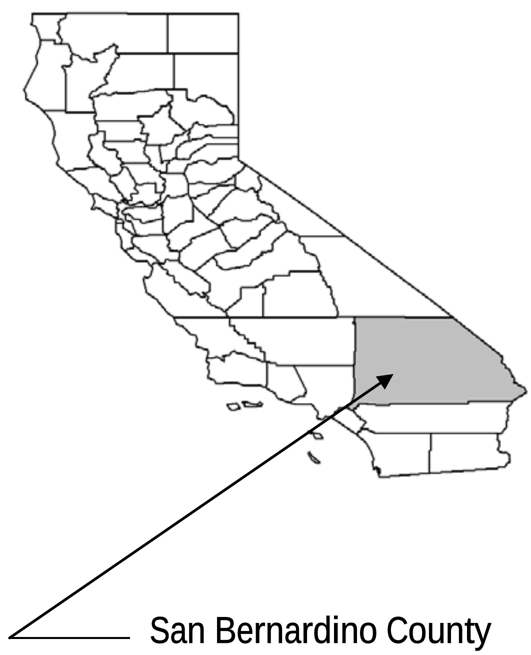
FLOOD INSURANCE STUDY

VOLUME 1 OF 4

SAN BERNARDINO COUNTY, CALIFORNIA
AND INCORPORATED AREAS



COMMUNITY NAME	COMMUNITY NUMBER
ADELANTO, CITY OF	060639
APPLE VALLEY, TOWN OF	060752
BARSTOW, CITY OF	060271
BIG BEAR LAKE, CITY OF	060731
CHINO, CITY OF	060272
CHINO HILLS, CITY OF	060754
COLORADO RIVER INDIAN RESERVATION	060069
COLTON, CITY OF	060273
FONTANA, CITY OF	060274
FORT MOJAVE INDIAN RESERVATION	060743
GRAND TERRACE, CITY OF	060737
HESPERIA, CITY OF	060733
HIGHLAND, CITY OF	060732
LOMA LINDA, CITY OF	065042
MONTCLAIR, CITY OF	060276
NEEDLES, CITY OF	060277
ONTARIO, CITY OF	060278
RANCHO CUCAMONGA, CITY OF	060671
REDLANDS, CITY OF	060279
RIALTO, CITY OF	060280
SAN BERNARDINO, CITY OF	060281
SAN BERNARDINO COUNTY, (UNINCORPORATED AREAS)	060270
TWENTYNINE PALMS, CITY OF	060734
UPLAND, CITY OF	065067
VICTORVILLE, CITY OF	065068
YUCAIPA, CITY OF	060739
YUCCA VALLEY, TOWN OF	060750

REVISED:
September 2, 2016

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
06071CV001D

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.

ATTENTION: On FIRM panels 06061C7930J, 06061C7940J, 06061C8709J, and 06061C8730J, the Cable Creek, Macy Basin, and Mill Creek levees have not been demonstrated by the community or levee owner to meet the requirements of Section 65.10 of the NFIP regulations in 44 CFR as it relates to the levee's capacity to provide 1-percent- annual -chance flood protection. The subject areas are identified on FIRM panels (with notes and bounding lines) and in the FIS report as potential areas of flood hazard data changes based on further review.

FEMA has updated the levee analysis and mapping procedures for non-accredited levees. Until such time as FEMA is able to initiate a new flood risk project to apply the new procedures, the flood hazard information on the aforementioned FIRM panel(s) that are affected by Cable Creek, Macy Basin, and Mill Creek levees are being added as a snapshot of the prior previously effective information presented on the FIRMs and FIS reports dated August 28, 2008. As indicated above, it is expected that affected flood hazard data within the subject area could be significantly revised. This may result in floodplain boundary changes, 1-percent- annual -chance flood elevation changes, and/or changes to flood hazard zone designations.

The effective FIRM panels (and the FIS report) will again be revised at a later date to update the flood hazard information associated with the Cable Creek, Macy Basin, and Mill Creek levees when FEMA is able to initiate and complete a new flood risk project to apply the updated levee analysis and mapping procedures.

This FIS report was revised on September 2, 2016. Users should refer to Section 10.0, Revisions Description, for further information. Section 10.0 is intended to present the most up-to-date information for specific portions of this FIS report. Therefore, users of this FIS report should be aware that the information presented in Section 10.0 supersedes information in Sections 1.0 through 9.0 of this FIS report.

Initial Countywide FIS Effective Date: March 18, 1996

First Revised Countywide FIS Date: August 28, 2008

Second Revised Countywide FIS Date: September 26, 2014

Third Revised Countywide FIS Date: February 18, 2015

Fourth Revised Countywide FIS Date: September 2, 2016

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FLOOD INSURANCE STUDY
SAN BERNARDINO COUNTY, CALIFORNIA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of San Bernardino County, California, including the Cities of Adelanto, Barstow, Big Bear Lake, Chino, Chino Hills, Colton, Fontana, Grand Terrace, Hesperia, Highland, Loma Linda, Montclair, Needles, Ontario, Rancho Cucamonga, Redlands, Rialto, San Bernardino, Twentynine Palms, Upland, Victorville, and Yucaipa; the Towns of Apple Valley and Yucca Valley; the Colorado River Indian Reservation; the Fort Mojave Indian Reservation; and the unincorporated areas of San Bernardino County (referred to collectively herein as San Bernardino County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3. This information will be used to update existing floodplain regulations as part of the Regular Phase of the NFIP. The information will also be used by local and regional planners to further promote sound land use and floodplain development.

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.

The Flood Insurance Studies for the communities listed in Section 1.1 were performed under contract to the Federal Emergency Management Agency (FEMA). Additional information on the study contractors for each study is provided in Table 1, “Flood Insurance Study Contractors.”

TABLE 1 - FLOOD INSURANCE STUDY CONTRACTORS

Community Name	Study Contractor	Contract or Interagency	Completion Date
San Bernardino County (Unincorporated Areas)	Toups Corporation	H-3692	September 1975
	P&D Technologies	EMW-83-C-1198	January 1985
	Aqua Resources, Inc	EMW-89-C-2844	*
	BSI Consultants, Inc.	EMW-90-C-3109	October 1991
Adelanto, City of	Toups Corporation	H-3692	February 1978
Barstow, City of	Toups Corporation	H-3692	March 1978
	BSI Consultants, Inc.	EMW-90-C-3109	October 1991
Big Bear Lake, City of	Boyle Engineering Corporation	N/A	
	Toups Corporation	H-3692	September 1975
Colton, City of	Toups Corporation	H-3692	March 1978
	U.S. Army Corps of Engineers (USACE), Los Angeles District	EMW-84-E-1506 Project Order No. 1, Amendment No. 12	March 1986
Fontana, City of	PRO Engineering	H-4721	November 1985
	Aqua Resources, Inc.	EMW-89-C-2844	July 1991
Hesperia, City of	Toups Corporation	H-3692	September 1975
Highland, City of	Toups Corporation	H-3692	September 1975
Loma Linda, City of	PRC Engineering	H-4721	November 1985
Needles, City of	Toups Corporation	H-3692	March 1978
Ontario, City of	Toups Corporation	H-3692	March 1978
Rancho Cucamonga, City of	Toups Corporation	H-3692	September 1975
Redlands, City of	U.S. Geological Survey	IAA-H-17-72, Project Order No. 4	March 1975
	USACE, Seattle District	IAA-EMW-84-E-1506, Project Order No. 1	December 1986
	PRC Engineering	EMW-83-C-1198	January 1985
San Bernardino, City of	CH2M Hill, Inc.	H-1658	May 1972
	BSI Consultants, Inc.	EMW-90-C-3109	November 1991
Twentynine Palms, City of	BSI Consultants, Inc.	EMW-90-C-3109	October 1991
	P&D Technologies	EMW-83-C-1198	*

*Data not available

1.3 Coordination

The following were contacted for information pertinent to the individual FISs: San Bernardino County agencies, including the Building and Safety Department, Planning Department, County Surveyor's Office, Road Department, and the San Bernardino County Flood Control District (SBCFCD); state agencies including the Division of Forestry, Department of Transportation, Department of Housing and Community Development, Division of Mines and Geology, and the Department of Water Resources; Federal agencies including the Forest Service, Natural Resources Conservation Service (NRCS) (previously known as the Soil Conservation Service), U.S. Geological Survey (USGS), Bureau of Indian Affairs, Bureau of Land Management, Bureau of Mines, U.S. Bureau of Reclamation (USBR), Federal Highway Administration, and the U.S. Army Corps of Engineers (USACE).

During the preparation of the initial FISs for the individual communities, FEMA representatives held coordination meetings with community officials, representatives of the study contractor for each study, and other interested agencies and citizens. The meetings, referred to as the initial, intermediate, and final Consultation Coordination Officer (CCO) meetings, were held at specified intervals during the preparation of the studies. The comments and issues raised at those meetings were addressed in the FIS for each community.

The dates of the initial and final CCO meetings held for San Bernardino County and the incorporated communities within its boundaries are shown in Table 2, "Initial and Final CCO Meetings."

TABLE 2 - INITIAL AND FINAL CCO MEETINGS

Community	Initial CCO Meeting or Coordination Meetings	Contract or Intermediate CCO Meeting	Final CCO Meeting
San Bernardino County	December 12, 1974	*	November 19, 1975
(Unincorporated Areas)	*	*	January 18, 1990
	June 1988	*	February 16, 1993
	August 17, 1989	October 31, 1991	February 16, 1993
	August 17, 1989	August 1, 1991 and August 17, 1992	March 2, 1994
Adelanto, City of	March 22, 1976	January 13, 1978	March 29, 1979
Barstow, City of	March 1976	*	December 13, 1978
	August 17, 1989	August 1, 1991	February 15, 1994
Big Bear Lake, City of	April 15, 1988	*	August 8, 1990

*Data not available

TABLE 2 - INITIAL AND FINAL CCO MEETINGS (continued)

Community	Initial CCO Meeting or Coordination Meetings	Contract or Intermediate CCO Meeting	Final CCO Meeting
Colton, City of	March 9, 1976 *	January 13, 1978 *	October 4, 1978 April 11, 1986
Fontana, City of	* June 1988	* *	April 18, 1983 June 8, 1992
Hesperia, City of	*	*	*
Highland, City of	* August 17, 1989	* October 31, 1991 and August 17, 1992	March 20, 1989 October 14, 1992
Loma Linda, City of	*	*	April 21, 1983
Needles, City of	March 16, 1976	*	June 22, 1978
Ontario, City of	March 15, 1977	June 7, 1977	December 14, 1978
Rancho Cucamonga, City of	*	*	May 18, 1983
Redlands, City of	* February 9, 1984	* *	January 28, 1978 November 10, 1987
San Bernardino, City of	* August 17, 1989	* October 31, 1991	January 24, 1978 February 16, 1993
Twentynine Palms, City of	March 30, 1990	*	February 15, 1994

*Data not available

A final CCO meeting for the ninth revision was held on October 23, 2013 to review the results. The meeting was attended by communities, FEMA and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of San Bernardino County, California, including the incorporated communities listed in Section 1.1.

All or portions of the flooding sources listed in Table 3, "Flooding Sources 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). The stream that was referred to as the San Sevaine Channel in previous FIS reports is now referred to as the Etiwanda/San Sevaine System.

TABLE 3 - FLOODING SOURCES STUDIED BY DETAILED METHODS

11th Street Storm Drain
Antelope Valley Wash
Armory Creek
Arrowhead Channel
Cable Creek
Cable Creek Channel
Carbon Canyon Creek
Chicken Springs Creek
Chino Creek
City Creek
Colorado River
Colton Southwest Storm Drain
Cucamonga Creek
Day Creek
Deer Creek
Del Rosa Channel
Desert Knolls Wash
Devil Creek
Eagle Pass Wash
East Adelanto Channel
East Barstow Channel
East Etiwanda Creek
East Rialto Storm Drain
Etiwanda/San Sevaine System
Grout Creek
Highgrove Channel
Hook Creek
Houston Creek
Joshua Tree Creek
Kitchen Wash
Knickerbocker Creek
Kuffel Canyon Creek
Lenwood Creek
Lillyhill Wash
Little Chino Creek
Little Mountain Channel-Devil Creek-Western Avenue Stormdrain
Little Sand Creek
Lytle Creek and South Fork Lytle Creek
Middle Fork Lytle Creek
Mojave River (At Barstow)
Mojave River (At Hesperia and Apple Valley)
Mojave River (Below Victorville)
Mojave River (Upper Narrows)
Mulberry Channel
Needles Flood Channel
North Barstow Creek
North Fork Lytle Creek
Old Deer Creek
Ontario Motor Speedway Drain
Pinyon Creek
Quail Wash
Rathbun Creek
Reche Canyon
Road Runner Wash
San Antonio Drain
San Timoteo Creek
San Timoteo Wash A
San Timoteo Wash B
Sand Creek
Santa Ana River
SBCFCD Channel A
Soapmine Creek
Southwest Barstow Channel A
The Zanja
Tributary to East Barstow Channel
Twentynine Palms Channel
Twin Creek Channel (formerly Lower Warm Creek)
Warm Creek
Wash A at Needles
Wash B at Needles
Washes B, C, and D at Barstow
Waterman Canyon
West Barstow Channel
Wildwood Channel
Wilson Creek
Yermo Flood Channel
Yucaipa Creek
Yucca Creek (At Joshua Tree)
Yucca Creek (At Yucca Valley)

Approximate analyses were used to study those areas having low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon, by FEMA and the incorporated communities.

