dune are significantly greater than the stillwater elevations calculated using the Monterey Harbor tide gage data. The ponding analysis is described in Section 3.2 of the TSDN, Hydraulic Analyses of the Carmel River. The impact of wave overtopping on lagoon water levels was not analyzed. nhc recommends that FEMA consider studying the potential for flooding due to wave overtopping and tsunamis as part of a large-scale coastal analysis.

3.4 Vertical Datum

All FISs and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FISs and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the finalization of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are being prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent communities may be referenced to NGVD 29. This may result in differences in base flood elevations across the corporate limits between the communities.

As noted above, the elevations shown in the FIS report and on the FIRM for Monterey County are referenced to NAVD 88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor.

The conversion from NGVD 29 to NAVD 88 ranged between 2.70 and 3.14 for this community. Accordingly, due to the statistically significant range in conversion factors, an average conversion factor could not be established for the entire community. The elevations shown in the FIS report and on the FIRM were, therefore, converted to NAVD 88 using a stream-by-stream approach. In this method, an average conversion was established for each flooding source and applied accordingly. For the Salinas River, elevations were converted to NAVD 88 on a reach-by-reach basis, applying different factors for the Salinas River near King City and the Salinas River near San Ardo. The conversion factor(s) for each flooding source in the community may be found in the following Table 12, "Vertical Datum Conversion."

The BFEs shown on the FIRM represent whole-foot rounded values. For example, a BFE of 102.4 will appear as 102 on the FIRM and 102.6 will appear as 103. Therefore, users that wish to convert the elevations in this FIS to NGVD 29 should apply the stated conversion factor(s) to elevations shown on the Flood Profiles and supporting data tables in the FIS report, which are shown at a minimum to the nearest 0.1 foot.

For more information on NAVD 88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20/June 1992, or contact the Spatial Reference System Division, National Geodetic Survey, NOAA, Silver Spring Metro Center, 1315 East-West Highway, Silver Spring, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

TABLE 12 – VERTICAL DATUM CONVERSION

STREAM	CONVERSION FACTOR (ft)
Arroyo Seco	2.99
Calera Creek	2.91
Canyon Del Rey (a.k.a. Arroyo Del Rey)	2.80
Carmel River	2.82
Carmel River South Highway 1 Overbank	2.75
Carmel River North Highway 1 Overbank	2.75
Carmel River Hacienda	2.77
Carmel River Schutte Overbank	2.82
Carmel River Garland Ranch	2.86
Castroville Boulevard Wash	2.74
Corncob Canyon Creek (to include Overflow)	2.72
East Branch Gonzales Slough	3.01
El Toro Creek	2.89
Elkhorn Slough	2.74
Gabilan Creek	2.75
Gonzales Slough	3.01
Harper Creek	2.93
Josselyn Canyon Creek	2.74
Natividad Creek	2.75
Pajaro River	2.71
Pine Canyon Creek	3.02
Reclamation Ditch	2.77
Salinas River (including Salinas River Overbank)	2.80
Salinas River (near King City)	2.99
Salinas River (near San Ardo)	3.14
San Benancio Gulch	2.95
San Lorenzo Creek	2.99
San Miguel Canyon Creek	2.73
Santa Rita Creek	2.72
Tembladero Slough	2.70
Thomasello Creek	2.72
Watson Creek	2.94

With the exception of the Corncob Canyon Creek Overflow as noted in the above table, a single conversion factor of 2.77 feet was used for all static elevations.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 1-percent annual chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1- and 0.2-percent annual chance floodplains; and 1-percent annual chance floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000 with a contour interval of 10 feet (U.S. Department of the Interior, 1948), and developed photogrammetrically, using aerial photographs at scales of 1:6,000 and 1:12,000 (Harl Pugh and Associates, 1978).

Floodplain boundaries on the Pajaro River and Thomasello Creek were interpolated using topographic maps at a scale of 1:4,800, with a contour interval of 4 feet, developed from USACE topographic maps and aerial photography (USACE, 1971; Spink Corporation, 1978).

Detailed-study reaches along the Pacific Coast were delineated using topographic maps at a scale of 1:4,800, with a contour interval of 4 feet, developed with aerial photographs (Ott Water Engineers, Inc., 1983).

The 0.2-percent annual chance floodplain boundaries were modified in some urbanized areas to include areas of inadequate drainage within the boundaries.

For streams studied by approximate methods, field checking by experienced engineers who performed to verify the floodplain boundaries shown on the Flood Hazard Boundary Maps (FHBMs) (U.S. Department of Housing and Urban Development, 1981).

Floodplain boundaries for creeks studied by approximate methods were established according to the professional judgment of engineers taking into account flood elevations estimated from available data, existing hydrologic and hydraulic analyses, correlations with similar streams, and field observations.

Some of the approximate floodplain boundaries on Canyon Del Rey were taken from the Master Drainage Plan for the Canyon Del Rey watershed (Monterey County Flood Control and Water Conservation District, 1977).

Approximate floodplain boundaries were delineated using topographic maps at a scale of 1:24,000 enlarged to 1:6,000 and 1:12,000, with a contour interval of 10 feet (U.S. Department of the Interior, 1948).

In the City of Del Rey Oaks, between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:4,800, with a contour interval of 10 feet (Monterey County Flood Control and Water Conservation District, 1977).

For those areas subject to shallow flooding associated with Canyon Del Rey, flood boundaries were delineated using available topographic information, field inspection, and the previously determined depths (Monterey County Flood Control and Water Conservation District, 1977).

In the City of Monterey, between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:1,200, with a contour interval of 2 feet (City of Monterey, 1975) derived from aerial photographs, in conjunction with the previously determined elevations.

Floodplain boundaries for detailed-study reaches along the Monterey Bay coastline were delineated using topographic maps developed from aerial photographs at scales of 1:1,200 and 1:4,800, with contour intervals of 2 and 4 feet, respectively (Ott Water Engineers, Inc., 1975; Ott Water Engineers, Inc., 1983).

For those areas subject to shallow flooding, floodplain boundaries were delineated on topographic maps at a scale of 1:1,200, with a contour interval of 2 feet (City of Monterey, 1975).

Approximate floodplain boundaries for Monterey Bay on the Pacific Ocean were taken from the FHBM (U.S. Department of Housing and Urban Development, 1974).

Floodplain boundaries for Canyon Del Rey were taken from the FIS for the City of Seaside (FEMA, 1981).

The boundaries for the ponding along Reclamation Ditch west of Carr Lake and U.S. Highway 101 were developed photogrammetrically using the aerial photographs referenced previously.

The 0.2-percent annual chance floodplain boundaries were modified in urbanized areas to include areas of inadequate drainage for local runoff.

The floodplain boundaries for the Reclamation Ditch were delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using a USGS 7.5-minute Quadrangle map, scale 1:24,000 (U.S. Department of the Interior, 1947). The backwater area of

Tembladero Slough was delineated using the elevation at the confluence of Tembladero Slough and the Reclamation Ditch. These floodplain boundaries are shown in Exhibit 2 and in the FIRM.

The floodplain boundaries for the Carmel River were delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using the topographic data.

The 1- and 0.2-percent-annual-chance floodplain boundaries for Harper Creek and San Benancio Gulch were delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:2,400, with a contour interval of 5 feet (James W. Sewall Company, 1977).

The 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, V, and VE); and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percentannual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

The floodplain boundaries for Calera and Watson Creeks were delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using available 2-foot contour topographic mapping. Floodplain boundaries for the 1-percent annual chance return interval flood were established from the maximum flood depth raster image of the study area exported from MIKE21. Polygons defining hazard zones were drawn based on the maximum flood depth raster, ground contours developed from LiDAR, and the influence of significant local structures observed on aerial photographs.

For each stream studied by detailed methods, the 1- and 0.2-percent annual chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:2,400, with a contour interval of 5 feet.

The 1- and 0.2-percent annual chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AO, AH, V, and VE), and the 0.2-percent annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent annual chance floodplain boundaries are close together, only the 1-percent annual chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

Levee Failure Scenarios for Carmel River

The BFEs developed for the Carmel River study area were originally based on three flood scenarios that were modeled using the split flow reaches: (1) flooding with the levees left in place (with-levees), (2) flooding with all left bank levees removed (without-left-levees), and (3) flooding with all right bank levees removed (without-right-levees). The BFEs for the left overbanks, main channel, and right overbanks were defined as the highest observed water surface elevation at each cross section based on these three scenarios.

The Carmel River study area contains multiple locations where either man-made levees or natural high ground caused the flow to become separated into one or more distinct channels. Such reaches, referred to as flow splits, behave independently until the channels merge again downstream or a significant low spot in the ground separating the two flows allows them to mix.

The modeling approach for levee failure scenarios varied at each split flow location according to the classification of the separating feature as high ground or man-made, local channel geometries, flood depths, and flooding characteristics in the reach. The following subsections present the various approaches used at the five split flow reaches in the Carmel River HEC-RAS model and explain how levee failure scenarios were considered in each.

Garland Ranch and Schulte Overbanks:
The Garland Ranch and Schulte Overbanks are formed by natural broad features and do not contain significant levees responsible for separation of the flows. Therefore, no levee failure scenarios were applied in these reaches.

Hacienda Carmel Ring Levee:
Hacienda Carmel is protected from modest flood events by a ring levee that completely surrounds the local structures of the community. The ring levee blocks the flow during flood events and causes a split flow to occur at the upstream end (station 18879) as the main channel of the Carmel River flows around the ring levee to the north and a smaller overbank channel is formed to the south. The main and overbank channels then rejoin immediately downstream of the ring levee at station 15740. During the 100-year flood event, water surface elevations in the Carmel River are higher than the elevation of the ring levee, implying that the community is flooded whether or not the levees fail. The Hacienda Carmel ring levee is unique in the sense that it acts both as a perimeter levee for the community and as a parallel left bank levee for the Carmel River. As a perimeter levee, the ring levee blocks flow from freely passing through Hacienda Carmel even if flooded. For this reason, the community is defined as an ineffective flow area for the with-levee scenario. However, for the without-left-levees scenario, flow is allowed to pass between the main channel and the Hacienda Carmel Overbank through the ring levee system. This was achieved by balancing the energy grades between the main channel and the overbank. In addition, the area inside the ring levee was no longer defined as ineffective flow for the without-left-levees scenario.

North and South Highway 1 Overbanks:
The without-right-levee and without-left-levee scenarios for the North and South Highway 1 Overbanks were particularly complicated to develop since the flow separations observed in these reaches were due to a combination of man-made and natural features. In order to calculate a reasonable levee failure scenario for each, energy balances were performed between the main channel and the overbank only at locations where man-made levees were responsible for flow separation.

Additional Levee Failure Scenarios

FEMA's levee modeling guidelines in Appendix H state "the evaluation [of flood inundation levels due to levee failure] shall include the possibility of simultaneous levee failure, failure of only the left side, and failure of only the right side..." Because a simultaneous levee failure scenario should always produce lower water surface elevations than the other two, the calculation of BFEs in the Carmel model focused on the results from the without-left and without-right-levees scenarios.

The levee failure modeling using split flow reaches in the Carmel River model appropriately describes the flood hazards in the study reach. However, the approach does not technically meet the requirements set forth in FEMA's Appendix H because it uses a non-traditional multi-channel configuration and does not address the simultaneous levee failure scenario. Therefore, additional levee failure scenarios of the downstream portion of the model were conducted using a single cross section that spans the main channel and both the left and right overbanks. The single cross section model was developed by joining the individual cross sections of the left overbank (FLDPLN1), the main channel (CHNL3 and CHNL2), and the right overbank (FLDPLN2) between stations 791 and 10140. This new model geometry was used to analyze the without-left-levees, without-right-levees, no-levees, and no-levees with encroachments scenarios.

A comparison of the BFEs predicted by the original split flow model and the new single cross section model based on the without-left-levees and without-right levees scenarios indicated that the two approaches produced similar results in most cases. However, there are cross sections where the single cross section model predicted higher BFEs in the overbanks than the original split flow approach. In these instances, the original BFEs were replaced by the higher values.

As described previously, the hydraulics of the flows in the downstream reaches of the Carmel River model are quite complex and, in some cases, poorly represented by the single cross section approach. A comparison of the BFEs predicted by the original split flow model and the new single cross section model based on the without-left-levees and without-right levees scenarios indicated that the split flow BFEs are considerably higher than the single cross section BFEs on the downstream end. This is caused by failure models of the uncertified levees that surround the overbank. An upstream levee breach or overtopping allows water to become trapped in the overbank and pond at the downstream end. This flooding pattern has been noted in the area during past events and could not be identified using the single cross section model. For this reason, results from the two modeling approaches were combined to capture such flooding effects as well as conform to FEMA modeling guidelines.

For the streams studied by approximate methods, only the 1-percent annual chance floodplain boundary is shown on the FIRM (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this FIS are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

Unless indicated otherwise, the floodways presented in this study were computed on the basis of equal-conveyance reduction from each side of the floodplain. For some streams in the county, the floodway limits might be more appropriately set using considerations of velocity of flow and slopes of channel banks to produce a prudent setback to allow for bank sloughing.

Overbank and channel velocities were a major factor in determining floodways. Excessive velocities were minimized where floodways were designated. Where 1-percent annual chance flood channel velocities were in excess of 6.0 feet per second, encroachments were set so that these velocities did not increase by more than 1.0 foot per second. However, slope protection measures against high velocities should be considered in any development of the floodway fringe.

Limitations were encountered along many streams in developing a floodway based on equal-conveyance reduction.

For Canyon Del Rey, equal-conveyance reduction was used in floodway computations for the detailed-study reach. In addition to the 1.0-foot rise and velocity criteria, maintaining storage was also considered. Ponding behind high highway culverts significantly lowered flows. The proposed floodway maintains storage where necessary to avoid increasing flows detrimentally.

For Arroyo Seco, equal-conveyance reduction was used in the floodway computations for the detailed-study reach. For nearly the entire reach, the floodway follows the 1-percent annual chance floodplain. For the remainder of the reach, excessive velocity rather than water-surface elevation rise was the limiting factor in floodway encroachment.

For Calera Creek, equal-conveyance reduction was used for the entire detailed-study reach except for a section from 180 feet above Robley Road to 1,105 feet above that road. For this section, a floodway is not applicable because a sidespill during the 1-percent annual chance flood west of the channel cannot be contained in the channel with less than a 1.0-foot rise in water-surface elevation. It must be advised that although the area is designated shallow flooding with depths less than 1.0 foot, high velocities may result upstream on the main channel if development occurs on this west bank near Robley Road.

For the Carmel River, equal-conveyance reduction was used in floodway computations for the entire detailed-study reach, except for the lowest 10,000 feet. In this case, the 1-percent annual chance flood flow could not be contained in the north and south overbanks without raising the water-surface elevation by more than 1.0 foot. Often, velocity increase was the controlling restriction rather than a 1.0-foot rise in water-surface elevation.

The floodway boundary for Harper Creek and San Benancio Gulch was mapped by marking the calculated distance from the centerline on each of the 207 cross-sections, and using the shape of the channel centerline as a guide, generating one line along either side of the channel that intersected the cross-sections in the appropriate location. For a large portion of the mapped channel, the floodway boundary as noted at each cross section was outside of the 1-percent annual chance floodplain boundary, which indicates that 1-percent annual chance flood is contained within the channel banks. When this situation occurred, the floodway boundary was assumed to coincide with the 1-percent annual chance floodplain.

For Elkhorn Slough, floodways were delineated without consideration of tidal influence from the Pacific Ocean.

For Gabilan Creek, equal-conveyance reduction was used in floodway computations for the entire detailed-study reach. Occasionally, velocity increase was the controlling restriction rather than a 1.0-foot rise in water-surface elevation.

For Natividad Creek, equal-conveyance reduction was used in floodway computations for the entire detailed-study reach, except immediately upstream from East Laurel Drive, where overbank storage must be retained to prevent increases in design flows.

For the Pajaro River, floodways were computed based on the lower elevations obtained assuming that the levees fail. No floodway was computed between cross sections G and H because of the independent shallow flooding that occurs south of the levees. A floodway is not appropriate in areas of shallow flooding.

For Pine Canyon Creek, equal-conveyance reduction was used for the entire detailed-study reach. For many sections, excessive velocities were the limiting factor rather than a 1.0-foot rise in water-surface elevation.

For Reclamation Ditch, equal-conveyance reduction was used in floodway computations for the entire detailed-study reach. Just downstream from Carr Lake, maintenance of the water-surface elevation in Carr Lake was the controlling restriction. The entire surface area of Carr Lake is retained as floodway to preserve storage.

For the Salinas River, the floodways were computed on the basis of equal-conveyance reduction. Because of its sandy bed, floodway velocities were of primary concern in the determination of the floodway boundaries. Care was taken to minimize excessive velocities in the channel under encroached conditions. Where velocities in the channel were in excess of 6 feet per second, floodway velocities were held to a maximum increase of 0.5 foot per second. For 1-percent annual chance flood velocities less than 6 feet per second, a maximum of 1 foot per second increase in floodway velocities was observed. In no event was more than a 1.0-foot rise in the water-surface elevation allowed. A floodway is not appropriate for Salinas River Overbank and therefore was not shown.

For San Miguel Canyon Creek, equal-conveyance reduction was used for the entire detailed-study reach. Velocity was often the limiting factor in the floodway computation.

For Thomasello Creek, a floodway was not computed because the flow that escapes the channel cannot be contained within a floodway without incurring a rise in water-surface elevation of more than 1.0 foot.

A floodway was not designated for the Monterey Vineyard Pond as confining the spill that flows toward old U.S. Highway 101 would create a surcharge greater than 1.0 foot. The pond does not have the storage capacity to significantly attenuate the 1-percent annual chance flow; therefore, providing the spill area is not blocked, fill placed in the 1-percent annual chance floodplain will not raise the flood elevations downstream.

Although no floodway was designated, development in this area should be restricted, especially at the spill point, so as not to create surcharges greater than 1.0 foot.

A floodway was not designated for the Monterey Vineyard property north of the pond as the 1- and 0.2-percent annual chance floods are contained in a culvert.

Gonzales Slough has enough storage capacity downstream of the Monterey Vineyard culvert to significantly attenuate the flow. Encroachment of the 1-percent annual chance floodplain with fill material would decrease the storage and, thus, cause higher flows downstream. After the floodway boundaries were computed a first time, the flows were recomputed with decreased storage capacity in the slough. The floodway boundaries were then recomputed with the higher flows. The floodway boundaries shown on the FBFM (Exhibit 2), therefore, reflect the loss of storage capacity caused by encroachment.

The floodways presented for San Lorenzo Creek and Salinas River were computed on the basis of equal-conveyance reduction from each side of the floodplain. Due to the sandy bed material in both San Lorenzo Creek and Salinas River, floodway velocities were of primary concern in the determination of the floodway boundaries.

Because of the extensive urbanization in the vicinity of Josselyn Canyon Creek, Del Monte Lake, and El Estero Lake, no floodways were computed for this FIS.

The floodways presented in this study were computed on the basis of equal-conveyance reduction from each side of the floodplain. Floodways were designated for Gabilan Creek, Natividad Creek, Reclamation Ditch, and Santa Rita Creek:

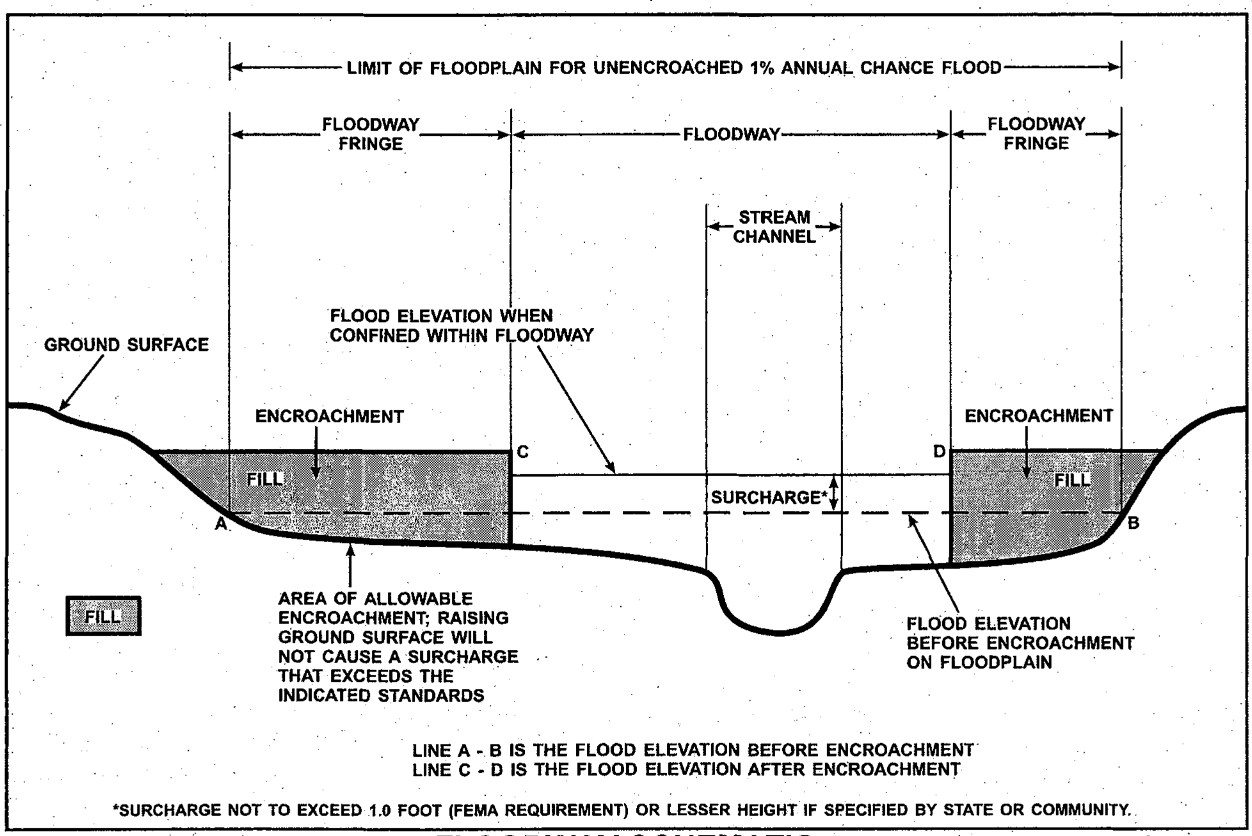
A floodway analysis was conducted on the Carmel River between RM 15.6 and RM 1.7. For this study, the floodway was computed by applying the equal-conveyance reduction method in HEC-RAS. The maximum allowable surcharge was 1.0 foot. Using the effective floodway as a guide, the resulting floodway delineation was refined to obtain smooth transitions from section to section. In several cases, the floodway width was increased upstream and/or downstream of bridges to avoid exacerbating flow existing pressure flow or roadway overtopping conditions. In confined reaches, the floodway was set at the 1-percent annual chance of exceedance flood hazard boundary.