Three flooding sources, Knickerbocker Creek, Mulberry Channel, and North Barstow Creek, were studied in detail, but no profiles or tabular data are provided. These streams were analyzed using detailed hydrologic and hydraulic analyses, but the results obtained indicated that the 1-percent annual chance (100-year) floodplain was less than 200 feet in width. Therefore, no further analyses were done to these streams. East Twin Creek and the upper San Antonio Channel were not studied in detail, since both have been fully improved with a capacity greater than the 1-percent annual chance flood.

All or portions of the flooding sources listed in Table 4, "Flooding Sources Studied by Approximate Methods," were studied by approximate methods.

TABLE 4 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS

Acorn Canyon Creek	Fortynine Palms Channel
Alto Loma Basins Overflow	Fox Wash
Apple Valley Dry Lake	Gateway Wash
Argus Channel	Goats Wash
Baldwin Lake	Grass Valley Creek
Bear Creek	Grass Valley Lake
Big Bear Lake	Green Valley Creek
Big Morongo Creek	Green Valley Lake
Borosolvay Wash	Half-Way Wash
Burnt Mountain Creek	Holiday Wash
Buzzard Wash	Horsethief Canyon Creek
Cable Creek	Hospital Canyon
Cajon Wash	Joshua Tree Creek
Cemetery Creek	Lake Arrowhead
City Creek	Lake Baldwin
Covington Wash	Lake Gregory
Coyote Wash	Leming Wash
Cucamonga Creek	Lemon Lilly Creek
Cypress Channel	Lenwood Channel
Daley Channel Overflow	Leopard Spring Creek
Day Creek	Little Bear Creek
Dean Wash	Little Chino Creek
Deer Creek	Little Morongo Creek
Del Rosa Channel	Little Sand Creek Channel
Demens Channel	Lodge Creek
Desert Knolls Wash	Long Canyon
Devil and Cable Canyon Channel	Lower Cucamonga Creek
Division Creek	Lower Mill Creek
East Burnt Mountain Creek	Lytle Creek Wash
East Fork Little Morongo Creek	Metcalf Creek
East Twin Creek	

TABLE 4 - FLOODING SOURCES STUDIED BY APPROXIMATE METHODS (cont.)

Mill Creek	Silver Lake
Mill Creek (at Big Bear Lake)	Silverwood Lake
Miller Creek	Slide Creek
Mojave River	Smith Canyon Creek
Mountain Home Creek	Smoke Tree Wash
North Barstow Tributary	Snow Creek
Oak Glen Creek	Soapmine Creek
Oasis Creek	Soda Lake
Oro Grande Creek	South Fork Lytle Creek
Palo Verde Wash	Storey Wash
Pinto Cove Wash	Swarthout Creek
Pinyon Creek	Sycamore Creek
Plunge Creek	The Zanja
Prado Lane Creek	Twins Lake
Quail Wash	Unnamed Creek Tributary to Twentynine Palms Channel
Rathbone Creek	Unnamed Washes Tributary to the Mojave River
Red Ant Creek	Van Dusen Creek
Roadrunner Wash	Water Canyon Tributary
Rockcrusher Channel	West Burnt Mountain Creek
San Antonio Creek	West Cucamonga Creek
San Timoteo Wash	West Fork Mojave River
Santa Ana River	Wildwood Channel
Saw Mill Creek	Wilson Creek
Seeley Creek	Yermo Flood Channel
Seeley East Creek	Yucca Creek
Seeley East Creek Tributary	
Sheep Creek	

Several streams originally studied by detailed methods were changed to approximate status in locations where it was impossible to determine base flood elevations (BFEs) within the accuracy limits established for detailed studies due to physical conditions. These locations generally involved high-velocity flow in unstable channels where bank erosion and debris deposition are the major factors influencing the depth and limits of floodflows. Flood boundaries determined in this manner are generally more reliable than those required for studies done by approximate methods. Other areas studied by approximate methods were chosen because no development was expected through 1980 in these areas.

2.2 Community Description

San Bernardino County is located in the southeastern portion of California. With an area of more than 20,000 square miles, it is the largest county in the United States and covers more territory than the states of Massachusetts, New Jersey, Delaware, and Rhode Island combined. The first development in San Bernardino County occurred from 1810 to 1820 when Franciscan missionaries from the San Gabriel Mission established a branch mission and mission ranchos in the San

Bernardino Valley, named after San Bernardino de Sienna. California became a Mexican territory in 1822, and by 1834 missionary influence in the San Bernardino Valley had ended. Ownership of the vast mission holdings passed to privately-owned ranchos. The ranchos in this area flourished during the 1830s and 1840s. In 1848, California became part of the United States and two years later was admitted as a state to the Union. Mormon colonists from Utah purchased Rancho San Bernardino in 1851 and began the settlement that is now the City of San Bernardino. In 1857, the first orange groves were planted and agriculture thrived in the area during the balance of the century. In the 1870s and 1880s railroads were built connecting the San Bernardino Valley with the rest of the county, hastening settlement of the area.

The population of San Bernardino County in 1975 was 693,400, according to a 1975 special census (U.S. Department of Commerce, 1975). Of this total, 547,600, or 79 percent, lived in the San Bernardino Valley and 400,800, or 58 percent, lived in the 14 incorporated cities in the county. San Bernardino is the largest city in the county and the county seat. According to the U.S. Bureau of the Census, the 2010 population of San Bernardino County was 2,035,210.

More than 90 percent of San Bernardino County is desert that contains low mountains, valleys, and dry lake beds. The remainder of the area consists of the San Bernardino Mountains and the San Bernardino Valley in the southwest corner of the county. Elevations in the county vary from 11,500 feet National Geodetic Vertical Datum of 1929 (NGVD) on San Gorgonio Peak in the San Bernardino Mountains to sea level at the southern end of Death Valley. The elevation of the San Bernardino Valley is approximately 1,000 NGVD.

Climatic conditions in the county vary substantially with the topography and region. In general, the climate of the San Bernardino Valley is similar to coastal southern California, except that it is warmer in summer and is not as foggy. This area is well suited for growing citrus and other semitropical fruits. The monthly average of daily extreme temperatures ranges from 37 degrees Fahrenheit (°F) minimum to 67°F maximum in January, and from 57°F to 96°F in July. Temperatures at residential and resort elevations in the San Bernardino Mountains are from 15°F to 20°F warmer than in the valley. The annual rainfall, most of which falls in the summer months, averages 16 inches in the valley area and from 20 to 30 inches in the mountains. The average annual rainfall in the desert area ranges from 2 to 5 inches.

Much of the development in San Bernardino County up until World War II was to serve the agricultural industry in the San Bernardino Valley. Following World War II, all of southern California, including the San Bernardino area, experienced a major influx of people, resulting in a tremendous increase in the rate of urban development. Most of the development in the mountain and desert areas has also occurred since World War II.

A major part of the development in the county has occurred along the valleys of the larger streams that provide a source of water. The result was that much of the development occurred within the floodplains of these streams.

The City of San Bernardino lies on an alluvial cone at the base of the San Bernardino Mountains in the southwestern corner of San Bernardino County in southern California. It is located 59 miles east of Los Angeles, 110 miles northeast of San Diego, and 469 miles southeast of the San Francisco Bay. The city encompasses an area of approximately 35 square miles and has a population of 209,924 (2010 census). Steady commercial and residential development is characteristic of the region.

The City of San Bernardino is drained by numerous streams and storm drains. The streams originate in the San Bernardino Mountains and flow through the city before joining the Santa Ana River on the southern edge of the city. The Santa Ana River flows westward through the city, eventually reaching the Pacific Ocean approximately 50 miles to the southwest.

The City of Adelanto, incorporated in 1970, is located on U.S. Highway 395 in the California High Desert in southwestern San Bernardino County. The city is situated 35 miles north of the City of San Bernardino via Interstate 15. The city encompasses approximately 50 square miles. The longest north-south boundary is 10.5 miles and the widest east-west boundary is 8.0 miles. The city is adjoined on the eastern boundary by George Air Force Base, and on the southern boundary by the City of Victorville.

The general pattern of drainage flow is from south to north through the City of Adelanto, draining the sloping alluvial plain that stretches northward from the Baldy Mesa near the summit of Cajon Pass to the corporate limits. The highest elevation within the corporate limits is 3,250 feet at the southwestern corner and the lowest elevation is 2,675 feet at the Fremont wash in the northeastern portion of the city.

The City of Barstow, which was incorporated in 1947, is located in the northwestern part of San Bernardino County, approximately 72 miles north of the City of San Bernardino, 134 miles northeast of Los Angeles, and 152 miles southwest of Las Vegas. Barstow is also the western point of origin of Interstate Highway 40 (previously U.S. Route 66), which traverses through Albuquerque and Oklahoma City to points east. It is situated in the middle of the Mojave Desert with the Calico Mountains lying to the north and the Ord Mountains to the south.

The Mojave River traverses easterly through the City of Barstow draining eventually into Soda and Silver Lakes near Baker. The only geographical constraint affecting the corporate limits of the city is the Mojave River, which serves to define the northern limit. The unincorporated area of Lenwood is adjacent to the City of Barstow on the west. The city encompasses approximately 23 square miles in area.

Due to the general pattern of drainage flow from initial accumulation in the hills to the south, northerly and northeasterly through the City of Barstow to the Mojave River, the nature of the sloping plain upon which the City of Barstow is situated and the lack of definition of flow paths thereon, several areas within the city are subject to shallow flooding. Sources that have historically generated sheet flooding are West Barstow Channel, Southwest Barstow Channel A, and Kitchen Wash. Shallow flooding caused by these sources has resulted in flooding of homes and roadway crossings, and attendant deposition of mud and debris at those locations. In addition to those sources mentioned above, these include the residential areas at the west end of East Barstow Channel, and the sloping alluvial plain in the southeast corner of the city.

The City of Big Bear Lake was incorporated in November 1980. It is located 30 miles northeast of the City of San Bernardino and occupies 6.95 square miles.

The City of Big Bear Lake occupies the west end of the south shore of Big Bear Lake, which has a surface area of 4.7 square miles. The watershed is a mountainous area with steep upper slopes leading into a mildly sloping valley. The area south of Goldmine Road is primarily natural forest and some areas cleared of timber. The vegetation consists of pine trees, brush, and grass. Residential construction is found in the lower reaches of Sand and Bow Canyons. The watershed's middle and lower portions are highly developed. Vegetation in the undeveloped residential areas is primarily forest with grass cover; undeveloped commercial areas are primarily grass with some forested locations. The area north of State Route 18, where Rathbun Creek enters Big Bear Lake, is an alluvial floodplain.

The City of Colton is situated on a gently sloping alluvial plain formed by discharges from Cajon Wash and Lytle Creek Channel. Colton is situated at the confluence of these tributaries with the Santa Ana River. The slope of the plain averages 2 percent through the major developed portion of the city.

2.3 Principal Flood Problems

Most of the major floods in San Bernardino County have occurred as a result of general winter storms. However, serious flooding has resulted from summer thunderstorms, particularly in the desert areas.

Large floods have occurred in San Bernardino County in 1862, 1867, 1884, 1891, 1910, 1916, 1926, 1927, 1931, 1937, 1938, 1961, 1966, and 1969. Historical information indicates that the flood of 1862 was probably the largest, although very little data are available on peak discharges. For most streams in the county, the 1969 flood is the largest flood of record, with an estimated frequency ranging from 50 to 120 years, depending on the location in the county.

The most injurious floods in terms of loss of life and financial loss were those of 1938 and 1969, due to extensive development within the floodplains of the larger rivers and streams. Damages in 1938 exceeded $12,000,000 and several lives were lost. During the floods of January and February 1969, in which 13 people died, financial losses surpassed $55,000,000.

The majority of the development in San Bernardino County is located in the San Bernardino Valley in the southwest corner of the county. This valley drains the south facing slopes of the San Bernardino Mountains, which rise abruptly from the valley floor. The topography of the valley floor depicts a number of coalescing alluvial fans extending from the canyon mouth, which becomes a fairly uniform plain several miles from the toe of the mountain slope. Most rainfall occurs as a result of general storms occurring between December and March. The vegetative cover on the mountain slopes to an elevation of about 5,000 feet NGVD consists primarily of brush that burns off periodically. Rainfall quantities increase with elevation; annual rainfall at the higher elevations is more than twice the annual amount falling on the valley floor. These factors combine to produce conditions whereby rainfall during major storms concentrates in stream channels and runs off very quickly, resulting in high peak flows with very high velocities.

These floodflows transport enormous quantities of debris from the mountain watershed, particularly during years when all or part of the watershed has been denuded of vegetation by fire. The debris-laden flows at high velocities pose unusual flood hazards, along all streams in the San Bernardino Valley that have not been fully improved as stable flood channels with adequate provision to negate the effects of erosion and deposition.

High velocities in the channel and the floodplain can cause extreme erosion in some areas. When velocities diminish as slopes flatten at obstructions, and as flood flows recede, debris and sediment transported from the mountains and eroded from channel banks and the floodplain upstream are deposited in the channel and on the floodplain. Another characteristic of major flood flows is lateral displacement of the streambed, which usually occurs when a local obstruction in the streambed, such as a bridge or culvert, causes debris to drop out with subsequent blocking of the channel. Floodflows will then be diverted onto the floodplain. These flows often tend to concentrate and cut various new channels, leaving parts of the old channel to be filled with debris. As much as 25 feet of sediment were deposited during the 1969 floods, with 1 to 6 feet of sediment deposition occurring in many areas. These erosion-deposition patterns can be more damaging than the flood waters themselves.

The San Bernardino Mountain resort and residential areas located in the canyons experience major problems of high velocity flood flows in the steep channels, which results in the occurrence of extreme amounts of erosion and deposition. The communities near the crest of the mountains are affected by flooding from smaller streams, due mainly to development in the floodplain and, in some instances, encroachment into the channel. Mudslides and mudflows present special flood problems in the Wrightwood area. During the 1969 floods, channels were blocked with mud, causing extensive overflow into adjacent areas.

The principal flood problem in the desert area is sheet flow flooding. Many areas had flooding up to 2 feet in depth during the 1969 floods in which homes, streets, and utilities were damaged. Some of the streams causing sheet flow flooding are Cucamonga Channel, Wildwood Channel, Twentynine Palms Channel, and Sand Creek.

Flood problems in the City of San Bernardino are limited primarily to street flooding and ponding as a result of storm drain inadequacies in developed areas. Flooding along Lytle Creek Wash and the Santa Ana River is minimized by flood control channelization and levees. Some flooding occurs as streams leave the foothill canyons and flow at shallow depths on the alluvial fan above developed areas.

The City of Adelanto is located in the Mojave Desert area of southern California and is situated on a gently sloping alluvial plain that has an average gradient of approximately 1 percent from south to north. The drainage area tributary to the city encompasses approximately 75 square miles, with initial accumulation in the Baldy Mesa area and on the slopes of the foothills of the San Bernardino Mountains, located 15 to 20 miles to the south.

Flood flows reaching the City of Adelanto are augmented by additional discharge generated on the plain itself. Due to the uniformity of slope and the level cross section of this planar formation, flood flows proceed as sheet flow down to and through the city. Due to the lack of incisement of flow paths, the resultant lack of concentration of flows, and the generally indeterminate nature of sheet flooding, most of Adelanto is subject to a potential hazard from flooding of less than 1 foot in depth.

This potential problem was demonstrated in the September 1976 storm when uncontrolled sheetflow caused damage to properties in the City of Adelanto. Several houses located in the flowline of East Adelanto Channel had water running through them.

The City of Barstow is situated on alluvial deposits dissected by numerous small intermittent streams. The primary hydrologic feature within the study area is the Mojave River, which originates in the San Bernardino Mountains. In general, the Mojave River flows in a northeasterly direction, discharging into Soda Lake. The flow of the Mojave River is seasonal though it carries discharges from Lake Arrowhead, Silverwood Lake, and Mojave Forks Reservoir.

The Mojave River is typical of major southern California drainage courses. It has a large drainage area (1,290 square miles at the City of Barstow) and has the potential of carrying large discharges as a result of major storms, yet is a dry sand wash most of the time. This condition makes it a particularly dangerous flooding source. The hazard was demonstrated in 1969 when the residential area along Crooks Avenue was flooded by the Mojave River.

The Mojave River crosses the broad alluvial surface of the Mojave River Basin and is the main source of recharge to the aquifers underlying the basin. The sandy channel of the river is highly permeable over much of its length, and large quantities of water are lost from the channel bed. For example, from 1931 to 1972, only 28 percent of the flow that entered the channel at the Forks reached the City of Barstow.

It should be noted that the natural stream flow of the Mojave River has been modified by the construction of two dams above the study reach. In 1971, the USACE completed the construction of the Forks Dam, a flood control structure located below the confluence of Deep Creek and the west fork of the Mojave River, where the river emerges from the San Bernardino Mountains. The outlet structure consists of a tunnel at about channel level. The tunnel has a maximum capacity of approximately 25,000 cubic feet per second (cfs) at the maximum reservoir capacity of 300,000 acre feet.

The drainage system of the area consists of small intermittent streams draining the hills located to the north and south of the city and emptying into the Mojave River. Water reaching the Mojave River is carried eastward out of the city limits. The highest elevation within the corporate limits is 2,720 feet, located near Barstow College. The lowest point of the city is 2,069 feet in the flowline of the Mojave River to the northeast. Elevations for most of the developed area of the city range from 2,100 to 2,400 feet.

The upper reaches of the stream channels are situated in the floor of steep canyons. An alluvial fan located at the mouth of the canyon consists of rock, gravel, and sediment transported by stream action. The alluvial fans are gently sloping, extending from the canyon mouth to the valley floor.

The other type of flooding found in the City of Barstow is that generated by channels draining various portions of the city. When the capacities of these channels are exceeded, the resulting overflow is in the form of sheet flooding.

Sheet flow flooding has occurred along the Lenwood Creek because of the contribution of numerous small streams within the study reach. No historical records of major floods causing substantial damage have been documented. Except for development within the city limits, there is very little development within the watershed of the study area. The minor tributary streams have been diverted with levees into the main watercourse.

Most recently, on July 18, 1984, a thunderstorm which lasted about two hours with rainfall intensity of 1.8 inches per hour in the area of the City of Big Bear Lake resulted in property damage and loss of life. The storm produced approximately a 0.2-percent annual chance (500-year) flood event. A major problem was the large amount of mud and debris from the loose alluvial soil carried by the flood.

The San Timoteo Wash encounters several undersized bridges and limited channel capacity along its 6-mile reach. This causes overland sheet flows from east to west along Redlands Boulevard. The San Timoteo Wash flows through the Interstate 15 underpass, over several railroad tracks and finally flows south to Cooley Ranch. San Timoteo Wash causes sheet flooding in the Cooley Ranch area.

Reche Canyon Channel drains 11 square miles of the Badlands and poses a serious problem to the City of Colton. The existing channel does not adequately contain the flow of a major flood, and most of the canyon floor is subject to flooding during a 1-percent annual chance event. At the canyon mouth there is alluvial fan flooding which is affected by the inadequate culvert at Barton Road and the design of the Barton Road and Reche Canyon Road intersection. The upstream conditions which push most of the flow into Reche Canyon Road just above the mouth of the canyon also contribute to this flooding.

The principal flood problems in the City of Fontana area usually occur around Banana Avenue and Foothill Boulevard along the San Sevaine Channel. Debris carried down the San Sevaine Channel blocks the culverts at Foothill Boulevard, forces water over the street, and floods dwellings along Banana Avenue. During the flood of 1978, residents of these dwellings incurred property damage in excess of $100,000.

Flooding has also occurred along the San Sevaine Channel at Baseline and Marlay Avenues because of insufficient culvert capacity. The majority of this overflow drains into open area and causes little damage except to the road crossings or the channel itself. Most of the major floods in the City of Hesperia have occurred as a result of summer thunderstorms, which are common in this desert area.

Most of the major floods in the City of Highland have occurred as a result of winter storms. However, serious flooding has resulted from summer thunderstorms, particularly in the desert areas.

The majority of the development in the City of Highland is located in the San Bernardino Valley in the southwestern corner of the county. This valley drains the south facing slopes of the San Bernardino Mountains, which rise abruptly from the valley floor. The topography of the valley floor depicts a number of coalescing alluvial fans extending from the canyon mouth, which become a fairly uniform plain several miles from the toe of the mountain slope. Most rainfall occurs as the result of general storms occurring between December and March. The vegetative cover on the mountain slopes to an elevation of approximately 5,000 feet consists primarily of brush that burns off periodically. Rainfall quantities increase with elevation; annual rainfall at the higher elevations is more than twice the annual amount falling on the valley floor. These factors combine to produce conditions whereby rainfall during major storms concentrates in stream channels and runs off very quickly, resulting in high peak flows with very high velocities.

The major watercourse affecting the City of Loma Linda is San Timoteo Creek. The flood of March 2, 1938, was very intense, with heavy runoff from the San Bernardino and San Gabriel Mountains. The damage was minimal in the San Timoteo area compared to other areas in San Bernardino County. The U.S. Army Corps of Engineers (referred to as the USACE during this time period) estimated flood damages to be approximately $225,000, most of which was related to damage to roads and railroads.

Although flooding was moderate on September 24, 1976, and January 16, 1978, damage to San Timoteo Creek was extensive. Flooding in the small foothills in the northern part of the city is generally minor and, under more severe conditions, consists largely of shallow street flooding.

The City of Needles is bounded on the northeast by the Colorado River. Historically, this has been the major flooding source in the Mojave Valley. This valley is of alluvial origin, and prior to the construction of levees for channelization, the river twisted and meandered through the area. Sharp bends with caving banks interspersed with broad shallow reaches, and a general pattern of aggradation were characteristics of the area. Prior to the construction of Hoover Dam, major snowmelt floods caused damage to the lower Colorado River basin each spring. Peak flood flows of 300,000 cfs and 220,000 cfs occurred in 1884 and 1921, respectively (U.S. Department of the Interior, 1969). These flows are far in excess of the present computed 0.2-percent annual chance frequency flood.

The general aggradation of the valley caused a threat of flooding to the City of Needles until completion of a dredged channel with the stabilized banks in 1951. Current flooding potential due to the Colorado River is limited to backwater inundation resulting from openings in the levee, designed to allow entrance of tributary flows and due to one point near Park Drive in the southeastern portion of the City of Needles, where the levee has insufficient height to contain the flood.

Due to the normally arid nature of the area, flooding sources other than the Colorado River itself are dry except during and shortly after a storm. When a major storm does move into the area, water collects rapidly as surface runoff and reaches the main channels in a short period of time. Consequently, resultant floodflows are of the flash type, having sharp peaks and short durations. Flooding problems other than those generated by the Colorado River are due to the potential of overtopping of the Needles Flood Channel in the central part of the city, and extensive potential for damage from uncontrolled sheet flooding in the northwestern portion of the city.

Some flooding problems have occurred along the Needles Flood Channel in recent years. In July 1974, Basin No. 2 overflowed as a result of thunderstorm activity. During tropical storm Kathleen of September 1976 (a more recent flood), these basins again filled rapidly and threatened another overflow, with the water surface in Basin No. 2 rising to within 1 foot of the spillway crest. Additionally, the drains had been left partially open, causing nuisance flows to course through the city downstream from the basin.

An example of the sheet flooding potential in the northwestern portion of the City of Needles occurred in 1976, when a 300-foot wide overflow of Road Runner Wash at River Road undermined 4 feet of the roadway in the area and severed a gas line. This flooding is typical of alluvial fan sheet flooding with unpredictable, highly braided flow paths and depths of flow ranging from 1 to 3 feet. The Atchison, Topeka & Santa Fe Railway, Interstate 40, and several series of dikes serve to collect these flows as they travel down the sloping alluvial plain in the northwestern portion of the city and direct them through the culverts and bridges, downstream to the Colorado River. Hazards immediately downstream of these culverts and bridges are greater than further upstream due to the collection and concentration of flows.

The location of the City of Ontario, the existence of several major watercourses that traverse the city, the general topography, and the lack of upstream control contribute to the major flood problems of this community. The principal flood problems result from flows of Cucamonga Creek and its tributaries, which originate in the mountains to the north of the city. As these flows exit the canyons at the foot of the San Gabriel Mountains, they flow across the sloping alluvial plain upon which the City of Ontario is situated. If not contained, these flows result in extensive high-velocity sheet flooding throughout the city.

Little streamflow occurs, except during and immediately after precipitation, because climatic and drainage area characteristics are not conducive to appreciable continuous runoff. During large storms, streamflow increases rapidly in response to effective precipitation. Large floods transport generous amounts of debris and travel at high velocities.

There is very limited historical information regarding the occurrence and magnitude of floods prior to 1884. Large floods were recorded in Cucamonga Creek and its tributaries in 1889, 1916, 1927, 1954, 1966, and 1969. The estimated peak discharge for the flood of 1969 was 14,100 cfs.

Three types of flooding conditions exist in the City of Ontario. These are flooding in defined channels, ponding, and sheet flooding. Flooding in defined channels is confined to segments of improved channels, where the flows have been concentrated, and adequate flood-control structures have been constructed. Flooding from ponding is created by manmade obstructions to flow, mainly east-west interstate highway construction and east-west railroad berms. This situation occurs at both the Southern Pacific and Union Pacific Railroads along San Antonio Drain, and at the Southern Pacific Railroad mainline for Ontario Motor Speedway Drain, Day Creek, and East Etiwanda Creek. Ponding also occurs behind Interstate 10 at the Ontario Motor Speedway Drain crossing. Depth in these ponding areas would reach a maximum of 3 feet for the 1-percent annual chance storm. Sheet flow flooding occurs through the most developed areas of the city. It occurs when capacities of existing channels throughout the city are exceeded, or when the upstream conditions are such that major portions of the peak flows leave the low-flow drainage patterns and flow overland in undefined flow paths at significant depths and high velocities. Sheet flow flooding is the major source of damage during floods of record.

Most of the major floods in the City of Rancho Cucamonga have occurred as a result of general winter storms. However, serious flooding has resulted from summer thunderstorms.

Overflows from The Zanja constitute the principal source of flooding in the City of Redlands. Flooding from The Zanja has resulted in the past from either debris obstruction in the channel or stream discharges that have exceeded channel or culvert capacity.

In addition, Morey Wash, another flooding source, drains an area of approximately 4 square miles, located predominantly in the southern part of the City of Redlands. Above Brookside Avenue, the flow paths are generally not well defined and tend to follow the street pattern. A well-entrenched channel between Tennessee Street and Brookside Avenue will contain the 1-percent annual chance flood. Flows will leave the channel at Tennessee Street due to a decrease in channel capacity downstream and the limited capacity of the bridge at that location. A significant reduction in channel capacity below Nevada Street, due primarily to a decrease in channel slope, will result in substantial overland flow in that area.

Floods inundate portions of the City of Redlands almost every year. Records show that 23 medium-to-large floods have occurred since construction of Mission Zanja in 1819. Most recently, floods have occurred in January and February 1969, in September 1976, and in 1978. On September 24, 1976, an intense local thunderstorm dropped 3.5 inches of rain in a 20- to 30-minute period. This heavy rain produced an extremely high rate of runoff that quickly exceeded the capacity of local drainage systems. Major overflows occurred on the eastern edge of the downtown business district, flooding the area and depositing mud up to 3 feet deep. Damages to houses, businesses, roads, and flood-control facilities reached $2 million (USACE, February 1984).