Floodways for Watson and Calera Creeks were computed on the basis of equal area reduction from each side of the floodplain. The results of these computations are tabulated at selected cross sections. Floodways were defined as coincident with the 1-percent annual chance floodplain at cross sections where the 1-percent annual chance peak discharge was conveyed entirely within the channel. Near river mile 3.5 on Calera Creek, a significant portion of the flow overtops the left bank and flows as shallow flow northwest of the channel. The floodway in this area was defined using the discharge capacity of the channel through this reach, 430 cfs, which is about 45 percent of the 1-percent annual chance discharge. The discharge from the channel and into the breakout area must be maintained for the floodway between river mile 3.5 and 3.0 to remain valid.

Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 13). The computed floodways are shown on the FIRM (Exhibit 2). In cases where the floodway and 1-percent annual chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 13, "Floodway Data." In order to reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 5, "Floodway Schematic."



FLOODWAY SCHEMATIC Figure 5

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Arroyo Seco								
A	89,355	625	3,390	11.1	486.8	486.8	486.8	0.0
B	90,512	355	3,070	12.2	493.8	493.8	493.8	0.0
C	91,721	400	4,450	8.4	501.8	501.8	501.8	0.0
D	92,537	525	3,220	11.7	503.3	503.3	503.3	0.0
E	94,015	315	2,780	13.5	509.8	509.8	510.2	0.4
F	95,735	335	3,290	11.4	518.3	518.3	518.4	0.1
G	97,197	835	3,660	10.3	526.1	526.1	526.1	0.0
H	98,528	280	2,580	14.6	535.0	535.0	535.0	0.0
I	99,878	810	3,750	10.0	541.8	541.8	541.8	0.0
J	102,287	655	3,680	10.0	554.2	554.2	554.3	0.1
K	103,437	855	3,990	9.2	560.6	560.6	560.6	0.0
L	104,364	630	3,300	11.1	567.1	567.1	567.2	0.1
M	105,784	665	4,480	8.2	573.7	573.7	573.7	0.0
N	107,194	690	4,510	8.1	579.0	579.0	579.0	0.0
O	109,504	435	3,200	9.0	593.0	593.0	593.0	0.0
P	110,674	845	4,620	6.2	596.8	596.8	596.8	0.0
Q	112,013	525	3,170	9.1	600.5	600.5	600.5	0.0
R	113,009	280	2,070	13.9	608.6	608.6	608.6	0.0
S	114,269	370	2,250	12.8	619.5	619.5	619.5	0.0
T	115,096	280	2,070	13.9	624.8	624.8	624.9	0.1
U	117,027	275	2,250	12.8	632.8	632.8	633.2	0.4
V	118,150	295	2,440	11.8	640.8	640.8	640.8	0.0
W	120,107	220	2,480	11.6	652.1	652.1	652.1	0.0
X	121,537	205	2,420	11.9	660.2	660.2	660.2	0.0
Y	122,347	235	1,870	15.3	664.3	664.3	664.3	0.0
Z	124,277	200	1,774	16.7	677.7	677.7	677.7	0.0
AA	125,562	205	2,240	12.8	686.6	686.6	686.6	0.0
AB	126,999	290	3,010	9.3	696.9	696.9	696.9	0.0

[1]Feet above confluence with Salinas River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

ARROYO SECO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Arroyo Seco (continued)								
AC	128,569	385	2,970	9.4	704.6	704.6	704.6	0.0
AD	130,682	255	2,260	12.4	716.6	716.6	716.6	0.0
AE	131,684	235	1,830	15.3	723.3	723.3	723.3	0.0
AF	133,812	320	3,210	8.7	735.9	735.9	735.9	0.0
AG	134,822	170	1,590	17.6	742.5	742.5	742.5	0.0
AH	136,516	265	2,290	12.2	753.5	753.5	753.5	0.0
AI	137,356	495	3,050	9.2	758.9	758.9	758.9	0.0
AJ	139,465	265	2,100	13.3	776.1	776.1	776.1	0.0
AK	140,922	190	1,930	14.5	786.9	786.9	786.9	0.0
AL	140,996	180	2,130	13.1	788.7	788.7	788.7	0.0

[1]Feet above confluence with Salinas River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

ARROYO SECO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Calera Creek								
A	467	147	464	3.8	240.4	240.4	240.4	0.0
B	871	56	210	8.4	246.8	246.8	246.8	0.0
C	1,021	95	409	4.3	250.1	250.1	250.1	0.0
D	1,640	78	330	5.4	256.1	256.1	256.1	0.0
E	3,304	87	355	5.0	282.1	282.1	282.1	0.0
F	4,373	46	311	5.7	296.9	296.9	297.2	0.3
G	4,560	107	399	4.4	300.8	300.8	300.8	0.0
H	4,894	92	328	5.4	301.6	301.6	301.9	0.3
I	5,743	119	441	4.0	309.2	309.2	309.6	0.4
J	6,784	75	266	6.7	316.1	316.1	316.8	0.7
K	6,842	97	314	5.6	317.4	317.4	317.5	0.1
L	7,300	72	202	8.8	318.8	318.8	318.9	0.1
M	7,382	90	432	4.1	323.1	323.1	232.1	0.0
N	7,733	126	523	3.4	328.9	328.9	329.0	0.1
O	8,017	98	223	7.2	328.9	328.9	328.9	0.0
P	9,146	65	181	8.9	335.9	335.9	335.9	0.0
Q	9,408	101	204	7.9	341.3	341.3	341.4	0.1
R	10,237	30	134	12.0	347.8	347.8	347.8	0.0
S	10,395	213	885	1.8	351.2	351.2	351.2	0.0
T	10,893	77	275	5.8	351.4	351.4	351.5	0.1
U	11,765	73	316	5.1	357.4	357.4	357.4	0.0
V	11,999	48	154	10.2	358.0	358.0	357.9	-0.1
W	12,423	41	173	9.0	362.1	362.1	362.1	0.0
X	12,510	24	164	9.5	364.6	364.6	364.6	0.0
Y	12,784	44	302	5.2	367.6	367.6	367.6	0.0
Z	12,832	33	279	5.6	368.7	368.7	368.7	0.0
AA	13,454	70	377	4.2	372.8	372.8	372.8	0.0
AB	13,672	26	145	10.8	372.8	372.8	372.8	0.0

[1]Feet above confluence with El Toro Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CALERA CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Calera Creek (continued)								
AC	13,816	101	243	6.5	378.3	378.3	378.3	0.0
AD	14,966	61	168	9.3	383.8	383.8	383.9	0.1
AE	15,347	114	248	6.3	388.8	388.8	389.0	0.2
AF	15,940	55	268	5.8	392.5	392.5	392.5	0.0
AG	16,178	39	104	8.1	394.1[2]	393.8[2]	393.8	0.0
AH	16,970	35	146	5.8	401.2[2]	400.5[2]	400.5	0.0
AI	17,221	32	121	7.0	406.5[2]	405.7[2]	405.7	0.0
AJ	17,373	27	110	2.2	409.7[2]	408.4[2]	408.4	0.0
AK	17,991	56	85	2.3	415.4[2]	414.0[2]	414.1	0.0
AL	18,351	114	138	4.4	416.4[2]	416.2[2]	416.2	0.0
AM	18,582	87	207	4.6	418.2	418.2	418.6	0.4
AN	20,645	110	320	3.0	437.5	437.5	438.2	0.7
AO	20,684	72	217	4.4	438.4	438.4	438.6	0.2
AP	21,098	193	327	2.0	441.8	441.8	441.9	0.1
AQ	21,149	136	263	3.7	442.3	442.3	442.3	0.0
AR	22,662	33	207	4.7	457.9	457.9	458.0	0.1
AS	23,025	50	145	6.7	459.7	459.7	459.7	0.0
AT	23,235	41	206	4.7	463.1	463.1	463.1	0.0
AU	23,594	40	149	6.5	467.1	467.1	467.1	0.0
AV	23,655	41	178	5.4	468.6	468.6	468.6	0.0

[1]Feet above confluence with El Toro Creek
[2]Reduced floodway discharge

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CALERA CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Canyon Del Rey								
A	1,450[1]	1,170	12,870	0.1	16.0	16.0	16.0	0.0
B	2,244[1]	60	460	1.3	16.6	16.6	16.6	0.0
C	2,729[1]	474	3,601	0.2	16.6	16.6	16.7	0.1
D	3,379[1]	346	2,702	0.2	16.6	16.6	16.7	0.1
E	4,024[1]	80	543	1.1	16.6	16.6	16.7	0.1
F	4,591[1]	50	311	2.0	16.6	16.6	16.7	0.1
G	5,139[1]	50	305	2.0	16.6	16.6	16.8	0.2
H	5,524[1]	55	580	1.0	28.3	28.3	29.3	1.0
I	6,703[1]	135	812	1.2	31.6	31.6	32.6	1.0
J	7,353[1]	16	61	11.2	40.4	40.4	40.4	0.0
K	7,903[1]	50	115	10.4	50.4	50.4	50.5	0.1
L	8,513[1]	24	172	4.0	61.7	61.7	61.7	0.0
M	9,353[1]	16	62	11.1	75.2	75.2	75.2	0.0
N	9,923[1]	50	208	3.8	81.6	81.6	82.5	0.9
O	10,703[1]	45	141	5.8	86.1	86.1	86.5	0.4
P	12,923[1]	146	1,372	0.5	99.6	99.6	100.0	0.4
Q	13,523[1]	147	782	1.3	99.6	99.6	100.0	0.4
R	14,663[1]	36	308	2.2	110.5	110.5	111.3	0.8
S	15,228[1]	40	201	1.8	110.7	110.7	111.5	0.8
T	16,283[1]	24	68	5.4	116.0	116.0	116.0	0.0
U	340[2]	19	37	8.0	236.0	236.0	236.0	0.0
V	1,135[2]	23	58	5.1	242.9	242.9	242.9	0.0
W	1,895[2]	16	42	7.0	251.9	251.9	251.9	0.0
X	2,585[2]	18	52	5.7	259.9	259.9	259.9	0.0
Y	3,480[2]	70	864	1.8	297.7	297.7	298.7	1.0
Z	4,690[2]	48	388	1.2	297.9	297.9	298.9	1.0
AA	5,445[2]	263	1,999	0.3	317.4	317.4	318.4	1.0
AB	6,195[2]	108	763	0.7	317.4	317.4	318.4	1.0