Flood flows in San Timoteo Creek within the corporate limits of the City of Redlands are contained in the channel. However, the channel banks are easily eroded by the creek, and the channel can shift position several hundred feet during floodflows.

Flooding from small foothill streams in the southern part of the city is generally minor, and, under more severe conditions, consists largely of shallow Street flooding. This flooding has not been studied because the flood hazard is considered to be minimal. The area in the vicinity of the City of Twentynine Palms receives 4 to 5 inches of rain annually, primarily from late summer thunderstorms. Precipitation in this area is usually the result of intense but short thunderstorms. Runoff is also intense, of short duration, and heavily laden with sediment. Flooding problems in the City of Twentynine Palms have occurred as a result of summer thunderstorms.

Historical recorded peak flows for selected flooding sources are shown in Table 5, “Historical Recorded Peak Flows.”

TABLE 5 – HISTORICAL RECORDED PEAK FLOWS

Stream	Water Year	Peak Discharge (cfs)
San Timoteo Creek[1]	1927	3,000
	1935	4,700
	1937	3,600
	1938	7,460
	1943	6,480
	1969	15,000
Wilson Creek[2]	1946	558
	1969	865
Carbon Canyon Creek[3]	1952	660
	1958	600
	1969	434
East Etiwanda Creek[4]	1970	1,785

[1]Near the City of Redlands, California, USGS Stream Gage No. 11057000, drainage area equals 118 square miles
[2]At Jefferson Street near the City of Yucaipa, California, SBCFCD Stream Gage No. 3601A2, drainage area equals 3.5 square miles
[3]At Ramona Avenue near the City of Chino, California, SBCFCD Stream Gage No. S-114A, drainage area equals 6.1 square miles
[4]At Pacific Electric Railroad near Etiwanda, California, SBCFCD Stream Gage No. 5-1710D, drainage area equals 8.5 square miles

2.4 Flood Protection Measures

The majority of the larger watercourses traversing developed areas in San Bernardino County have been improved to control flooding. Two major flood control dams, San Antonio Dam and the Mojave River Dam, are earthfill dams designed to control floods of greater magnitude than the 1-percent annual chance flood. A number of debris basins, retarding basins, and water-spreading basins provide a significant flood-control function. The following are lined channels with capacity equal to or greater than the 1-percent annual chance flood:

Devil Creek Diversion Channel
Cypress Drain
East Twin Creek
San Antonio Channel
San Antonio-Chino Creek Channel
Warm Creek

The following are channels with revetted levees designed to contain 1-percent annual chance or greater flood:

Cajon Creek
City Creek
Mill Creek
Lytle Creek
Quail Wash
Santa Ana River
Upper East Twin Creek

The following are graded trapezoidal channels with rail and wire revetments:

Carbon Creek
City Creek
Day Creek
Deer Creek
Hospital Channel
Knickerbocker Creek
Mulberry Channel
Pinyon Creek
Reche Canyon
Sand Creek
San Sevaine Channel
San Timoteo Creek
Twentynine Palms Channel
Wildwood Creek
Cucamonga Creek
Del Rosa Channel

The following are graded trapezoidal channels:

Arrowhead Channel
Cemetery Wash
East Etiwanda Creek
North Barstow Tributary
Plunge Creek
Soapmine Creek
Van Dusen Creek
Yermo Flood Channel

These classifications are general, because many of the channels have more than one type of improvement. Further, many streams not listed have improvements to handle low flows and minor flooding but are completely inadequate to handle the 1-percent annual chance flood. There are a number of levees, rail and wire revetments, and other bank stabilization measures along the Mojave River to protect bridges, highways, and various other amendments adjacent to the river. However, most of the length of the river has not been improved to contain the 1-percent annual chance flood.

San Bernardino County has adopted floodplain zoning for a number of streams and lakes to preclude development of flood hazard areas. The watercourses that have zoned floodplains are listed below:

Cucamonga Creek
Santa Ana River
Lytle and Cajon Creeks
Swarthout Creek
Mojave River Forks
Reservoir
Silverwood Lake
Green Valley Lake
Big Bear Lake
Baldwin Lake
Erwin Lake
Rathbone Creek
Pipes Wash
Lucerne Lake
Rabbit Lake
Mojave River
Airport Wash

Several lakes and streams that have been floodplain zoned are not included in this study, because of little existing development and no proposed development through 1980. San Bernardino County also has a subdivision ordinance that designates the County Planning Commission to review and approve or disapprove all subdivision proposals. This ordinance specifically states that areas subject to flood hazard, inundation, or erosion shall not be subdivided except under restrictions as approved by the County Planning Commission.

The USACE has constructed several projects within the City of San Bernardino, each designed to control the standard project flood (SPF). Groins and levees have been constructed along Lytle and Cajon Washes to control the location of the channel. In its lower reach, Lytle Creek is contained by an open rectangular concrete channel and an unimproved channel. The East Branch Lytle Creek Channel has been improved to a concrete-lined channel with a standard project design frequency. Devil Creek has been diverted from its natural channel into Cajon Wash. The channel of East Twin Creek, from just above 40th Street downstream to the confluence with Warm Creek, has been improved by levee and channel construction. Below the confluence with Warm Creek, this improved channel is designated as the East Twin and Warm Creek Channel. City Creek and Warm Creek have been diverted from their historic channels through the city by levees and channel improvements. The historic channels of City and Warm Creeks are now used to collect local drainage and to satisfy water rights.

The SBCFCD has constructed many channels within the city. Most of these channels are designed to carry the 1-percent annual chance flood within a channel constructed with crib-type walls of rails and steel fabric. Freeboard is provided in many areas by levees constructed of sandy, alluvial material. However, these levees cannot be counted upon to provide protection as they are generally highly erodible. These channels include Cable Creek, Devil Creek Channel, Del Rosa Channel, Little Sand Creek, Sand Creek, Warm Creek, and San Timoteo Creek. Many of these channels have debris basins where the creek leaves the foothills.

Several channels of the SBCFCD feed into underground storm drains. The Little Mountain Channel is one of these and it presents an unusual condition. The channel is designed for the 1-percent annual chance flood; however, the storm drain is capable of carrying only approximately the 10-percent annual chance (10-year) flood. Hence, extensive flooding can occur near the storm drain inlet until the waters spread into enough adjacent streets to carry the flow away.

The City of San Bernardino has constructed an extensive storm drain system designed for the 5-percent annual chance (20-year) storm using an underground and surface collection system. Since most of the city slopes away from the mountains, many of the streets are designed to carry storm waters. Hence, extensive street flooding may occur quite frequently and sand bagging is necessary to keep storm waters out of some low-lying houses.

The improvements made to the streams include a check dam at the upstream end of the improved Little Sand Creek channel, crib walls on the Sand Creek Channel from Date Street to Lynwood Drive, and construction of a percolation basin between Highland Avenue and Date Street. Concrete-lined channels have been constructed on the Del Rosa Channel and Warm Creek from Base Line Road to Ninth Street and on the Twin Creek Channel from the confluence with the Santa Ana River to the Atchison, Topeka & Santa Fe Railway.

The City of Adelanto has two ordinances delineating areas of flood hazard and regulating development on the floodplain. The emergency ordinance developed for participation of communities in the NFlP designates the City of Adelanto as a flood-hazard area and provides for the issuance of flood insurance under the Emergency Program. Additionally, the City of Adelanto has adopted an ordinance that requires protection of all new development from 1-percent annual chance frequency flooding through elevation of building pads above the expected depth of sheet flooding in the vicinity.

The only structural improvements affecting flooding in the City of Adelanto are those designed to protect George Air Force Base from local sheet flooding. A levee has been constructed above the southern boundary of the base adjacent to the City of Adelanto corporate limits and is designed to protect the runway from flooding. This levee collects and concentrates flows, directing them westerly into the City of Adelanto by way of the East Adelanto Channel, which is a natural drainage course.

The only flood protection measures that have been constructed in the City of Adelanto are elevated pads and concrete-block walls designed to protect existing buildings from shallow sheet flooding characteristic of the area. Most of the length of the Mojave River has not been improved. There are a number of levees, rail and wire revetments, and other bank stabilization measures along the Mojave River to protect bridges, highways, and various other facilities adjacent to the river. However, none of these levees can protect against the 1-percent annual chance flood.

The Armory Channel reach has been improved. The improved channel is a graded trapezoidal channel with levees along the right bank and left bank for some reaches. At local street crossings with depression, the channel section is constructed with riprap on both sides of crossings. The channel flows through a reinforced concrete box culvert and reinforced concrete pipe from Eleventh Street to Muriel Drive.

Lenwood Creek is a natural channel with little or no improvements, even though there are numerous levees constructed across the small streams that are being diverted into the Lenwood Channel. These levees are located south of Lenwood Road between Interstate 15 and Sun Valley Road.

San Bernardino County has improved some streams through construction of lined channels with revetted levees designed to contain the 1-percent annual chance or greater flood, graded trapezoidal channels with rail and wire revetments, and graded trapezoidal channels. Big Bear Lake and Rathbun Creek have floodplain zoning to restrict development of flood hazard areas.

The City of Colton has not adopted a zoning ordinance that either delineates areas of flood hazard or regulates development on floodplains, other than the emergency ordinance developed for participation in the NFIP. However, the city consults the SBCFCD on an informal basis for technical advice on subdivision development and open-space zoning.

The USACE, in cooperation with the SBCFCD, has constructed several major flood control improvements in the City of Colton within the last 35 years. These are Lytle Creek Channel, Warm Creek Channel, and the recent improvements to the Santa Ana River. All of these improvements are designed for the SPF to provide complete containment of the 1-percent annual chance flood. The State Department of Transportation completed a concrete channel improvement for Highgrove Channel in connection with the construction of the freeway along U.S. Highway 91 (Interstate 15E). The SBCFCD and the City of Colton have built some protective works and storm drain improvements for Reche Canyon Channel, Santa Ana River, and 11th Street Storm Drain.

A listing of channel improvements within the City of Colton is given below by flooding source.

<u>11th Street Storm Drain</u>

From the Southern Pacific Railroad yard to N Street, 50-foot-wide trapezoidal channel with a 10-foot-wide pilot channel with grouted riprap side slopes 3 feet deep.

<u>Highgrove Channel</u>

Riverside Freeway to La Cadena Drive, 10-foot bottom width, 25-foot top width, 5-foot-deep concrete trapezoidal channel with 1.5:1 side slopes.

<u>Santa Ana River</u>

The SBCFCD levee on the southeast side of the channel protecting the refuse disposal site. Approximately 5 feet of riprap with post and wire revetment for approximately 6,100 feet from station 293,400 to 299,500. The USACE Standard Project improved channel for approximately 5,000 feet from station 310,919 to above the confluence with East Twin Creek.

<u>Warm Creek Channel</u>

The USACE built the Warm Creek concrete channel to contain the SPF. During recent floods, severe sediment deposition has occurred in both the Santa Ana River and Warm Creek, reducing the levels of protection. Modifications to the Santa Ana River and Warm Creek are planned for construction in 1986 and will abate SPF flooding except in the areas immediately upstream of the Southern Pacific Railroad and Interstate 10 Freeway adjacent to Warm Creek. The modifications are described in the “Lytle and Warm Creeks, San Bernardino

County, California" Supplement to Design Memorandum No. 1, April 1984, USACE (USACE, April 1984).

Reche Canyon Channel

The Reche Canyon Channel flows from Barton Road to the Santa Ana River. It consists of an entrenched trapezoidal, soft-bottom channel about 85 feet wide and 11 feet deep. All of the 1-percent annual chance floodflows of Reche Canyon Channel can be conveyed in this channel with no breakouts. Reche Canyon Channel between Barton Road and the Santa Ana River has varying dimensions. From Barton Road to Cooley Road, it is about 85 feet wide by 11 feet deep; from Cooley Road to Riverside Freeway, it is about 80 feet wide by 13 feet deep; from Riverside Freeway to Mt. Vernon Avenue, it is about 80 feet wide by 15 feet deep; and from Mt. Vernon Avenue to the Santa Ana River, it is about 85 feet wide and 16 feet deep. The last reach has perched levees ranging from 4 to 8 feet high with no major side slope protection with the exception of scattered riprap on the outside curves.

Lytle Creek Channel

USACE Standard Project improved from confluence with Warm Creek Channel to the Flood Control Basin above Foothill Boulevard. The main drainage in the City of Fontana is the San Sevaine Channel. The channel enters the city at Devore Freeway, where it parallels East Etiwanda Creek. These channels are concrete lined and trapezoidal with a vertical wall down the middle to maintain separation of flow. Prior to 1990, these channels split and became separate earthen channels, downstream of Victoria Avenue, where the original alignment of San Sevaine Channel flowed easterly joining the Old San Sevaine Channel, then southerly through Fontana and San Bernardino County. Channel improvements to San Sevaine Channel, completed in 1990, included the construction of a new concrete-lined channel adjacent to Etiwanda Creek from Victoria Avenue to Foothill Boulevard. The improvements also include the construction of twin 10-foot by 8-foot underground box conduits along Baseline Avenue from the newly constructed San Sevaine Channel to Old San Sevaine Channel. Three debris basins along the channel, although outside the Fontana corporate limits, aid in protecting Fontana from flood hazards.

The first basin is north of Devore Freeway. The second, Banana Basin, is located at the southern end of Banana Avenue. The third, Hickory Basin, is in the northwestern corner of the Kaiser Steel Corporation property. Central portions of Fontana are drained by East Fontana Channel. This concrete-lined trapezoidal channel runs easterly along the Atchison, Topeka & Santa Fe Railway and empties into the Merrill and Linden Basins. It has an average depth of 5 feet and a base that varies from 6 to 12 feet wide.