[1]Feet above confluence with Monterey Bay
[2]Feet above Blue Lakespur Lane

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CANYON DEL REY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Canyon Del Rey (continued)								
AC	7,275	64	148	3.3	324.6	324.6	324.6	0.0
AD	7,935	75	570	0.3	346.5	346.5	347.5	1.0
AE	8,865	13	73	1.8	348.9	348.9	348.9	0.0
AF	9,780	56	491	0.7	365.0	365.0	365.0	0.0
AG	10,780	43	81	3.8	368.3	368.3	368.3	0.0
AH	11,941	260	1,873	0.2	390.3	390.3	391.3	1.0
AI	12,941	255	1,735	0.2	390.3	390.3	391.3	1.0

[1]Feet above Blue Lakespur Lane

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CANYON DEL REY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Carmel River								
A	10,140	510	4,090	5.6	39.4	39.2	39.7	0.5
B	10,501	551	4,548	5.0	39.7	39.7	40.6	0.9
C	12,343	1,520	7,459	3.0	42.4	42.4	43.3	0.9
D	13,373	910	4,812	4.7	44.1	44.1	45.0	1.0
E	13,978	852	4,406	5.2	46.0	46.0	46.5	0.5
F	14,613	1,090	6,382	3.6	47.0	47.0	47.9	0.9
G	15,070	827	4,471	5.1	48.3	48.3	48.6	0.4
H	15,740	600	3,787	6.0	49.3	49.3	50.0	0.8
I	16,921	445	2,394	7.6	53.3	53.3	54.2	0.9
J	17,117	456	3,034	6.0	55.1	55.1	55.6	0.6
K	18,531	227	2,870	6.3	58.1	58.1	58.9	0.7
L	20,107	742	5,250	4.3	61.6	61.6	62.5	1.0
M	20,989	620	3,927	5.3	63.7	63.7	64.4	0.7
N	21,330	700	4,184	5.0	64.3	64.3	65.3	1.0
O	22,394	250	3,101	6.7	67.9	67.9	68.9	1.0
P	23,764	240	3,364	6.2	72.2	72.2	72.8	0.6
Q	24,520	290	3,472	6.0	74.5	74.5	74.8	0.3
R	25,396	573	3,001	7.0	76.7	76.7	76.8	0.1
S	26,240	380	3,231	6.5	78.7	78.7	79.7	1.0
T	27,993	410	5,257	4.0	83.2	83.2	84.0	0.8
U	29,401	170	2,719	7.7	85.8	85.8	86.2	0.4
V	30,087	355	3,971	5.3	87.4	87.4	88.4	1.0
W	35,444	308	4,029	5.2	101.8	101.8	101.8	0.0
X	35,747	442	5,100	4.1	102.5	102.5	102.4	0.0
Y	37,100	428	4,341	4.8	104.4	104.4	104.8	0.5
Z	38,494	130	1,942	10.8	110.4	110.4	110.3	0.0
AA	40,243	170	2,824	7.4	117.3	117.3	117.4	0.1
AB	40,967	250	3,671	5.7	118.8	118.8	119	0.3

[1]Feet above confluence with Pacific Ocean

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CARMEL RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Carmel River (continued)								
AC	42,352	197	2,419	8.6	122.9	122.9	122.9	0.0
AD	43,052	235	2,733	7.1	125.3	125.3	125.8	0.5
AE	44,103	189	2,502	7.8	128.7	128.7	129.0	0.3
AF	45,140	160	2,176	8.9	132.2	132.2	132.3	0.1
AG	46,225	185	2,484	7.8	136.1	136.1	136.2	0.1
AH	47,602	268	3,041	6.4	141.0	141.0	141.3	0.3
AI	48,650	225	2,685	7.2	145.2	145.2	145.3	0.0
AJ	49,362	191	2,719	7.1	148.1	148.1	148.4	0.3
AK	51,120	259	2,625	7.4	152.8	152.8	152.8	0.0
AL	52,141	248	2,489	7.8	157.6	157.6	157.6	0.0
AM	52,851	295	3,205	6.1	159.5	159.5	160.3	0.8
AN	53,918	300	2,998	6.5	166.3	166.3	167.3	0.9
AO	54,566	168	2,169	8.9	168.2	168.2	169.2	1.0
AP	55,645	368	3,840	5.1	171.5	171.5	172.3	0.8
AQ	56,665	417	2,811	6.9	175.1	175.1	175.4	0.3
AR	57,242	512	3,661	5.3	179.8	179.8	180.4	0.6
AS	60,555	198	2,059	9.4	193.8	193.8	193.8	0.0
AT	61,943	278	3,395	5.7	203.3	203.3	203.8	0.6
AU	62,633	233	2,545	7.6	205.6	205.6	205.9	0.3
AV	64,412	600	4,045	4.8	212.9	212.9	213.9	1.0
AW	65,101	513	3,471	5.6	216.9	216.9	217.9	1.0
AX	66,155	353	2,802	6.9	221.6	221.6	222.6	1.0
AY	66,848	316	2,164	8.2	225.8	225.8	225.8	0.1
AZ	67,552	886	3,495	5.1	230.8	230.8	231.5	0.7
BA	68,259	213	1,846	9.6	233.2	233.2	233.5	0.3
BB	68,598	221	2,294	7.7	235.7	235.7	236.6	0.8
BC	69,296	263	2,787	6.4	239.9	239.9	240.4	0.5
BD	70,643	503	2,698	6.6	247.1	247.1	247.5	0.4

[1]Feet above confluence with Pacific Ocean

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CARMEL RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Carmel River (continued)								
BE	71,554	463	3,384	5.2	252.0	252.0	253.0	1.0
BF	72,441	429	3,142	5.6	257.6	257.6	258.0	0.4
BG	73,853	491	2,904	6.1	264.3	264.3	265.3	0.9
BH	74,559	276	2,178	8.1	268.9	268.9	269.1	0.2
BI	75,273	493	3,098	5.7	272.3	272.3	273.3	1.0
BJ	76,281	419	2,746	6.5	279.6	279.6	280.0	0.4
BK	77,010	191	1,872	9.5	284.7	284.7	285.7	0.9
BL	77,128	225	2,538	6.9	286.8	286.8	287.8	0.9
BM	77,912	309	2,740	6.2	290.8	290.8	291.3	0.5
BN	78,151	436	3,592	4.7	291.7	291.7	292.6	1.0
BO	79,246	391	2,834	6.0	298.3	298.3	298.4	0.1
BP	80,500	210	2,602	6.5	309.3	309.3	310.2	1.0
BQ	81,216	130	1,843	9.2	312.8	312.8	313.3	0.5
BR	81,541	126	1,701	9.9	314.2	314.2	315.2	1.0
BS	82,596	129	1,802	9.4	321.7	321.7	321.9	0.2
BT	82,935	235	2,588	6.5	324.5	324.5	324.5	0.1
BU	84,207	170	1,573	10.7	332.3	332.3	332.7	0.4
BV	84,389	147	1,911	8.8	336.2	336.2	336.2	0.0
BW	85,997	401	2,475	4.9	344.3	344.3	344.9	0.6
BX	86,447	362	1,987	6.1	347.4	347.4	347.8	0.4
BY	87,827	430	2,511	4.8	359.0	359.0	359.1	0.1
BZ	90,305	259	1,898	6.4	379.2	379.2	379.2	0.0
CA	91,638	123	1,118	10.8	389.1	389.1	389.1	0.0
CB	92,573	388	2,666	4.5	397.3	397.3	397.3	0.0
CC	93,448	165	1,332	9.1	406.3	406.3	406.3	0.0
CD	94,504	207	1,800	6.7	415.1	415.1	415.1	0.0
CE	95,896	114	1,235	9.8	427.0	427.0	427.0	0.0
CF	96,919	117	1,200	10.1	435.8	435.8	435.8	0.0

[1]Feet above confluence with Pacific Ocean

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CARMEL RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Carmel River (continued)								
CG	97,531[1]	299	2,097	5.8	443.0	443.0	443.0	0.0
CH	98,050[1]	152	2,295	5.3	449.8	449.8	449.8	0.0
CI	98,154[1]	158	1,902	6.4	458.1	458.1	458.1	0.0
CJ	99,060[1]	140	1,557	7.8	463.6	463.6	463.6	0.0
CK	99,763[1]	133	1,190	10.2	469.7	469.7	469.7	0.0
Carmel River Hacienda Carmel Overbank								
A	828[2]	140	961	4.7	54.8	54.8	55.8	1.0
B	1,020[2]	183	943	4.8	55.4	55.4	56.2	0.9
C	2,596[2]	203	742	6.1	58.2	58.2	59.2	1.0

[1]Feet above confluence with Pacific Ocean
[2]Feet above convergence with Carmel River Main Channel

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CARMEL RIVER – CARMEL RIVER HACIENDA CARMEL OVERBANK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Castroville Boulevard Wash								
A	8,298	15	19	6.6	10.4	10.4	10.4	0.0
B	9,148	10	16	7.8	15.1	15.1	15.1	0.0
C	9,280	25	23	5.4	16.9	16.9	17.6	0.7
D	9,486	15	24	5.2	19.4	19.4	19.4	0.0
E	9,836	20	59	2.1	25.4	25.4	25.4	0.0
F	10,856	15	31	4.0	25.5	25.5	26.0	0.5
G	11,078	30	123	1.0	29.1	29.1	30.0	0.9
H	11,698	15	20	6.3	31.3	31.3	31.8	0.5
I	11,960	25	61	2.0	37.6	37.6	37.6	0.0
J	12,200	15	34	3.7	40.1	40.1	40.1	0.0
K	12,665	20	63	2.0	45.0	45.0	45.4	0.4
L	12,805	20	89	1.4	46.9	46.9	47.5	0.6
M	13,041	40	178	0.7	48.6	48.6	49.1	0.5
N	13,592	25	54	2.3	49.7	49.7	50.4	0.7
O	13,796	35	147	0.9	54.3	54.3	54.5	0.2
P	14,496	25	47	2.7	56.9	56.9	57.8	0.9
Q	14,746	30	125	1.0	61.7	61.7	62.3	0.6
R	15,146	15	41	3.0	61.7	61.7	62.4	0.7
S	15,499	15	24	5.2	63.5	63.5	64.2	0.7
T	15,745	15	39	3.2	65.7	65.7	66.6	0.9
U	16,077	15	46	2.7	67.8	67.8	68.7	0.9
V	16,589	15	38	3.3	72.1	72.1	72.7	0.6
W	16,939	15	34	3.7	75.0	75.0	75.9	0.9
X	17,116	20	73	1.7	78.3	78.3	78.4	0.1
Y	17,288	25	99	1.3	79.5	79.5	79.6	0.1
Z	17,414	40	147	0.9	79.8	79.8	80.6	0.8
AA	18,114	45	143	0.9	79.9	79.9	80.7	0.8
AB	18,248	20	32	3.9	81.6	81.6	81.7	0.1

[1]Feet above confluence with Moro Cojo Slough

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CASTROVILLE BOULEVARD WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Castroville Boulevard Wash (continued)								
AC	18,382[1]	15	44	2.8	82.8	82.8	83.0	0.2
AD	18,628[1]	20	54	2.3	84.2	84.2	84.7	0.5
AE	18,767[1]	30	93	1.3	84.4	84.4	85.4	1.0
AF	18,927[1]	10	30	4.2	84.7	84.7	85.6	0.9
Corncob Canyon Creek								
A	1,300[2]	160	849	1.7	8.7	7.9[3]	8.0[3]	0.1
B	3,023[2]	150	638	2.2	8.7	7.9[3]	8.7[3]	0.8
C	3,532[2]	100	267	6.0	8.9	8.9	9.9	1.0
D	4,767[2]	115	1,162	1.3	20.6	20.6	21.6	1.0
E	5,502[2]	56	604	2.3	20.8	20.8	21.8	1.0
F	6,434[2]	66	803	1.7	25.9	25.9	26.1	0.2
G	7,507[2]	87	372	3.9	26.3	26.3	27.0	0.7
H	8,582[2]	130	1,297	0.1	28.3	28.3	29.2	0.9
I	9,477[2]	70	656	0.2	28.3	28.3	29.2	0.9
J	10,592[2]	70	708	0.2	28.3	28.3	29.2	0.9
K	11,620[2]	130	732	6.1	28.3	28.3	29.2	0.9
L	12,884[2]	61	15	6.5	39.3	39.3	39.3	0.0
M	14,107[2]	70	27	3.5	54.2	54.2	54.2	0.0
N	14,853[2]	67	16	5.8	65.6	65.6	65.6	0.0

[1]Feet above confluence with Moro Cojo Slough
[2]Feet above confluence with Elkhorn Slough
[3]Elevation computed without consideration of tidal effects from Pacific Ocean

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CASTROVILLE BOULEVARD WASH – CORNCOB CANYON CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
East Branch Gonzales Slough								
A	498[1]	25	70	2.8	144.9	144.9	144.9	0.0
B	859[1]	30	50	3.9	147.4	147.4	147.4	0.0
El Toro Creek								
A	3,008[2]	99	447	4.5	63.8	63.8	63.9	0.1
B	4,898[2]	78	298	6.7	78.1	78.1	78.1	0.0
C	6,528[2]	91	420	4.8	94.0	94.0	94.1	0.1
D	8,208[2]	106	463	4.3	108.4	108.4	108.4	0.0
E	9,768[2]	91	421	4.8	120.4	120.4	120.4	0.0
F	11,438[2]	101	359	5.6	129.7	129.7	130.2	0.5
G	13,318[2]	59	228	8.8	149.4	149.4	149.4	0.0
H	14,968[2]	72	389	5.1	164.3	164.3	164.4	0.1
I	17,058[2]	61	436	4.6	178.3	178.3	179.0	0.7
J	18,988[2]	67	442	4.5	190.9	190.9	191.9	1.0
K	20,888[2]	53	267	7.1	206.0	206.0	206.0	0.0
L	22,205[2]	185	476	4.5	226.2	226.2	226.3	0.0
M	22,674[2]	148	506	4.3	231.3	231.3	231.3	0.0
N	22,906[2]	144	450	4.8	234.7	234.7	234.7	0.0

[1]Feet above confluence with Gonzales Slough
[2]Feet above confluence with Salinas River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

EAST BRANCH GONZALES SLOUGH – EL TORO CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Elkhorn Slough								
A	700	407	5,724	0.2	8.7	5.2[2]	5.2[2]	0.0
B	2,640	661	5,302	0.2	8.7	5.2[2]	5.2[2]	0.0
C	5,803	711	5,748	0.2	8.7	5.2[2]	5.2[2]	0.0
D	8,171	1,407	13,117	0.1	8.7	5.2[2]	5.2[2]	0.0
E	10,902	697	4,913	0.3	8.7	5.2[2]	5.2[2]	0.0
F	13,794	898	5,015	0.3	8.7	5.2[2]	5.2[2]	0.0
G	16,581	582	3,960	0.3	8.7	5.2[2]	5.2[2]	0.0
H	19,470	885	4,732	0.3	8.7	5.2[2]	5.2[2]	0.0
I	21,973	565	2,763	0.5	8.7	5.3[2]	5.3[2]	0.0
J	25,058	764	2,496	0.6	8.7	5.3[2]	5.3[2]	0.0
K	27,785	354	1,391	1.2	8.7	5.4[2]	5.4[2]	0.0
L	30,779	358	1,410	1.2	8.7	5.6[2]	5.7[2]	0.1
M	32,388	290	1,316	1.3	8.7	5.7[2]	5.8[2]	0.1
N	34,292	508	3,711	0.6	8.7	7.9[2]	8.4[2]	0.5
O	35,797	519	3,698	0.6	8.7	7.9[2]	8.5[2]	0.6
P	37,897	441	3,647	0.4	8.7	7.9[2]	8.5[2]	0.6
Q	39,119	476	2,628	0.6	8.7	7.9[2]	8.5[2]	0.6
R	40,875	251	1,174	1.5	8.7	8.0[2]	8.6[2]	0.6
S	42,255	167	574	2.5	8.7	8.1[2]	8.7[2]	0.6
T	43,064	282	879	1.7	8.7	8.4[2]	9.2[2]	0.8
U	44,592	300	754	2.3	11.1	11.1	11.4	0.3
V	45,697	313	1,508	0.9	14.7	14.7	14.8	0.1
W	47,492	426	1,153	1.5	14.8	14.8	15.0	0.2
X	48,452	294	1,004	1.6	19.1	19.1	19.1	0.0
Y	49,911	237	722	2.5	22.2	22.2	22.8	0.6
Z	51,696	110	387	4.7	25.8	25.8	26.5	0.7
AA	52,971	174	420	4.1	30.6	30.6	31.5	0.9
AB	53,930	50	295	5.3	36.1	36.1	36.7	0.6

[1]Feet above confluence with Pacific Ocean
[2]Elevation computed without consideration of tidal effects from Pacific Ocean

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

ELKHORN SLOUGH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Elkhorn Slough (continued)								
AC	56,205	250	313	6.6	42.3	42.3	42.6	0.3
AD	57,854	46	207	6.1	50.8	50.8	50.8	0.0
AE	58,887	39	213	5.9	54.4	54.4	54.4	0.0
AF	60,983	42	225	5.6	63.1	63.1	63.1	0.0
AG	62,967	34	148	10.2	67.2	67.2	67.8	0.6
AH	65,752	74	219	8.3	76.2	76.2	76.5	0.3
AI	67,386	45	272	5.5	81.6	81.6	82.5	0.9
AJ	69,670	50	237	6.2	89.7	89.7	90.0	0.3
AK	71,721	45	226	5.3	96.8	96.8	97.4	0.6
AL	73,372	39	171	7.0	105.0	105.0	105.1	0.1
AM	74,849	44	145	7.9	110.5	110.5	110.5	0.0
AN	76,029	57	256	4.5	117.4	117.4	118.3	0.9
AO	77,983	81	249	4.0	132.3	132.3	132.6	0.3
AP	79,233	188	321	3.2	139.5	139.5	139.7	0.2
AQ	80,177	24	53	7.5	147.2	147.2	147.4	0.2
AR	81,222	25	74	5.4	156.4	156.4	156.4	0.0
AS	82,738	23	54	7.5	174.0	174.0	174.0	0.0

[1]Feet above confluence with Pacific Ocean

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

ELKHORN SLOUGH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Gabilan Creek								
A	4,492	884	5,929	0.3	52.9	52.9	53.8	0.8
B	5,429	414	1,345	1.5	52.9	52.9	53.9	1.0
C	6,586	124	358	5.6	55.8	55.8	56.4	0.6
D	7,440	110	310	6.8	58.1	58.1	58.3	0.2
E	7,632	50	266	7.5	58.3	58.3	58.4	0.1
F	8,426	62	338	5.9	60.3	60.3	60.8	0.5
G	9,816	58	308	6.5	67.7	67.7	68.1	0.4
H	10,389	72	413	4.8	71.7	71.7	72.3	0.6
I	10,739	64	235	8.5	79.9	79.9	80.1	0.2
J	12,439	288	594	3.4	90.6	90.6	91.2	0.6
K	13,191	44	230	8.7	93.4	93.4	93.9	0.5
L	13,989	58	359	5.6	96.9	96.9	97.4	0.5
M	15,563	145	668	3.0	107.5	107.5	108.5	1.0
N	16,795	159	429	4.7	113.8	113.8	113.9	0.1
O	17,433	72	480	4.2	119.6	119.6	119.7	0.1
P	18,735	53	183	10.9	122.5	122.5	122.5	0.0
Q	19,688	51	220	9.1	127.7	127.7	127.7	0.0
R	20,763	58	262	7.6	136.1	136.1	136.1	0.0
S	21,609	39	196	10.2	140.3	140.3	140.3	0.0
T	22,447	106	365	5.5	144.7	144.7	144.9	0.2
U	23,348	88	251	8.0	149.9	149.9	149.9	0.0
V	24,750	244	486	4.1	159.5	159.5	159.6	0.1
W	25,682	203	537	3.7	162.3	162.3	162.9	0.6
X	26,432	308	421	4.7	166.6	166.6	166.6	0.0
Y	27,762	330	390	5.1	172.1	172.1	172.2	0.1
Z	28,452	336	433	4.6	176.4	176.4	176.5	0.1
AA	29,555	235	364	5.5	183.1	183.1	183.1	0.0
AB	30,404	118	273	7.3	186.5	186.5	186.5	0.0
AC	31,681	54	332	6.0	194.9	194.9	194.9	0.0

[1]Feet above confluence with Reclamation Ditch

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

GABILAN CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Gonzales Slough								
A	2,559	25	40	2.7	136.1	136.1	136.9	0.8
B	2,678	140	1,770	0.2	136.2	136.2	137.1	0.9
C	3,714	145	1,760	0.2	136.2	136.2	137.1	0.9
D	3,823	85	380	0.6	136.2	136.2	137.1	0.9
E	4,025	35	40	5.9	136.6	136.6	137.1	0.5
F	4,266	100	1,220	0.2	138.0	138.0	138.4	0.4
G	4,554	70	850	0.3	138.0	138.0	138.4	0.4
H	4,684	65	300	1.0	138.0	138.0	138.4	0.4
I	4,926	65	670	0.4	138.0	138.0	138.4	0.4
J	5,057	90	880	0.4	138.0	138.0	138.4	0.4
K	6,178	105	800	0.4	138.0	138.0	138.4	0.4
L	6,412	105	1,220	0.3	140.7	140.7	140.9	0.2
M	7,325	184	1,900	0.2	140.7	140.7	140.9	0.2
N	7,551	210	1,760	0.2	141.6	141.6	141.8	0.2
O	8,753	85	400	0.9	141.7	141.7	141.8	0.1
P	10,109	55	200	1.9	145.1	145.1	145.1	0.0
Q	10,290	60	330	1.2	145.1	145.1	145.2	0.1