Flood-control facilities outside the corporate limits that can provide flood protection to Fontana are West Fontana Channel, Mulberry Channel, and the Lytle Creek groins. West Fontana Channel is a trapezoidal earthen channel, with a base that is approximately 10 feet wide and a depth that varies from 2 to 4 feet. It runs westerly along the Atchison, Topeka & Santa Fe Railway and empties into Banana Basin. Mulberry Channel is a concrete-lined trapezoidal channel with an approximate depth of 7 feet and a base width that varies from 10 to 20 feet. The channel runs westerly along Interstate 10 until it empties into the San Sevaine Channel.

The Lytle Creek groins are composed of grouted riprap and are approximately 10 feet high on the western bank. The groins, located northeast of Fontana, were constructed by the USACE to confine floodwater.

Channel improvements completed in 1990 include a concrete-lined channel along Declez Channel from the corporate limits to Cypress Avenue.

One of the major flood control measures that controls the watercourses that pass through the City of Hesperia is the Mojave River dam, which is an earthfill dam designed to control floods of magnitude greater than a 1-percent annual chance flood. There are a number of levees, railroad wire revetments, and other bank stabilization measures along the Mojave River to protect bridges, highways, and various other improvements adjacent to the river. However, most of the length of the river has not been improved to contain the 1-percent annual chance flood.

Warm Creek is a lined channel with a capacity equal to or greater than a 1-percent annual chance flood. City Creek is a channel with revetted levees designed to contain a 1-percent annual chance or greater flood. This channel is graded trapezoidally with rail and wire revetment. Plunge Creek is a graded trapezoidal channel. These classifications are general, because many of the channels have more than one type of improvement.

San Timoteo Creek runs diagonally through the City of Loma Linda, starting in the hills southeast of the city and emptying into the Santa Aria River to the northwest. San Timoteo Creek consists of a trapezoidal earthen channel lined with wire and pipe revetments that protect the sidewalls. It has a depth of approximately 10 feet and varies in width from 50 to 80 feet. The channel under Interstate 10 has two concrete culverts, each 40 feet wide and 20 feet high. San Timoteo Creek can convey flows of 9,000 cfs, approximating a 40-year frequency flood, before overflowing its banks near Anderson Street.

To the northeast, Mission Zanja Channel diverts storm runoff northerly into the Santa Aria River. The channel is 10 feet deep and 50 feet wide and is stabilized with wire and pipe revetments; there is a 25-foot-wide culvert at Bryn Mawr Avenue. The Bryn Mawr Avenue Bridge has restricted discharge capacity of the channel to a 2-percent annual chance frequency flood.

In addition to the emergency ordinance developed for participation of the communities in the NFIP, the City of Needles has an ordinance designed to protect new development from lesser local flooding problems. It requires elevation of building pads a minimum of 1 foot above the elevation of the Street. This, however, is only sufficient to allow for localized drainage and does not represent a substantial protection against 1-percent annual chance frequency sheet flooding in floodprone areas.

The USBR and the SBCFCD have constructed a number of flood control and protective works in the vicinity of the City of Needles. The most substantial of these are the Colorado River levee system, Eagle Pass Wash, and the Needles Flood Channel. Other than these three projects, flood protection measures in the area are limited to earthen dikes designed to direct, collect, and control overland sheetflow that is generated southwest of the city and flows toward it on its path to the Colorado River.

The improvements to the Colorado River done by the USBR consist of straightening and dredging of the channel, construction of levees, and riprap bank stabilization. The design of these levees is such as to establish, for most of the segment of the Colorado River in the vicinity of Needles, a channel of approximately 1-percent annual chance capacity.

Eagle Pass Wash, or S Street Channel, through use of an earthen levee system, collects sheetflows from a number of tributaries, including Eagle Pass Wash, upstream of the Atchison, Topeka & Santa Fe Railway. From this retention basin, flows pass over a spillway from which they are conveyed downstream to the Colorado River through the developed portion of the city by way of a concrete-lined channel.

The Needles Flood Channel is a system of retention basins with connecting drop structures and channels that intercept flows from the hills to the south of the city and convey them to the east away from the developed portion of Needles. This system is essentially of 1-percent annual chance capacity with small overflows occurring at Basins 1 and 2.

A listing of channel improvements within Needles is given below by flooding sources.

Buzzard, Coyote, Fox, and Lemming Washes

Downstream from the Atchison, Topeka & Santa Fe Railway, flows are collected by a system of levees and ditches that direct them into a series of six bridges under Interstate 40.

Colorado River

Entire reach - dredged and stabilized channel with 1-percent annual chance design levee along northeast bank. N Street to Bridge Road crossing - 1-percent annual chance design levee on southwest bank.

Eagle Pass Wash

At upstream limit of detailed study near intersection of El Monte and Parkway Streets - 10-foot high earthen levee running north-south and keeping flow in main channel 300 feet upstream of Atchison, Topeka & Santa Fe Railway debris basin defined by 3,400- foot-long levee system.

Debris Basin Spillway to 497 feet downstream - transition from an 80-foot by 20-foot spillway to a 30-foot by 13-foot rectangular concrete channel. 497 feet downstream of spillway to Colorado River - 30-foot by 13-foot reinforced concrete rectangular channel.

Needles Flood Channel

Basin No. 1 - Earthfill dam with 2:1 side slope that collects flows from Wash A. 100-foot-wide concrete spillway.

Basin No. 1 to Basin No. 2 - 5-foot bottom width, 11-foot-deep trapezoidal channel with Drop Structure No. 1 - 10-foot drop, 3.5-foot weir.

Basin No. 2 - Earthfill dam with 2:1 side slope that collects flows from Lillyhill Wash. 160-foot-wide spillway.

Basin No. 2 to Basin No. 3 - 9.5-foot bottom width, 11-foot deep trapezoidal earth channel with Drop Structure No. 2 - 17-foot drop, 9-foot weir.

Basin No. 3 - Earthfill dam with 2:1 side slope and 60-foot-wide spillway.

Basin No. 3 to D Street - 11-foot bottom width, 11-foot deep trapezoidal earth channel.

D Street Crossing - 95-foot-long, 12-inch by 12-inch reinforced concrete box.

D Street to Drop Structure No. 3 - 11-foot bottom width, 11-foot-deep trapezoidal earthen channel.

Drop Structure No. 3 - 2-foot drop, 10-foot weir. Interstate 40 - 145-foot-long double 12-inch by 7-inch reinforced concrete box.

Basin No. 4 - Earthfill dam with 2:1 side slope.

Basin No. 4 to Basin No. 5 - 25-foot bottom width, 6-foot-deep trapezoidal earthen channel with Drop Structure No. 4 - 20-foot drop, 25-inch weir.

Basin No. 5 to Drop Structure No. 5 - 30-foot bottom width trapezoidal earthen channel.

Drop Structure No. 5 and U.S. Highway 95 - 12-foot drop into 124-foot-long double 150-inch corrugated metal pipe under highway.

U.S. Highway 95 to Atchison, Topeka & Santa Fe Railway Bridge - 55-foot bottom width, 5-foot-deep, rock and wire revetted rectangular channel.

Atchison, Topeka & Santa Fe Railway - 48-foot-long, four-span wooden trestle.

Road Runner Wash

The Atchison, Topeka & Santa Fe Railway is protected by a dike that directs flows through four bridges under the railroad. Downstream from the railroad to Interstate 40, a 1,800-foot-long, 100-foot-high, north-south running levee directs flows into the Interstate 40 bridge.

Downstream from the Interstate 40 bridge, an 8-foot-long, 4-foot- high, north-south running levee prevents flows from spreading to the west and directs them toward the Colorado River.

Wash B

Downstream from U.S. Highway 95, Wash B is collected by an earthen levee system directing the flow into a 50-foot bottom width, 20-foot-deep graded dirt channel.

Wash C

A north-south running levee collects runoff from Holiday Drive, and points west of Holiday Drive and south of Wash C. Other than the emergency ordinance developed for participation of communities in the NFIP, the City of Ontario has not adopted a zoning ordinance that delineates areas of flood hazard or regulates development in floodplains.

The SBCFCD, the USACE, and the City of Ontario, with the assistance of the U.S. Department of Housing and Urban Development (USHUD), have constructed a number of flood protection and control facilities in the City of Ontario. The Turner basins on Deer Creek and West Cucamonga Creek Channel below Mission Boulevard are of 1-percent annual chance design, and Cucamonga Creek is a USACE standard project design improvement.

A full listing of flood protection measures resulting from channel improvements in the City of Ontario is given below according to flooding source.

Cucamonga Creek

Downstream of the Pomona Freeway (State Highway 60), a phase of the USACE Cucamonga Creek project utilized standard project design criteria. This improvement contains both 0.2- and 1-percent annual chance floods and was considered in this report. Upstream of State Highway 60 to the Cucamonga Debris Basin north of the corporate limits, all additional phases of the USACE Cucamonga Creek Project are of 1-percent annual chance design and were completed in 1982. On West Cucamonga Creek from Fourth Street to C Street, there is a 5-foot by 20-foot green belt channel with side slopes of 4:1. From C Street to the Union Pacific Railroad, there is a 5-foot by 30-foot earthen trapezoidal channel with limited post and wire revetments. From the Union

Pacific Railroad downstream to the Ely Percolation and Retention Basins, there is an 8.5-foot by 16-foot 100-year design, reinforced, concrete-lined channel with 1.5:1 side slopes. The Ely Percolation and Retention Basins have 1-percent annual chance capacity, but are subject to erosion during a 1-percent annual chance flood. From Ely Percolation and Retention Basins to Cucamonga Creek, there is a 5-foot by 80-foot rectangular earthen channel with post and wire revetments.

Deer Creek

For its entire length, the USACE, under the Cucamonga Creek Project, constructed a new Deer Creek Channel, which is of 1-percent annual chance design.

Day Creek

From the upstream limit of study to Interstate 10, there is a 5-foot by 75-foot earthen rectangular channel with post and wire revetments. From the Southern Pacific Railroad to Wineville retention basin is a 5-foot by 75-foot earthen rectangular channel with post and wire revetments. Wineville retention and percolation basin has a 1-percent annual chance capacity. Downstream from Wineville retention basin, there is a 7-foot by 30-foot earthen trapezoidal channel with 3:1 slide slopes.

San Antonio Drain

From Sixth Street to Fifth Street, there is a 36-inch reinforced concrete pipe; from Fifth Street to E Street, a 39-inch reinforced concrete pipe; from E Street to D Street, a 39-inch corrugated metal pipe; and from D Street to Vesta Street, a 54-inch corrugated metal pipe.

Ontario Motor Speedway Drain

On Ontario Motor Speedway Drain, there is a 7-foot by 12-foot reinforced concrete box under Interstate 10. On Old Deer Creek from the northern corporate limits to the Southern Pacific Railroad, there is a 6-foot by 14-foot rectangular reinforced concrete channel. From the Southern Pacific Railroad to Joy Road, there is a 5-foot by 20-foot graded earthen trapezoidal channel with 2:1 side slopes. From Joy Road to the downstream study limit, there is a 5-foot by 3-foot graded earthen rectangular channel with post and wire revetments.

The majority of the larger watercourses traversing developed areas in San Bernardino County have been improved to control flooding. A number of debris basins, retarding basins, and water-spreading basins provide a significant flood-control function.

The USACE, Los Angeles District, has contracted a number of flood protection and control facilities in the City of Rancho Cucamonga. Cucamonga Creek, Demens Creek, Deer Creek, and Rillside Creek Channels are USACE standard project design improvements. The USACE improvements on Cucamonga Creek consisted of approximately 7.5 miles of rectangular channel from Ontario Airport north to and including a 650-acre-foot debris basin. On Demens Creek, approximately 2 miles of rectangular channel was constructed from the confluence with Cucamonga Creek to and including a 160-acre-foot debris basin. On Deer Creek, the USACE 42 constructed 8 miles of rectangular concrete channel from the confluence with Cucamonga Creek to and including a 310-acre-foot debris basin. On Hillside Creek, a mile of rectangular channel was constructed from the confluence with Deer Creek to and including a 40-acre-foot debris basin.

Other than the emergency ordinance developed for participation of communities in the NFIP, the City of Rancho Cucamonga has not adopted a zoning ordinance that delineates areas of flood hazard or regulates development in floodplains.

The Zanja is, for the most part, an excavated earthen channel. Locally, there are grade stabilizers and rock masonry, stone riprap, concrete slab, and post and wire revetments to protect the side slopes. These improvements are usually at or near bridges and provide some protection to the abutments. A 500-foot-long concrete, rectangular, underground culvert carries flows through the downtown area between Texas Street and 9th Street. The capacity of the culvert is, however, limited to flows of approximately 2,500 cfs.

Morey Wash is an entrenched, earthen channel that is overgrown with vegetation in many places. The channel is protected by rock and wire fencing in some reaches. Culverts or bridges exist for all street crossings; however, none is large enough to pass the 1-percent annual chance flood.

A flood-control levee system is located on the south bank of Mill Creek from the corporate limits, north of Baden Avenue, to the eastern corporate limits of the city. The portion of the levee system to the west of Newport Avenue was built by the USACE, and the portion to the east was built and is being maintained by the SBCFCD. This levee does not provide protection from the 1-percent annual chance storm event.

Within the City of Redlands, a bluff forms a boundary of the Santa Ana River Wash. This bluff ranges in height from 30 feet at Mountain View Avenue to 15 feet at Wabash Avenue. Major floods can be contained within the channel and low floodplain; however, the bluff is subject to erosion by the river.