[1]Feet above U.S. Highway 101 culvert

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

GONZALES SLOUGH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Harper Creek								
A	456[1]	16	61	3.2	386.5	386.5	386.6	0.0
B	1,020[1]	40	36	5.5	402.4	402.4	402.4	0.0
C	1,222[1]	35	199	1.1	414.8	414.8	415.1	0.3
D	1,500[1]	27	55	3.9	421.3	421.3	421.6	0.3
E	1,946[1]	14	25	7.7	434.3	434.3	434.3	0.0
F	2,247[1]	12	23	8.1	444.9	444.9	444.9	0.0
G	2,561[1]	12	42	4.4	458.1	458.1	458.9	0.8
H	3,240[1]	25	44	3.9	480.6	480.6	480.7	0.0
I	3,493[1]	36	72	2.4	490.3	490.3	490.4	0.1
J	4,101[1]	22	53	3.2	517.4	517.4	517.7	0.3
K	4,657[1]	28	77	2.2	538.2	538.2	538.3	0.1
L	5,053[1]	25	35	4.4	552.1	552.1	552.5	0.4
M	5,603[1]	18	24	6.6	573.5	573.5	573.7	0.2
N	6,029[1]	14	22	7.2	589.0	589.0	589.0	0.0
O	6,247[1]	31	28	5.5	600.2	600.2	600.2	0.0
P	6,382[1]	13	22	7.3	604.9	604.9	604.9	0.0
Natividad Creek								
A	3,844[2]	1,266	7,824	0.1	46.5	46.5	46.5	0.0
B	6,358[2]	498	2,461	0.3	47.3	47.3	47.3	0.0
C	7,424[2]	840	6,800	0.1	47.3	47.3	47.3	0.0
D	8,415[2]	710	4,060	0.2	47.3	47.3	47.3	0.0
E	9,419[2]	29	108	6.5	47.3	47.3	47.3	0.0
F	10,450[2]	39	134	5.2	52.3	52.3	53.3	1.0

[1]Feet above confluence with San Benancio Gulch
[2]Feet above confluence with Reclamation Ditch

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

HARPER CREEK – NATIVIDAD CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pajaro River								
A	200	1,535	4,419	9.9	11.3	11.3	11.3	0.0
B	2,840	4,570	27,409	1.6	15.0	15.0	15.0	0.0
C	7,680	2	2	2	18.2	18.2	2	2
D	10,400	2	2	2	20.5	20.5	2	2
E	13,101	2	2	2	22.4	22.4	2	2
F	13,219	2	2	2	22.4	22.4	2	2
G	15,760	2	2	2	24.1	24.1	2	2
H	46,145	2	2	2	50.4	50.4	2	2
I	48,395	2	2	2	52.9	52.9	2	2
J	52,015	2	2	2	56.9	56.9	2	2
K	54,105	2	2	2	59.5	59.5	2	2
L	57,665	2	2	2	62.4	62.4	2	2
M	60,610	2	2	2	64.8	64.8	2	2
N	60,850	2	2	2	64.8	64.8	2	2
O	62,270	1,340	7,784	5.5	65.4	65.4	65.4	0.0
P	66,110	300	4,152	10.4	68.1	68.1	68.6	0.5
Q	68,240	300	4,099	10.5	71.2	71.2	71.9	0.7
R	71,020	304	6,052	7.1	77.1	77.1	77.4	0.3
S	73,820	271	5,692	7.6	80.5	80.5	80.8	0.3
T	76,380	500	6,064	7.1	82.6	82.6	83.1	0.5
U	79,237	393	6,471	6.6	85.4	85.4	86.0	0.6

[1]Feet above mouth at Pacific Ocean
[2]Floodway computed without consideration of levee

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

PAJARO RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[2]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pajaro River – Without Consideration of Levee								
A-B[1]								
C	7,680	5,116	21,892	2.0	15.6	15.6	15.8	0.2
D	10,440	5,488	28,165	1.5	16.1	16.1	16.7	0.6
E	13,101	5,350	28,665	1.5	16.5	16.5	17.3	0.8
F	13,219	5,315	29,269	1.5	16.6	16.6	17.4	0.8
G	15,760	5,422	30,289	1.4	17.0	17.0	17.8	0.8
H	46,145	3,683	18,408	2.3	45.7	45.7	46.7	1.0
I	43,395	2,700	13,953	3.1	47.0	47.0	47.8	0.8
J	52,015	2,200	10,093	4.3	50.8	50.8	51.1	0.3
K	54,105	2,100	10,804	4.0	52.5	52.5	53.2	0.7
L	57,665	2,400	11,024	3.9	55.5	55.5	56.3	0.8
M	60,610	1,375	8,709	4.9	59.5	59.5	59.8	0.3
N	60,850	1,320	9,916	4.3	60.8	60.8	60.8	0.0
O-U[1]								

[1]Cross-section data shown on Pajaro River
[2]Feet above mouth at Pacific Ocean

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

PAJARO RIVER-WITHOUT CONSIDERATION OF LEVEE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pine Canyon Creek								
A	3,124	119	240	6.3	298.0	298.0	298.8	0.8
B	4,362	67	170	8.8	308.7	308.7	308.7	0.0
C	4,597	54	360	4.2	312.4	312.4	312.4	0.0
D	5,852	27	130	11.5	324.9	324.9	324.9	0.0
E	7,565	42	180	8.3	344.0	344.0	344.0	0.0
F	8,906	38	140	10.7	357.6	357.6	357.6	0.0
G	10,004	61	180	8.3	368.3	368.3	368.3	0.0
H	11,190	42	470	3.2	391.4	391.4	391.9	0.5
I	12,258	30	130	11.5	394.9	394.9	394.9	0.0
J	13,848	42	160	9.4	410.8	410.8	410.8	0.0
K	14,608	54	450	3.3	423.6	423.6	424.5	0.9
L	16,435	46	270	5.6	435.3	435.3	435.3	0.0
M	18,055	40	200	7.5	449.5	449.5	449.5	0.0
N	19,108	53	260	5.8	458.1	458.1	458.1	0.0
O	19,560	68	850	1.8	468.9	468.9	469.6	0.7
P	20,078	35	270	5.6	469.3	469.3	470.3	1.0
Q	20,535	33	140	10.7	470.7	470.7	470.7	0.0

[1]Feet above confluence with Salinas River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

PINE CANYON CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Reclamation Ditch								
A-Z*								
AA	35,065	53	310	1.5	40.5	40.5	40.5	0.0
AB	36,655	537	1,988	0.5	40.8	40.8	40.8	0.0
AC	38,305	45	260	4.0	41.0	41.0	41.0	0.0
AD	40,510	45	278	3.8	42.5	42.5	42.5	0.0
AE	43,094	458	1,486	1.7	43.8	43.8	43.8	0.0
AF	45,749	216	635	1.7	45.8	45.8	45.8	0.0
AG	47,588	4,250	21,018	0.1	46.6	46.6	46.6	0.0
AH	52,228	550	587	0.8	46.6	46.6	46.6	0.0
AI	54,379	49	379	1.2	51.1	51.1	51.6	0.5
AJ	56,144	30	337	1.4	52.4	52.4	52.7	0.3
AK	58,740	64	516	0.9	52.4	52.4	52.7	0.3
AL	61,443	76	498	0.9	58.2	58.2	58.5	0.3
AM	63,616	111	838	0.6	58.4	58.4	58.7	0.3
AN	66,676	132	1,298	0.4	59.5	59.5	59.8	0.3

[1]Feet above confluence with Tembladero Slough
*Data Not Available

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

RECLAMATION DITCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Salinas River								
A	2.165	1,945	14,019	6.1	11.6	11.6	12.4	0.8
B	6.706	1,360	12,252	6.9	13.4	13.4	14.3	0.9
C	12.144	2,059	17,192	4.9	17.5	17.5	18.5	1.0
D	17.846	4,860	25,254	3.4	20.8	20.8	21.4	0.6
E	20.381	5,522	26,305	3.2	22.7	22.7	23.1	0.4
F	24.235	1,183	13,640	4.2	25.7	25.7	25.9	0.2
G	27.086	3,263	33,500	2.5	26.9	26.9	27.3	0.4
H	31.891	2,591	19,020	4.5	28.4	28.4	28.9	0.5
I	40.762	2,350	26,873	3.2	34.4	34.4	35.4	1.0
J	45.302	4,137	36,383	2.3	35.7	35.7	36.7	1.0
K	51.163	3,215	26,146	3.3	39.0	39.0	39.6	0.6
L	55.598	1,154	14,318	5.9	42.1	42.1	42.5	0.4
M	59.981	2,106	21,044	4.0	45.1	45.1	45.8	0.7
N	65.102	2,336	23,622	3.6	48.3	48.3	49.3	1.0
O	71.438	1,562	20,171	4.2	51.9	51.9	52.8	0.9
P	75.715	345	7,380	11.5	54.0	54.0	55.0	1.0
Q	81.206	905	18,824	4.5	60.1	60.1	60.7	0.6
R	84.797	1,208	20,997	4.1	60.8	60.8	61.5	0.7
S	89.866	2,834	41,183	2.1	62.6	62.6	63.4	0.8
T	97.469	4,726	44,627	1.9	63.8	63.8	64.7	0.9
U	355.080	1,385	12,457	6.9	287.2	287.2	287.7	0.5
V	358.618	1,562	14,306	6.0	291.4	291.4	291.9	0.5
W	360.888	1,409	14,862	5.8	294.4	294.4	295.1	0.7
X	363.475	1,719	18,068	4.8	296.1	296.1	296.5	0.4
Y	366.379	1,594	13,075	6.6	298.3	298.3	298.8	0.5
Z	368.966	1,584	16,251	5.3	300.9	300.9	301.5	0.6
AA	459.730	1,432	11,260	7.8	411.1	411.1	411.7	0.6
AB	462.106	1,251	10,670	8.2	415.3	415.3	415.5	0.2

[1]Feet above confluence with Pacific Ocean

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SALINAS RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Salinas River (continued)								
AC	464.904[1]	1,229	12,120	7.3	418.1	418.1	418.7	0.6
AD	466.646[1]	1,347	12,630	7.0	420.8	420.8	421.3	0.5
AE	468.125[1]	1,526	13,590	6.5	422.7	422.7	423.0	0.3
Salinas River Overbank								
F	6,450[2]	1,915	13,440	2.1	25.6	25.6	26.3	0.7

[1]Feet above confluence with Pacific Ocean along profile baseline
[2]Feet above convergence with Salinas River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SALINAS RIVER - SALINAS RIVER OVERBANK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
San Benancio Gulch								
A	177	16	50	10.0	237.2	237.2	237.3	0.1
B	599	18	52	9.6	251.1	251.1	251.2	0.1
C	1,123	32	62	8.0	264.8	264.8	264.8	0.0
D	1,343	19	52	9.4	270.3	270.3	270.3	0.0
E	1,519	63	326	1.5	283.7	283.7	283.7	0.0
F	1,847	37	65	7.5	284.7	284.7	284.7	0.0
G	2,358	24	70	6.9	294.9	294.9	294.9	0.0
H	2,886	45	245	1.9	312.5	312.5	312.6	0.1
I	3,398	26	56	8.4	320.1	320.1	320.1	0.0
J	3,710	36	368	1.3	334.2	334.2	334.4	0.3
K	4,121	13	45	10.4	337.2	337.2	337.2	0.0
L	4,670	18	80	6.2	346.8	346.8	346.8	0.0
M	5,121	41	64	7.2	358.0	358.0	358.0	0.0
N	5,570	40	63	7.2	370.5	370.5	370.5	0.0
O	5,881	54	133	2.2	383.4	383.4	383.4	0.0
P	6,374	28	41	6.9	396.1	396.1	396.1	0.0
Q	7,027	22	71	4.4	416.9	416.9	417.7	0.8
R	7,238	25	81	3.5	421.3	421.3	422.2	1.0
S	7,770	13	37	7.6	437.4	437.4	437.8	0.3
T	8,462	20	36	7.6	448.7	448.7	448.7	0.0
U	9,062	14	32	8.6	463.5	463.5	460.5	0.0
V	9,649	11	28	9.1	487	487	487.0	0.0
W	10,309	15	30	8.1	507.3	507.3	507.3	0.0
X	10,983	42	155	1.5	534.5	534.5	534.5	0.0
Y	11,482	10	26	9.1	550.1	550.1	550.1	0.0
Z	11,801	39	90	2.5	571.3	571.3	571.3	0.0
AA	12,368	43	40	5.5	590.6	590.6	590.6	0.0
AB	12,898	53	94	2.7	609.7	609.7	609.8	0.0