The Twentynine Palms Channel and Donnell Basin (a water-spreading basin) were constructed between 1958 and 1972, to provide flood protection to the Twentynine Palms' business district. The Twentynine Palms Channel is a graded trapezoidal channel with rail and wire revetment.

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-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year 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 100-year flood (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 flooding source studied by detailed methods affecting the community.

A flood-frequency analysis was made for many of the streams in San Bernardino County, by fitting a log-Pearson Type III distribution (U.S. Water Resources Council, 1967) to the peak discharge data for the stream gaging stations in the region. Coefficients of skew were computed for all stations. The resulting skew varied widely between stations, due to their shortness of record and other factors. A value of zero was then substituted for the actual skews (USACE, 1962).

The results of this analysis provided peak discharge values at the gage sites for the 10-, 2-, 1-, and 0.2-percent annual chance recurrence intervals. Peak discharges for other points along the gaged streams were computed from those at the gage sites by use of the formula $Qs = Qg (As \div Ag)a$. Qs and Qg are flows at site and gage and As and Ag are drainage areas at site and gage. The exponent “a” was computed for streams with multiple gagings by solving the equation for “a” using the known gage values for Qs, As, Qg, and Ag. A determination of the exponent “a” for streams with single gaging stations was made by plotting peak-discharge values for gages in similar hydrologic regions against drainage area on log-log paper and determining “a” as the slope of the best fit line through the points.

Peak discharges for streams with poor or no stream gage records were determined by using discharge values of nearby gaged streams with similar hydrologic characteristics. Differences in drainage areas beyond the ungaged study stream and the nearby gaged reference stream were adjusted by use of the previously mentioned equation.

Available hydrologic studies and analyses that have been made in the study area by various agencies were reviewed. A number of these studies used methods and presented flood-frequency data that are directly applicable to the FISs. Use was made of these studies wherever possible, especially as a basis for peak discharges of many streams.

The West End Soil Conservation District provided 10-, 4-, 2-, 1-, and 0.2-percent annual chance peak discharges for Cucamonga Creek, Deer Creek, Day Creek, Etiwanda Creek, and San Sevaine Creek (West End Soil Conservation District, 1958).

A USACE report (USACE, 1972) provided 1-percent annual chance peak discharges for Wilson Creek, Oak Glen Creek, and Yucaipa Creek. The discharges for the 10-, 2-, and 0.2-percent annual chance frequencies were determined for these studies by applying ratios to the 1-percent annual chance values that were based on the frequency curves of surrounding stream gages.

Another report by the USACE (USACE, 1960) provided 10-, 2-, 1-, and 0.2-percent annual chance peak discharges for Coyote Hole Creek. For the original study for the City of San Bernardino, data from the above three sources were analyzed and compared. Using the data as a guide, discharge-frequency relationships depicting runoff per square mile were developed for use on the ungaged drainage areas and for computing flows of various frequencies at locations where complete frequency-discharge data were not available. Inconsistencies in the hydrologic data were noted in a few instances; however, these differences were generally insignificant.

Many of the creeks within San Bernardino have been gaged by the USGS at locations where they leave the foothills; the USGS provided discharge-frequency data for these creeks. Discharge-frequency data were also provided for several locations along the Santa Ana River and Lytle Creek Wash. Standard project floodflow estimates were provided by the USACE for all of its constructed projects. The SBCFCD provided 1-percent annual chance design flows for its channels at selected locations.

For the revised study, the 1-percent annual chance flood discharges were computed using the USACE HEC-1 computer program (USACE, 1987 and 1990). The point rainfall was extracted from the San Bernardino County Hydrology Manual (SBCHM) (San Bernardino County Flood Control District, 1986), and the unit hydrographs were calculated using LAPRE-1, which converts S-Graphs into unit hydrograph ordinates. The Muskingum Channel routing method was used to route the hydrographs through the various channel reaches. Stream gage information was used to determine the peak flow for the Twin Creek Channel using the frequency analysis in the Water Resources Council (WRC) Guidelines Bulletin 17B (U.S. Department of the Interior, 1982).

To define discharge-frequency data for the streams in the City of Adelanto, a regional relationship of peak discharge to drainage area was developed for the study area. All available stream gage records in the same hydrologic region as the study area were obtained. Thirteen gaged streams satisfied this requirement; however, none had more than 15 years of record, and many had years of no measurable flow. An individual analysis of each gage would have introduced large inaccuracies due to the short period of record. Therefore, a synthesis of stream gaging data was made in accordance with the methods outlined by the USACE (USACE, 1974). The synthesized gage was then analyzed by the standard log-Pearson Type III method (U.S. Department of the Interior, 1982).

The peak discharges, as determined above, were combined with peak discharges computed by the USACE (USACE, 1966) for a nearby drainage basin in order to develop a graph of peak discharge versus drainage area. Peak discharges for the streams under study were then computed from the graph by locating the peak discharge corresponding to the drainage area of the study stream. Flood discharge-frequency data were developed for the previously studied streams in the City of Barstow, using a regional relationship of peak discharges to drainage area.

Hydrologic analyses were performed for the 1-percent annual chance flood using HEC-1 (USACE, 1987 and 1990) for Lenwood and Armory Channels. The unit hydrograph calculations were performed using LAPRE-1 (USACE, 1989) as a pre-processor for the HEC-1 run, which converts the S-graph into unit hydrograph ordinates.

The point rainfall data for the 1-percent annual chance frequency were extracted from the SBCHM. The soils group classifications for the drainage area were obtained from the soil map from the Mojave River area, Soil Survey of San Bernardino County, California, issued February 1986 by NRCS. The curve numbers with the respective soil groups were selected from the SBCHM.

The hydrologic analysis for the Mojave River in the vicinity of the City of Barstow is based on the available Flood Plain Information (FPI) Report, prepared by the USACE, dated October 1968. The intermediate regional floodflow (1-percent annual chance peak flood) at old U.S. Highway 66 is 18,500 cfs for a 1,290-square-mile area. The same document indicates that the intermediate regional flood for Mojave River at Lenwood Creek is 19,500 cfs for 1,233 square miles of drainage area.

The 1-percent annual chance peak flows of the Mojave River at Barstow have been modified to include the effects of urbanization up to the present time. Hydrologic analyses were carried out to establish peak discharge- frequency relationships for Rathbun Creek. These analyses were conducted in accordance with the procedures outlined in the SBCHM, as discussed in the Master Plan of Drainage, Rathbun Creek (Boyle Engineering Corporation, 1989).

The unit hydrograph method was used in the analysis of Rathbun Creek. The flood hydrographs and peak discharges for the 1-percent annual chance flood on Rathbun Creek were computed based on a 24-hour general rainstorm. Because of the historical evidence of large quantities of suspended and bedload material, such as occurred during the July 18, 1984, flood, the 1-percent annual chance flows were bulked by 150 percent.

A regional relationship of basin characteristics to streamflow characteristics was used to define discharge-frequency data for several of the streams studied in the

City of Colton. The effects of urbanization on runoff for these same streams were accounted for by utilizing the results of a USGS study (U.S. Department of the Interior, 1970) that provided a digital simulation of the effects of urbanization on runoff in the upper Santa Ana Valley.

The Highgrove Channel contains a large ponding area caused by the embankment of La Cadena Drive. The effects of ponding on the peak discharge were accounted for by using the USACE HEC-1 Flood Hydrograph computer program (USACE, 1987 and 1990), utilizing the Modified Puls Reservoir Routing subroutine. Significant reductions in peak discharges were computed for this stream.

A hydrology report (USACE, 1975) prepared by the USACE for the Santa Ana River provided peak discharges for that watercourse. Warm Creek was improved by the USACE in 1979 to contain the SPF of 90,000 cfs. The 1-percent annual chance discharge in Warm Creek is 67,000 cfs (USACE, April 1984).

The Reche Canyon Creek discharges were computed using the gage data at Barton Road crossing. The frequency curve based on 1952-1970 data did not adequately reflect the current stream gage data; therefore, a new (1984) curve was generated using 33 years of record. The March 3-4, 1943, storm was used to compute the SPF value. The SPF runoff was computed using the synthetic unit hydrograph derived from the San Timoteo s-graph. The new frequency curve was graphically drawn using the 33 discharge-median plotting positions and the computed SPF value. The new curve predicts lower discharges on Reche Canyon than those shown in the 1980 report.

San Timoteo Wash discharge-frequency curves for San Timoteo Wash at the canyon mouth and at the Santa Ana River were developed from the stream gages on San Timoteo Wash near Redlands and San Timoteo Wash near Loma Linda. The stream flow record of the Redlands gage was extended by correlation with the Loma Linda gage operated by the USGS. The WRC Guidelines Bulletin 17B (U.S. Department of the Interior, 1982) was used to generate the discharge-frequency curve for San Timoteo Wash.

The new curve shows lower discharge values on San Timoteo Wash than the curve in the 1973 FPI Study (USACE, March 1973). The San Timoteo Wash 1-percent annual chance flows break out of the small man-made channel along its 6-mile reach.

Hydrologic analyses were determined for the portion of San Sevaine Channel between Victoria Avenue and Foothill Boulevard, based on the newly constructed San Sevaine Channel adjacent to the Etiwanda Channel. The analyses showed that the 1-percent annual chance flood discharge is contained within the channel banks of the newly constructed San Sevaine Channel and East Etiwanda Channel from Victoria Avenue to Foothill Boulevard, and within the twin 10-foot by 8-foot underground box conduits along Baseline Avenue, from the newly constructed San Sevaine Channel to Old San Sevaine Channel.

Hydrologic analyses for the San Sevaine Channel between Jurupa Avenue and Patton Road are based on the assumption of separated flows for San Sevaine Channel and East Etiwanda Channel, as determined for the original study developed for the City of Fontana.

The 10-, 2-, 1-, and 0.2-percent annual chance peak discharges for the San Sevaine Channel were computed by the West End Soil Conservation District (West End Soil Conservation District, 1958). The peak discharges for Lytle Creek were determined using USGS Water Resources Investigations 77-21 (U.S. Department of the Interior, 1977), which is a compilation of regional stream gage data. These discharges were used in the alluvial fan analysis to define the approximate limits of alluvial fan flooding. The 1-percent annual chance peak discharge along the West Fontana Channel was computed using the USACE HEC-1 Flood Hydrograph Computer Program (USACE, 1987 and 1990), and criteria based on the SBCHM (San Bernardino County Flood Control District, 1986). The peak discharges for San Timoteo Creek through the City of Loma Linda were established using data from the FIS for the City of Redlands and from a USACE hydrology review report (USACE, 1977). Peak discharges for Mission Zanja Channel were also obtained using that report. Peak discharge-frequency curves were developed using the log-Pearson Type III method (U.S. Department of the Interior, 1982).

The San Timoteo Creek discharge is reduced as storm water travels through the city as a result of overflow losses across Interstate 10 as well as flow divergence outside the corporate limits. There is also considerable storage volume just south of Interstate 10. Discharge-frequency data for streams studied through the City of Needles were developed from a regional relationship of peak discharge to drainage area for the study site.

The SBCFCD Diversion Channel at the southern edge of the city was constructed with five small flood-control dams that retain and pond the flows. The effects of ponding on the peak discharges were accounted for by using the USACE HEC-1 Flood Hydrograph computer program utilizing the Modified Puls Reservoir Routing Subroutine (USACE, 1987 and 1990). Significant reductions in peak discharges were computed for these streams.

The 1-percent annual chance peak discharge for the Colorado River was taken from a report (U.S. Department of the Interior, 1969) prepared by the USBR. Peak discharges for the 10-, 2-, and 0.2-percent annual chance recurrence intervals were taken from statistical analyses and studies previously prepared by the USBR.

Peak discharges for Cucamonga Creek, West Cucamonga Creek at the confluence with Cucamonga Creek, Deer Creek, and Old Deer Creek were obtained from studies prepared by the USACE (USACE, 1973). Peak discharges for East Etiwanda Creek were taken from a West End Soils Conservation District report (West End Soil Conservation District, 1958).

A gaging station on Day Creek, located near Etiwanda, was the principal source of data for defining discharge-frequency relationships for this stream. The gage has been operating intermittently since 1927, providing a total of 44 years of record. The gage is owned and operated by the USGS (Gage No. 11-670) and has a drainage area of 4.6 square miles. Values of the 10-, 2-, 1-, and 0.2-percent annual chance peak discharges at the gage site were obtained from a log-Pearson Type III distribution of annual peak flow data (U.S. Department of the Interior, 1982). Peak discharges for points downstream of the gage site were computed from the peak discharges at the gage site by using the results of a previous study (West End Soil Conservation District, 1958) that relates flows at gage sites to downstream flows.

To define discharge-frequency data for San Antonio Drain and Ontario Motor Speedway Drain, a regional relationship of basin characteristics to streamflow characteristics (U.S. Department of the Interior, 1970) was used. The effects of urbanization on runoff were accounted for by utilizing the results of a USGS study (U.S. Department of the Interior, 1974) that provided a digital simulation of the effects of urbanization on runoff in the upper Santa Ana Valley.

The Ontario Motor Speedway Drain, Day Creek, East Etiwanda Creek, and Magnolia Avenue Drain contain large ponding areas due to freeway and railroad embankments. The effects of ponding on the peak discharges were accounted for by using the USAGE HEC-1 Flood Hydrograph computer program (USACE, 1987 and 1990) utilizing the Modified Puls Reservoir Routing subroutine. Significant reductions in peak discharges were computed for these streams. Discharges presented were reviewed by the USAGE, the City of Ontario, the USGS, and the SBCFCD.

Flood discharges on San Timoteo Creek, Mill Creek, and the Santa Ana River through the City of Redlands were determined by fitting the log-Pearson Type III distribution (U.S. Water Resources Council, 1967) to their respective records of observed annual peaks. San Timoteo Creek has a 41-year annual peak record near Redlands. Mill Creek has a 38-year annual peak record near Yucaipa. The Santa Ana River has a 14-year annual peak record at Waterman Avenue, near the City of San Bernardino. However, the record at Waterman Avenue was extended to 54 years by correlating annual flood peaks at Waterman Avenue with flood peaks on the Santa Ana River near Menotne. For each of these streams, the site for which annual peaks were recorded is only a short distance from the respective study reach, and no adjustment of discharge was made for the intervening drainage area. A detailed description of the hydrologic analysis for The Zanja is given in Detailed Project Report, Mission Zanja Creek, San Bernardino County, California, Draft Appendix A, Hydrology (USACE, 1985). The following is a brief summary of that analysis.

A regional mean peak discharge versus drainage area was developed from stream gage data. A typical log standard deviation based on the “San Timoteo Creek near Redlands” stream gage record was used. A regional log-skew coefficient was derived by averaging the computed station log-skew coefficients from seven gages in the region with more than 25 years of record.

Frequency statistics for seven rural stream gages with greater than 25 years of record in or near the study area were used to develop a generalized log-skew coefficient. A generalized log-skew coefficient of 0.3 was determined from the weighted average (by years of record) of the computed station log-skew coefficients of the gages. This generalized log-skew coefficient was adopted to be used in developing frequency curves derived from the regional analysis.

Five stream gages within the San Timoteo and The Zanja basins were used to develop the regional mean peak discharge versus drainage area relationships. The relationship is applicable to undeveloped watersheds. Of the three stream gages within The Zanja drainage basin, only the gage at Ninth Street and The Zanja was used in the regional analysis. Only the Ninth Street gage was used because the other two are seriously affected by insufficient channel capacity and urban development.

The relationship between mean peak discharge and drainage area size was determined by fitting a curve through the plotted mean peak discharges of the five stream gages. The Ninth Street gage has a short period of record (13 years) in comparison with the other gages and the record occurred during a relatively wet period, so the mean peak discharge was taken into consideration, but was not weighted heavily. The percent impervious cover of the gaged basins used was 10 percent or less. The log standard deviation used in the regional analysis was taken from the gage with the longest and most reliable record, "San Timoteo Creek near Redlands." The adopted log-skew coefficient was 0.3. Because the regional relationships apply to undeveloped watersheds, and the subareas of The Zanja basin have various degrees of present urbanization, a discharge frequency versus percent imperviousness relationship, developed for the "Wilson Creek at Jefferson Street" gage, was applied in The Zanja basin. To develop the discharge frequency versus percent imperviousness relationship, a series of floods resulting from applying 100, 80, 60, 40, and 10 percent of the standard project rainfall (SPR) to the present condition SPF 50 unit hydrograph for the Jefferson Street watershed were computed. The exceedence frequency of the values of peak discharge for the five ratios of SPR were noted on the present condition peak discharge-frequency curve. Using increasing percentages of imperviousness and appropriate adjustments to the unit hydrograph n-value parameter, new sets of floods resulting from the same percentages of SPR were computed and plotted at the frequency noted for present conditions. The resulting family of peak discharge-frequency curves reflects the change in basin runoff due to increasing imperviousness. Peak discharge-frequency values for The Zanja were determined by routing and combining n-year subarea hydrographs above the concentration point for which information was desired. The n-year subarea hydrographs were derived by multiplying subarea SPF hydrographs by the ratio of n-year to SPF peak discharge determined from the family of peak discharge- frequency curves described above for the particular subarea imperviousness.

For flooding sources through the City of Twentynine Palms, the USACE HEC-1 computer program (USACE, 1987 and 1990) was used to compute peak discharge values at the concentration points of the 12 drainage basins for the 50-, 10-, and

1-percent annual chance recurrence interval floods. For each concentration point, the flood frequency curve was defined by fitting the computed peak discharge values and their frequency of occurrence to a log-Pearson Type III distribution by the method of least-squares. Peak discharge values for Twentynine Palms Channel were calculated based on guidelines established in a USGS publication entitled "Magnitude and Frequency of Floods in California" (U.S. Department of the Interior, 1977).

Stream gaging stations that were used in the hydrologic analyses are listed in Table 6, "Stream Gaging Stations," with their gage numbers, drainage area, and length of record. Of the gages listed, only those so noted were directly applicable to their respective streams.

Peak discharge-drainage area relationships for flooding sources studied by detailed methods are shown in Table 7, "Summary of Discharges." Analyses were carried out to establish the peak elevation-frequency relationships for each flooding source studied by detailed methods affecting the City of Ontario.

Elevations for floods of the selected recurrence intervals on a portion of Magnolia Avenue Drain are shown in Table 8.

TABLE 6 – STREAM GAGING STATIONS

Gage Number	Stream Name and Location	Drainage Area (Square Miles)	Number of Years of Record
10-2512	Spring Creek near Furnace Creek	0.21	15
10-2514	Ibex Creek near Tecopa, California	0.20	15
10-2523	China Spring Creek near Mountain Pass	0.94	15
10-2625	Mojave River (at Barstow)	1,290.00	42
10-2530	Gourd Creek near Ludlow	0.30	15
10-2560	Whitewater River at Whitewater	57.4	23
10-2580	Tahquitz Creek near Palm Springs	16.8	25
10-2581	Palm Canyon Tributary near Anza	0.5	9

TABLE 6 – STREAM GAGING STATIONS (continued)

Gage Number	Stream Name and Location	Drainage Area (Square Miles)	Number of Years of Record
10-2585	Palm Canyon near Palm Springs	93.30	38
10-2590	Andreas Creek near Palm Springs	8.60	23
10-2604	Cushenberry Creek near Lucerne Valley	6.36	12
10-2605	Deep Creek near the City of Hesperia	136.00	43
10-2610	West Fork of Mojave River near the City of Hesperia	74.70	42
10-2615	Mojave River at Lower Narrows	514.00	69
10-2618	Beacon Creek at Helendale	0.72	12
10-2626	Boon Creek near the City of Barstow	0.24	15
10-2631	Zzyzx Creek near Baker	0.23	11
10-2635	Big Rock Creek near Valyermo	22.90	50
10-2640	Little Rock Creek near Little Rock	49.00	42
10-2645.3	Pine Creek near Palmdale	1.37	15
10-2645.6	Spencer Canyon Creek near Fairmount	3.60	15
10-2646	Oak Creek near Mojave	15.80	14
10-2646.05	Joshua Creek near Mojave	3.83	15
10-2647	Pewee Creek near Bardsburg	0.14	15
10-2648.4	Sand Creek near Inyokern	1.02	15
10-2649.15	Crust Creek near Westend	0.13	15
11-515	Santa Ana River at Mentone[1]	209.00	55

[1]Gage used directly for indicated stream

TABLE 6 – STREAM GAGING STATIONS (continued)

Gage Number	Stream Name and Location	Drainage Area (Square Miles)	Number of Years of Record
11-540	Mill Creek near the City of Yucaipa[1]	38.1	50
11-555	Plunge Creek near East Highlands[1]	16.9	53
11-558	City Creek near the City of Highland[1]	18.6	53
11-570	San Timoteo Creek near the City of Redlands[1]	119.0	41
11-575	San Timoteo Creek near the City of Loma Linda	125.0	17
11-585	East Twin Creek near Arrowhead Springs[1]	8.8	53
11-586	Waterman Canyon Creek near Arrowhead Springs[1]	4.7	49
11-620	Lytle Creek near the City of Fontana[1]	46.3	39
11-630	Cajon Creek near Keen Brook[1]	40.6	52
11-635	Lone Pine Creek near Keen Brook	15.1	42
11-636.8	Devil Canyon Creek near the City of San Bernardino	5.6	50
11-665	Santa Ana River at Riverside Narrows	850.0	45
11-670	Day Creek at Etiwanda	4.6	45
11-693	South Fork San Jacinto Tributary near Valle Vista	2.2	9
11-695	San Jacinto River near San Jacinto	141.0	44
11-700	Bautista Creek near Hemet	39.4	22
11-730	San Antonio Creek near Claremont	16.5	55

[1]Gage used directly for indicated stream

TABLE 6 – STREAM GAGING STATIONS (continued)

Gage Number	Stream Name and Location	Drainage Area (Square Miles)	Number of Years of Record
11-734.7	Cucamonga Creek at the City of Upland	10.1	43
S-1114A[2]	Carbon Creek at Ramona[1]	6.1	27
S-2702A[2]	Reche Canyon at Barton Road[1]	11.2	15
V-9-2250[3]	East Fork of West Fork of Mojave River above Cedar Springs	11.2	11
3501B	Mission Zanja Channel at Tippecanoe Avenue near the City of Loma Linda	25.3	33

[1]Gage used directly for indicated stream
[2]Conservation District
[3]Operated by the California Department of Water Resources

TABLE 7 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
11TH STREET STORM DRAIN					
At Santa Ana River	1.0	330	520	660	1,400
At Valley Boulevard	0.7	250	400	490	1,000
ANTELOPE VALLEY WASH					
At Mojave River Avenue	16.5	N/A	N/A	6,400	N/A
At Peach Avenue	15.8	N/A	N/A	6,380	N/A
At Pico Avenue	14.4	N/A	N/A	6,200	N/A
ARMORY CHANNEL					
At Muriel Drive	1.33	*	*	353	*
ARROWHEAD CHANNEL					
--[1]	5.2	500	1,250	2,400	8,600
--[1]	4.5	500	1,200	2,300	8,200

*Data not available
[1]Because values were taken from frequency/discharge curves, no specific location information has been determined

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
BASIN APEX					
At apex	8.4	1,409	3,029	3,518	4,210
BASIN 2					
At apex	1.1	295	664	768	904
BASIN 3					
At apex	0.7	242	544	622	714
BASIN 4					
At apex	0.3	104	237	271	312
BASIN 5					
At apex	0.3	111	256	298	353
BASIN 6					
At apex	0.9	336	753	861	987
BASIN 7					
At apex	1.8	494	1,096	1,265	1,485
BASIN 8					
At apex	0.7	284	594	686	815
BASIN 9					
At apex	1.7	420	880	1,028	1,255
BASIN 10					
At apex	1.7	481	979	1,125	1,329
BASIN 11					
At apex	1.4	555	1,125	1,292	1,525
BASIN 12					
At apex	25.3	2,044	5,676	7,247	10,293
BUZZARD WASH					
At Colorado River	5.0	200	1,300	2,400	8,600

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
CARBON CANYON CREEK					
At Chino Creek	6.0	370	1,200	1,700	2,000
Downstream of confluence with Little Chino Creek	5.6	370	1,200	1,700	4,100
Upstream of confluence with Little Chino Creek	2.4	180	580	810	1,900
Upstream at English Road	1.5	120	340	540	1,200
CEMETERY CREEK (Approximate Study)					
At Paxton Road	1.6	190	950	1,500	2,600
Upstream limit of study	0.3	80	310	460	730
CHICKEN SPRINGS CREEK					
--[1]	1.6	210	550	780	1,800
--[1]	0.7	175	380	500	1,200
CHINO CREEK					
--[1]	13.0	900	3,500	6,600	18,500
CITY CREEK					
Upstream of Lower Warm Creek Channel confluence	4.45	*	*	1,845	*
Upstream of Tippecanoe Avenue	3.99	*	*	1,737	*
Upstream of Victoria Avenue	2.65	*	*	1,396	*
Upstream of Palm Avenue	1.91	*	*	1,298	*
COLORADO RIVER					
At the City of Needles	170,600	*	*	40,000	*
At Bullhead City	169,300	*	*	40,000	*
Just downstream of Piute Wash	*	*	*	45,000	*
Just downstream of Sacramento Wash	*	*	*	49,600	*
At Parker	*	*	*	40,000	*
At Palo Verde Dam	*	*	*	40,000	*
Just downstream of Tyson Wash	*	*	*	46,400	*

*Data not available
[1]Because values were taken from frequency/discharge curves, no specific location information has been determined

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
COLORADO RIVER (continued)					
Just downstream of Arroyo Salada	*	*	*	46,600	*
At I-10/Blythe	*	*	*	43,200	*
Just downstream of Trigo Wash	*	*	*	46,900	*
Just downstream of Gould Wash	*	*	*	47,000	*
At Imperial Dam	*	*	*	40,000	*
At I-8/Yuma	*	*	*	40,000	*
COLTON SOUTHWEST STORM DRAIN					
At Santa Ana River	1.9	450	860	1,200	2,600
At San Bernardino Freeway (Upstream side)	1.6	400	750	1,000	2,200
At E Street	1.5	400	750	1,000	2,200
COVINGTON CREEK (Approximate Study)					
At Paxton Road	17.6	690	4,900	8,300	17,000
Upstream limit of study	17.0	670	4,800	8,100	16,000
COYOTE WASH					
At Colorado River	1.25	150	750	1,200	3,100
At Upper Limit	0.5	100	500	750	2,100
CUCAMONGA CREEK					
At Pomona Freeway	44.7	2,200	10,000	16,000	25,000
At A Street	26.1	1,500	8,200	12,000	21,000
At Foothill Boulevard	20.7	1,400	6,200	8,000	11,000
DAY CREEK					
Downstream of Southern Pacific Railroad	18.0	880	3,300	3,900	*
At Southern Pacific Railroad	18.0	880	3,300	5,400	12,000
At San Bernardino Freeway	17.9	880	3,300	5,400	12,000
DEER CREEK					
At San Bernardino Avenue	20.2	1,200	5,400	7,400	10,000