[1]Feet above confluence with El Toro Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SAN BENANCIO GULCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
San Benancio Gulch (continued)								
AC	13,595[1]	19	29	7.0	627.6	627.6	627.6	0.0
AD	14,023[1]	14	44	4.9	644.3	644.3	645.0	0.8
AE	14,390[1]	21	29	6.8	656.0	656.0	656.0	0.0
AF	14,921[1]	35	41	4.5	678.8	678.8	678.8	0.0
AG	15,432[1]	9	24	7.6	697.9	697.9	698.0	0.1
AH	15,639[1]	15	46	3.9	705.4	705.4	705.4	0.0
AI	16,083[1]	44	180	1.0	723.8	723.8	723.8	0.0
AJ	16,682[1]	16	40	3.8	744.4	744.4	744.8	0.4
AK	17,688[1]	37	115	1.3	782.8	782.8	782.9	0.1
AL	17,954[1]	18	72	1.9	794.4	794.4	794.4	0.1
AM	18,154[1]	18	21	6.3	800.8	800.8	800.8	0.0
AN	18,374[1]	46	100	2.0	812.9	812.9	812.9	0.0
AO	18,830[1]	10	18	7.5	830.6	830.6	830.6	0.0
San Lorenzo Creek								
A	2,688[2]	340	1,800	10.4	300.6	300.6	300.6	0.0
B	4,157[2]	340	2,590	7.2	305.7	305.7	306.0	0.3
C	4,585[2]	380	2,920	6.4	309.7	309.7	309.7	0.0
D	5,215[2]	250	1,630	11.4	310.0	310.0	310.0	0.0
E	6,697[2]	769	6,030	3.1	314.7	314.7	315.0	0.3
F	7,754[2]	364	1,890	9.9	319.2	319.2	319.2	0.0
G	8,539[2]	295	3,270	5.7	326.3	326.3	326.3	0.0
H	10,489[2]	478	3,440	5.4	328.4	328.4	328.4	0.0
I	11,839[2]	1,127	8,060	2.3	329.5	329.5	329.7	0.2

[1]Feet above confluence with El Toro Creek
[2]Feet above confluence with Salinas River

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SAN BENANCIO GULCH – SAN LORENZO CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
San Miguel Canyon Creek								
A	90	14	70	9.8	16.2	16.2	17.0	0.8
B	1,241	78	183	3.8	19.0	19.0	20.0	1.0
C	2,427	112	152	4.5	24.6	24.6	25.0	0.4
D	3,388	30	96	4.6	30.6	30.6	30.7	0.1
E	4,600	32	140	3.2	37.3	37.3	37.9	0.6
F	5,406	83	351	1.3	42.4	42.4	43.4	1.0
G	6,693	36	141	3.1	49.4	49.4	49.8	0.4
H	7,762	60	81	5.4	56.2	56.2	56.3	0.1
I	8,637	63	144	3.1	63.6	63.6	64.0	0.4
J	9,724	51	80	5.5	75.2	75.2	75.4	0.2
K	10,357	33	144	3.1	82.9	82.9	83.2	0.3
L	11,744	23	135	3.3	93.5	93.5	93.5	0.0
M	12,587	26	63	4.8	95.4	95.4	95.6	0.2
N	13,509	20	44	6.8	109.1	109.1	109.1	0.0
O	14,791	28	66	4.6	120.8	120.8	120.8	0.0
P	15,818	31	117	1.3	125.1	125.1	126.1	1.0
Q	16,646	32	220	1.5	147.7	147.7	148.5	0.8
R	17,616	18	103	1.2	155.8	155.8	156.7	0.9
S	18,475	17	23	5.2	165.6	165.6	165.9	0.3
T	19,531	14	19	4.2	175.1	175.1	175.7	0.6
U	20,349	17	26	3.1	190.4	190.4	191.2	0.8
V	21,382	14	14	5.6	210.1	210.1	210.6	0.5
W	22,224	10	13	6.1	236.7	236.7	237.1	0.4

[1]Feet above U.S. Highway 101

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SAN MIGUEL CANYON CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Santa Rita Creek								
A	25,323[1]	61	146	3.2	48.7	48.7	49.7	1.0
B	27,214[1]	94	116	4.0	59.3	59.3	59.7	0.4
C	28,719[1]	69	112	4.2	67.0	67.0	68.0	1.0
D	30,795[1]	20	61	7.6	75.4	75.4	75.5	0.1
E	32,660[1]	29	94	4.9	83.7	83.7	83.7	0.0
F	34,410[1]	36	94	4.9	89.7	89.7	89.7	0.0
G	36,440[1]	38	109	4.3	102.9	102.9	102.9	0.0
H	38,071[1]	29	103	4.5	114.6	114.6	115.4	0.8
I	40,527[1]	120	358	1.3	128.2	128.2	128.6	0.4
J	42,524[1]	87	91	5.1	137.4	137.4	137.9	0.5
K	44,933[1]	72	159	2.9	148.9	148.9	149.4	0.5
L	47,013[1]	52	126	3.7	162.6	162.6	163.4	0.8
Tembladero Slough								
A	21,800[2]	419	2,230	2.4	12.1	12.1	13.1	1.0
B	22,986[2]	263	2,160	1.8	12.3	12.3	13.3	1.0
C	23,928[2]	335	2,670	1.6	12.6	12.6	13.5	0.9
D	25,043[2]	165	1,270	3.1	12.8	12.8	13.7	0.9
E	26,307[2]	196	1,920	2.5	14.4	14.4	15.3	0.9
F	27,324[2]	95	830	5.5	14.4	14.4	15.4	0.9
G	28,460[2]	286	2,900	1.6	16.1	16.1	16.9	0.8
H	29,651[2]	345	3,500	1.4	16.1	16.1	17.0	0.9
I	30,804[2]	270	2,400	2.0	16.1	16.1	17.0	0.9
J	31,756[2]	233	2,300	1.9	16.1	16.1	17.1	1.0
K	32,448[2]	30	420	0.3	16.2	16.2	17.2	1.0
L	32,816[2]	70	870	0.1	16.2	16.2	17.2	1.0

[1]Feet above confluence with Tembladero Slough
[2]Feet above confluence with Pacific Ocean

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SANTA RITA CREEK – TEMBLADERO SLOUGH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Watson Creek								
A	45	25	139	4.3	407.8	407.8	408.8	1.0
B	258	32	133	4.6	411.7	411.7	411.7	0.0
C	659	36	127	4.7	415.2	415.2	415.2	0.0
D	1,417	34	122	4.6	425.3	425.3	425.3	0.0
E	2,399	47	137	4.0	434.3	434.3	434.3	0.0
F	3,463	12	45	10.6	449.7	449.7	449.7	0.0
G	3,551	31	139	3.5	452.4	452.4	452.4	0.0
H	3,670	33	83	5.8	453.2	453.2	453.2	0.0
I	3,948	35	92	5.3	458.9	458.9	458.9	0.0
J	4,350	32	103	4.7	468.7	468.7	468.7	0.0
K	4,642	15	51	9.5	474.2	474.2	474.2	0.0
L	5,109	26	91	5.3	486.8	486.8	486.8	0.0
M	5,297	31	62	7.8	494.0	494.0	493.9	-0.1
N	5,514	29	104	4.7	499.0	499.0	499.0	0.0
O	5,913	24	56	8.7	505.5	505.5	505.5	0.0
P	6,026	65	142	3.4	509.8	509.8	509.8	0.0
Q	6,282	31	67	7.2	512.5	512.5	512.6	0.1
R	6,612	27	88	5.5	521.0	521.0	521.4	0.4
S	7,440	45	104	4.7	537.2	537.2	537.5	0.3
T	8,249	18	79	6.1	549.0	549.0	549.4	0.4
U	8,549	19	49	9.3	552.1	552.1	552.1	0.0
V	9,226	24	85	5.4	568.8	568.8	568.8	0.0
W	9,488	53	108	4.3	572.7	572.7	572.7	0.0
X	10,027	32	62	7.4	586.3	586.3	586.4	0.1
Y	10,157	28	88	5.2	591.0	591.0	591.0	0.0
Z	10,553	19	70	4.6	596.2	596.2	596.2	0.0
AA	10,607	20	103	3.1	599.3	599.3	599.3	0.0
AB	10,850	88	165	2.0	600.0	600.0	600.0	0.0

[1]Feet above confluence with Calera Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

WATSON CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Watson Creek								
AC	11,331	26	44	7.4	605.2	605.2	605.2	0.0
AD	11,928	16	49	6.7	616.0	616.0	616.0	0.0
AE	12,526	11	42	7.7	637.2	637.2	637.2	0.0
AF	12,710	19	39	8.3	650.0	650.0	650.0	0.0
AG	13,045	19	47	7.0	660.2	660.2	660.2	0.0
AH	13,146	43	221	1.5	669.4	669.4	669.5	0.1
AI	13,453	22	53	6.2	671.5	671.5	671.5	0.0
AJ	14,092	30	52	6.2	689.2	689.2	689.2	0.0
AK	14,350	11	50	6.5	700.2	700.2	700.3	0.1
AL	14,713	12	34	9.6	716.6	716.6	716.6	0.0
AM	14,900	23	77	4.2	721.9	721.9	722.0	0.1
AN	14,994	50	192	1.7	729.0	729.0	729.2	0.2
AO	15,320	23	69	4.7	730.1	730.1	730.1	0.0
AP	15,905	30	65	5.0	740.3	740.3	740.3	0.0
AQ	16,071	116	247	1.3	748.2	748.2	748.2	0.0
AR	16,315	25	57	5.8	748.5	748.5	748.5	0.0
AS	16,541	21	58	5.6	753.8	753.8	753.8	0.0
AT	17,393	16	48	6.7	772.2	772.2	772.2	0.0
AU	17,435	12	57	5.7	774.5	774.5	774.5	0.0
AV	17,829	25	75	4.3	781.2	781.2	781.2	0.0
AW	17,945	29	79	3.5	787.4	787.4	787.3	-0.1
AX	18,551	12	36	7.6	810.6	810.6	810.9	0.3
AY	18,724	50	126	2.2	812.8	812.8	813.2	0.4
AZ	18,992	21	61	4.5	820.2	820.2	820.6	0.4
BA	19,378	20	36	7.6	837.2	837.2	837.4	0.2
BB	19,520	18	35	8.0	848.7	848.7	849.0	0.3
BC	19,770	26	53	5.2	860.2	860.2	860.5	0.3
BD	20,027	21	37	7.6	867.3	867.3	867.5	0.2

[1]Feet above confluence with Calera Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

WATSON CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Watson Creek								
BE	20,076	8	40	6.5	873.2	873.2	874.1	0.9
BF	20,587	37	70	3.9	883.4	883.4	883.6	0.2
BG	20,846	29	53	5.2	886.2	886.2	886.2	0.0

[1]Feet above confluence with Calera Creek

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

WATSON CREEK

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 1-percent annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 1-percent annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone AR

Area of special flood hazard formerly protected from the 1-percent annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1-percent annual chance or greater flood event.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the 1-percent annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 1-percent annual chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no base flood elevations are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent annual chance floodplain, areas within the 0.2-percent annual chance floodplain, and to areas of 1-percent annual chance flooding where average depths are less than 1 foot, areas of 1-percent annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent annual chance flood by levees. No base flood elevations or depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications. For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent annual chance floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies. For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent annual chance floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable.

The current FIRM presents flooding information for the entire geographic area of Monterey County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each identified flood-prone incorporated community and the unincorporated areas of the county. This countywide FIRM also includes flood hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community, up to and including this countywide FIS, are presented in Table 14, "Community Map History."

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Carmel-by-the-Sea, City of	April 2, 2009	None	April 2, 2009	April 2, 2009
Del Rey Oaks, City of	May 14, 1976	None	November 4, 1981	April 2, 2009
Gonzales, City of	May 24, 1974	November 28, 1975	November 18, 1981	April 2, 2009
Greenfield, City of	April 2, 2009	None	April 2, 2009	April 2, 2009
King City, City of	December 27, 1974	May 23, 1978	October 15, 1981	April 2, 2009
Marina, City of	February 17, 1988	None	February 17, 1988	February 3, 1993 April 2, 2009
Monterey, City of	October 18, 1974	February 11, 1977	July 2, 1981	June 17, 1986 April 2, 2009
Monterey County (Unincorporated Areas)	February 21, 1978	April 24, 1979 November 17, 1981	January 30, 1984	August 5, 1986 September 27, 1991 April 2, 2009
Pacific Grove, City of	April 2, 2009	None	April 2, 2009	April 2, 2009
Salinas, City of	March 15, 1974	December 6, 1974 October 29, 1976 June 6, 1978	November 4, 1981	April 2, 2009

TABLE 14

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Sand City, City of	December 3, 1976	None	June 3, 1986	April 2, 2009
Seaside, City of	June 7, 1974	December 19, 1975	July 2, 1981	August 19, 1986 April 2, 2009
Soledad, City of	July 18, 1983	None	July 18, 1983	May 15, 1984

TABLE 14

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTEREY COUNTY, CA AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Monterey County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS Reports, FHBMs, FBFMs, and FIRMs for all of the incorporated and unincorporated jurisdictions within Monterey County.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this FIS can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, 111 Broadway, Suite 1200, Oakland, California 94607-4052.

9.0 BIBLIOGRAPHY AND REFERENCES

A. L. Kroeber. (1967). Handbook of the Indians of California. Berkeley: California Book Company.

Aero-Geodetic Corporation. (City of Marina, November 26, 1979). City of Marina Aerial Topographic Maps, Scale 1:2,400, Contour Interval 2 feet.

Bestor Engineers, Inc. (October 1979). Lakeside Village Subdivision, Grading Plan.

California Department of Water Resources. (October 1976, with microfiche update dated 1986). Rainfall Analysis for Drainage Design.

City of Monterey. (Monterey, California, May 1975). Topographic Maps, Scale 1:1,200, Contour Interval 2 feet.

City of Salinas. (1975). Resident's Handbook for the City of Salinas.

City of Santa Cruz Museum, Permanent Display of American Indian Artifacts. Santa Cruz, California.

Cook, Terry D., CPSS/SC. (October 13, 1991). Soils Study for Permeability Assessment, City of Marina Infiltration Ponds, Marina, California. Prepared for Ensign & Buckley Engineering.

D. E. Overton. (1966). "Muskingum Routing of Upland Stream Flow," Journal of Hydrology, Volume IV, No. 3.

Federal Emergency Management Agency. (February 17, 1988). Flood Insurance Rate Map, City of Marina, Monterey County, California.

Federal Emergency Management Agency, Federal Insurance Administration. (August 5, 1986). Flood Insurance Study, Monterey County, California (Unincorporated Areas).

Federal Emergency Management Agency. (1981). Flood Insurance Study, City of Seaside, California.

Gary S. Breschini. (1972). The Indians of Monterey County. Monterey: d'Angelo Publishing Company.

Harl Pugh & Associates. (September 1978). Aerial Photogrammetry of Monterey County, California, Scales 1:6,000 and 1:12,000.

I. J. Hunt. (1959). "Design of Seawalls and Breakwaters," Proceeding of ASCE, Vol. 85, no. WW3.

James R. Pagenkopf, et al. (August 1976, with modifications made by Ott Water Engineers, Inc.). A Two-Dimensional Finite Element Circulation Model, A User's Manual for CAFÉ-1. R. M. Parsons Laboratory, M.I.T.

Meteorology International, Inc. Deep-Water Wave Statistics for the California Coast. California Department of Boating and Waterways.

Monterey County, California. (January 1979). Monterey County Drainage Study-Carr Lake and Reclamation Ditch, Monterey County Master Drainage Plan.

Monterey County. (1968). Monterey County General Plan.

Monterey County Flood Control and Water Conservation District. (January 1979). Monterey County Drainage Study – Carr Lake and Reclamation Ditch. Prepared for the Monterey County Master Drainage Plan.

Monterey County Flood Control and Water Conservation District. (June 1977). Monterey County Master Drainage Plan Maps for Canyon Del Rey Watershed, Scale 1:4,800, Contour Interval 10 feet.

Neill Engineers, Inc. (October 1985). Improvement Plan, Zewe Subdivision, Portion of Lot 10.

Ott Water Engineers, Inc. (August 1984). Northern California Coastal Flood Studies. Prepared for the Federal Emergency Management Agency.

Ott Water Engineers, Inc. (1983). Aerial Photography, Scale 1:4,800, Contour Interval 4 feet.

Ott Water Engineers, Inc. (1975). Aerial Photography, Scale 1:1,200, Contour Interval 2 feet.

R. S. Dobson. (March 1967). A Program to Construct Refraction Diagrams and Compute Wave Heights for Waves Moving into Shoaling Waters. Stanford University.

Spink Corporation. (Sacramento, California, 1978). Aerial Photography, Scale 1:4,800.

U.S. Army Corps of Engineers, Hydrologic Engineering Center. (May 1984). HEC-2 Water-Surface Profiles, Users Manual. Davis, California.

U.S. Army Corps of Engineers, San Francisco District. Isohyetal Map, 50-year Normal Annual Precipitation, 1906-1956.

U.S. Army Corps of Engineers, Waterways Experiment Station. (February 1979). Technical Report HL-79-2, A Numerical Model for Tsunami Inundation. J. R. Houston and H. L. Butler (authors).

U.S. Army Corps of Engineers, Waterways Experiment Station. (December 1978). Technical Report H-78-26, Flood Insurance Study, Tsunami Prediction for the West Coast of the Continental United States. J. R. Houston and A. W. Garcia (authors).

U.S. Army Corps of Engineers, Coastal Engineering Research Center. (July 1978). Technical Aid No. 78-2, Revised Runup Curves for Smooth Slopes. P. N. Stoa (author).

U.S. Army Corps of Engineers. (January 1978). Review Report – Flood Control and Allied Purposes, Pajaro River Basin, California. San Francisco, California.

U.S. Army Corps of Engineers. (1978). California Coast Storm Damage, Winter 1977-1978. G. W. Domurat (author).

U.S. Army Corps of Engineers. (1977). Shore Protection Manual.

U.S. Army Corps of Engineers. (July 1974). Flood Control Alternatives for Pajaro Valley – Pajaro River, Salsipuedes Creek, and Corralitos Creek. San Francisco, California.

U.S. Army Corps of Engineers, Waterways Experiment Station. (May 1974). Technical Report H-74-3, Flood Insurance Study: Tsunami Prediction for Pacific Coastal Communities. J. R. Houston and A. W. Garcia (authors).

U.S. Army Corps of Engineers, San Francisco District. (April 1974). Hydrology Engineering Office Report, Carmel River Basin.

U.S. Army Corps of Engineers, Hydrologic Engineering Center. (October 1973). Generalized Computer Program HEC-2, Water-Surface Profiles.

U.S. Army Corps of Engineers. (June 1973). Interim Report for Flood Control and Allied Purposes, Pajaro River Basin, California. San Francisco, California.

U.S. Army Corps of Engineers, Hydrologic Engineering Center. (January 1973). HEC-1 Flood Hydrograph Package. Davis, California.

U.S. Army Corps of Engineers, Hydrologic Engineering Center. (January 1973). HEC-1 Flood Hydrograph Package, User's Manual. Davis, California.

U.S. Army Corps of Engineers. (1971). Pajaro River Topographic Maps, Scale 1:1,200, Contour Interval 2 feet.

U.S. Army Corps of Engineers, San Francisco District. (September 1970). A Report on January and February 1969 Floods, Central Coast Streams, California, Vol. II, Appendix B.

U.S. Army Corps of Engineers. (January 1962). Statistical Methods in Hydrology. Leo R. Beard (author).

U.S. Department of Agriculture, Soil Conservation Service. (1986). Urban Hydrology for Small Watersheds, Technical Release 55.

U.S. Department of Agriculture, Soil Conservation Service. (April 1978). Soil Survey of Monterey County, California.

U.S. Department of Agriculture, Soil Conservation Service. (August 1972). "Hydrology," National Engineering Handbook, Section 4.

U.S. Department of Commerce, Bureau of the Census. (March 1981). 1980 Census of Population, Housing, Advanced Reports.

U.S. Department of Commerce, National Climatic Data Center. (1955-1983). Three-Hourly North American Surface Weather Maps. Asheville, North Carolina.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. (1945-1983). Tide Tables, High and Low Water Predictions, West Coast of North and South America.

U.S. Department of Commerce, National Climatic Data Center. (1944-1983). Meteorological Record for San Francisco, California, Airport. Asheville, North Carolina.

U.S. Department of Housing and Urban Development, Federal Insurance Administration. (Revised November 17, 1981). Flood Hazard Boundary Map, Monterey County, California (Unincorporated Areas). Scale 1:24,000.

U.S. Department of Housing and Urban Development, Federal Insurance Administration. (October 18, 1974, revised February 1977). Flood Hazard Boundary Map, City of Monterey, California, Scale 1:12,000.

U.S. Department of the Interior, Geological Survey. (1987). Roughness Characteristics of Natural Channels.

U.S. Department of the Interior, Geological Survey. (October 25, 1978). Unpublished records.

U.S. Department of the Interior, Geological Survey. (Carmel Valley, California, 1948, Photorevised 1979; Chualar, California). 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 10 feet.

U.S. Department of the Interior, Geological Survey. (Salinas, California, 1947, Photorevised 1984). 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 10 feet.

U.S. Water Resources Council, Hydrology Committee. (1977). "Guidelines for Determining Flood Flow Frequency," Bulletin 17A.

U.S. Water Resources Council, Hydrologic Committee. (March 1976). "Guidelines for Determining Flood Flow Frequency," Bulletin 17.