*Data not available

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
DEMENS BASIN TURNOUT	3.7	*	*	6.83	*
DEMENS CREEK	0.08	*	*	111	*
DESERT KNOLLS WASH					
At Apple Valley Road	7.4	1,131	1,981	3,120	4,170
--[1]	6.3	200	1,500	2,700	*
--[1]	0.3	100	500	700	1,500
DEVIL CREEK	5.7	*	*	5,583	*
EAGLE PASS WASH					
At Colorado River	11.7	650	3,200	5,800	17,000
Downstream of Atchison, Topeka & Santa Fe Railway	11.7	650	3,200	5,800	17,000
Upstream of Atchison, Topeka & Santa Fe Railway	4.3	300	1,500	2,700	8,100
At southwest corner of Section 30	3.0	230	1,200	2,100	6,200
At extension of Rio Vista Avenue	2.1	180	900	1,600	4,700
At east-west line dividing Sections 36 and 1	1.3	120	600	1,100	3,300
EAST ADELANTO CHANNEL					
At Auburn Avenue	33.3	900	3,000	5,200	16,000
Downstream of confluence with East Adelanto Channel Tributary B	32.7	900	3,000	5,200	16,000
At Helendale Road (Adelanto Road)	5.2	350	1,200	2,000	6,000
EAST ADELANTO CHANNEL TRIBUTARY A					
At Auburn Avenue	14.7	660	2,200	3,800	11,000
At Bartlett Avenue	10.8	500	1,700	3,000	9,000
At Duchess Avenue	10.3	500	1,700	2,900	8,700
EAST ADELANTO CHANNEL TRIBUTARY B					
At confluence with East Adelanto Channel	27.2	840	2,800	4,800	14,000
At Duchess Avenue	27.1	840	2,800	4,800	14,000

*Data not available
[1]Because values were taken from frequency/discharge curves, no specific location information has been determined

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
EAST BARSTOW CHANNEL					
At Atchison, Topeka & Santa Fe Railway	2.5	200	1,000	1,800	5,400
Downstream of confluence with Tributary of East Barstow Channel	2.4	200	1,000	1,800	5,400
Upstream of confluence with Tributary of East Barstow Channel	1.6	140	730	1,300	3,900
At Eleventh Street	1.3	120	620	1,100	3,300
At Barstow Road	1.0	100	500	900	2,700
EAST ETIWANDA CREEK					
At Wineville Percolation and Retention Basin	2.6	*	*	2,108[2]	*
At Airport Drive	1.6	*	*	1,376[2]	*
At Union Pacific Railroad	1.5	*	*	1,344[2]	*
At Interstate Highway 10	1.4	*	*	1,260[2]	*
At San Bernardino Avenue and Etiwanda Avenue	0.9	*	*	900[2]	*
ETIWANDA/SAN SEVAINE SYSTEM					
At upstream of Riverside Drive	51.0	*	*	11,200	24,400
FOX WASH					
At Colorado River	4.8	200	1,300	2,300	8,400
At Upper Limit of Detailed Study	4.4	200	1,200	2,200	7,800
GROUT CREEK					
--[1]	5.8	700	2,000	3,200	7,000
--[1]	5.0	700	2,000	3,200	7,000
HIGHGROVE CHANNEL					
At Riverside Reservoir	4.7	450	700	2,000	3,900
At La Cadena Drive	4.1	430	540[3]	1,700[3]	3,200
At Atchison, Topeka & Santa Fe Railway	2.6	320	800	1,200	1,400[3]

*Data not available
[1]Because values were taken from frequency/discharge curves, no specific location information has been determined
[2]Drainage Area and discharge only considers contributing area downstream of confluence with Etiwanda/San Sevaine System
[3]Flow limited by freeway culvert

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
HOOKE CREEK					
At confluence with Fern Canyon	1.85	2,340	3,280	3,650	4,550
HORSE CANYON CREEK					
At apex	3.79	302	843	1,219	2,594
HOUSTON CREEK					
--[1]	0.8	190	440	650	1,350
--[1]	0.2	30	150	210	400
JOSHUA TREE CREEK					
Upstream of confluence with Yucca	113.1	4,800	15,000	20,000	38,000
--[1]	6.5	250	1,200	2,200	6,200
--[1]	1.2	100	250	500	1,300
KITCHEN WASH					
At Interstate Highway 40	0.9	90	460	830	2,500
At Armory Road	0.6	70	340	610	1,800
At Rimrock Road	0.3	40	200	360	1,100
KNICKERBOCKER CREEK					
--[1]	1.0	190	500	700	1,500
--[1]	0.5	160	310	420	900
KUFFEL CANYON CREEK					
--[1]	0.6	130	350	500	1,100
--[1]	0.4	100	230	350	750
LEMING WASH					
At confluence with Fox Wash	5.0	200	1,300	2,400	8,600
LENWOOD CREEK					
At Main Street	139.7	*	*	11,340	*
LILLYHILL WASH					
Below spillway	*	0	0	250	2,000
At San Bernardino County Flood Control District Diversion Channel	0.98	100	500	900	2,700

*Data not available
[1]Because values were taken from frequency/discharge curves, no specific location information has been determined

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
LILLYHILL WASH (continued)					
At Lillyhill Drive	0.85	90	440	880	2,400
At southerly boundary of Section 1	0.57	70	330	590	1,800
LITTLE CHINO CREEK					
Upstream of confluence with Carbon Canyon Creek	3.1	220	730	1,000	2,400
Upstream Limit of Study	1.2	100	330	460	1,000
LITTLE SAND CREEK					
Upstream of Marshall Blvd	1.35	*	*	1,128	*
LYTLE CREEK AND SOUTH FORK LYTLE CREEK					
Downstream of confluence with Middle Fork Lytle Creek	40.7	4,300	16,000	23,000	65,000
Upstream of confluence with Middle Fork Lytle Creek	4.9	800	2,800	3,900	10,000
LYTLE CREEK (EAST BRANCH)					
At 4th Street	190.0	*	*	11,200	*
At Interstate 10	190.0	*	*	39,800	*
MAGNOLIA AVENUE DRAIN					
At Philadelphia Street	0.8	130	370	580	1,300
MIDDLE FORK LYTLE CREEK					
Upstream of confluence with South Fork Lytle Creek	34.9	3,800	14,000	20,000	57,000
Upstream of confluence with North Fork Lytle Creek	12.0	1,600	5,800	8,300	22,400

*Data not available

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
MISSION ZANJA					
Upstream of Interstate Highway 10	21.2	1,200	3,400	5,100	11,200
Downstream of confluence with Morey Arroyo	19.9	1,100	3,200	5,000	12,400
MOJAVE RIVER (AT BARSTOW)					
At Irwin Road	1,290	*	*	18,820	*
MOREY WASH					
At confluence with The Zanja	4.15	720	2,200	3,450	8,500
MULBERRY CHANNEL					
--[1]	3.0	250	1,000	1,800	4,000
--[1]	1.7	150	700	1,250	2,600
MOJAVE RIVER					
Upper Narrows	510.0	8,000	20,000	26,500	38,500
Below the City of Victorville	53.0	8,000	20,000	26,000	39,000
At Atchison Topeka & Santa Fe Railroad	510.0	16,000	26,000	31,000	74,000
NEEDLES FLOOD CONTROL CHANNEL					
At Atchison, Topeka & Santa Fe Railway	2.74	170	950	1,520	3,340
At Basin No. 5	2.65	170	950	1,520	3,340
Upstream of Basin No. 5	1.73	80	480	670	840
Downstream of Basin No. 3	1.63	80	480	670	840
Downstream of Basin No. 2	1.57	80	510	830	1,100
Downstream of Basin No. 5	0.59	30	180	330	430
NORTH BALSTON CREEK					
--[1]	2.9	100	1,100	1,800	5,900
--[1]	1.9	100	900	1,500	4,900
NORTH FORK LYTLE CREEK					
Upstream of confluence with Middle Fork Lytle Creek	22.9	2,700	10,200	14,700	42,600

*Data not available
[1]Because values were taken from frequency/discharge curves, no specific location information has been determined

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
OAK GLEN CREEK (Approximate Study)					
At Jefferson Street	6.2	500	1,700	2,400	5,900
Upstream Limit of Study	4.4	380	1,300	1,800	4,300
OLD SAN SEVAINE CHANNEL					
At San Bernardino-Riverside County Line	40.6	1,600	4,800	7,800	17,000
At Foothill Boulevard	29.6	1,600	4,800	8,530	17,000
ONTARIO MOTOR SPEEDWAY DRAIN					
Approximately 8,000 feet downstream of Southern Pacific Railroad	3.9	290	840	1,300	3,200
Downstream of Southern Pacific Railroad	2.8	250	360	600	1,500
At Southern Pacific Railroad	2.8	250	880	1,500	3,700
Downstream of San Bernardino Freeway	2.5	200	770	1,200	1,200
At San Bernardino Freeway	2.5	200	770	1,400	3,400
PINYON CREEK					
--[1]	2.5	150	550	950	2,550
--[1]	0.8	75	275	340	800
QUAIL WASH					
Upstream of confluence with Joshua Tree Creek	105.3	4,500	14,000	18,000	35,000
Upstream Limit of Detailed Study	104.0	4,500	14,000	18,000	35,000
RATHBUN CREEK					
At Big Bear Lake	6.37	*	*	11,000	*
At State Route 18 (Big Bear Boulevard)	6.02	*	*	10,800	*
At Moonridge Road	3.34	*	*	7,200	*
At Lassen Drive	0.82	*	*	1,200	*

*Data not available
[1]Because values were taken from frequency/discharge curves, no specific location information has been determined

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RECHE CANYON					
--[1]	12.0	500	1,900	6,200[2]	9,000
--[1]	5.0	250	1,100	1,800	5,700
ROAD RUNNER WASH					
At Interstate 40	6.00	400	2,000	3,500	10,000
SAN ANTONIO DRAIN					
At Vesta Street	2.8	800	1,500	2,100	4,300
At San Bernardino Freeway	2.4	750	1,400	1,900	3,900
SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT CHANNEL A					
At Needles Flood Control Channel	0.92	90	470	850	2,500
At Interstate Highway 40	0.66	70	370	670	2,000
Approximately 400 feet upstream of Interstate Highway 40	0.32	40	200	380	1,100
At Clary Drive	0.16	30	120	220	670
At southerly boundary of Section 31	0.10	20	90	160	470
SAN TIMOTEO CREEK					
At confluence with Santa Ana River	126.0	3,200	11,000	17,200	45,000
At Barton Road	121.0	3,500	12,500	20,400	49,000
At San Timotoe Canyon Road	119.0	3,500	12,500	20,400	57,000
At San Bernardino County/ Riverside County Line	109.0	3,500	12,500	20,400	57,000
SAND CREEK					
Upstream of Highland Avenue	3.20	*	*	2,496	*

*Data not available
[1]Because values were taken from frequency/discharge curves, no specific location information has been determined
[2]SBCFCD design flow

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
SANTA ANA RIVER					
Downstream of Warm Creek	700.0	*	*	180,000	*
Upstream of Warm Creek	505.5	*	*	113,000	*
SHEEP CREEK					
At apex	14.52	894	2,581	3,753	8,006
SOAP MINE WASH					
--[1]	3.9	550	1,100	2,000	7,000
--[1]	3.3	550	1,100	2,000	6,500
SOUTHWEST BARSTOW CHANNEL A					
At Atchison, Topeka & Santa Fe Railway	2.8	220	1,100	2,000	5,900
At H Street	1.3	120	600	1,100	3,300
THE ZANJA					
At confluence with Santa Ana River	25.23	1,450	3,500	4,050	5,900
Downstream of Bryn Mawr	21.40	1,400	4,100	6,100[2]	14,500
Downstream of New Jersey Street	20.10	1,400	4,100	6,100	14,500
Downstream of Nevada St.	15.95	1,200	3,600	5,400	13,500
At Texas Street	15.59	1,300	3,700	5,800	14,000
At First Street	15.19	1,250	3,800	5,900	15,000
Overland Flow		0[3]	300[3]	2,400[3]	11,500[3]
At Fifth Street	14.47	1,300	4,100	6,100	15,500
Overland flow		270[3]	1,700[3]	3,700[3]	13,100[3]
At Redlands Boulevard	9.59	620	2,100	3,300	9,100
Overland flow		320[3]	1,800[3]	3,000[3]	8,800[3]
At Interstate Highway 10	9.59	620	2,000	3,200	8,600
At Dearborn Street	6.84	660	2,200	3,500	9,200
--[1]	1.4	200	700	820	2,200
--[1]	0.18	660	2,250	3,550	9,200

*Data not available

[1]Because values were taken from frequency/discharge curves, no specific location information has been determined

[2]The Interstate 10 bridge downstream of Bryn Mawr limits the flow in The Zanja to 3,000 cfs. The remaining 3,100 cfs for the 1-percent annual chance flood are diverted from The Zanja to the west along the south side of Interstate 10. This breakout is in the City of Loma Linda.

[3]Overland flow

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
TRIBUTARY TO EAST BARSTOW CHANNEL					
At confluence with East Barstow Channel	0.8	80	420	760	2,300
At Rimrock Road	0.7	80	380	690	2,000
At corporate limits	0.4	50	250	450	1,300
TWENTYNINE PALMS CHANNEL					
Upstream of Bullion Mountain Road	72.8	3,000	12,200	21,500	60,000
Downstream of Amboy Road	63.6	2,800	11,500	20,000	58,000
At Utah Trail	17.5	*	*	6,700	*
At Twentynine Palms Highway	9.5	466	1,900	3,300	8,800
TWIN CREEK CHANNEL					
Upstream of Santa Ana River confluence[1]	50.2	4,630	9,420	12,300	21,270
Upstream of Santa Ana River confluence	47.8	*	*	13,500	*
WARM CREEK					
Upstream of Santa Ana River	194.5	*	*	67,000	*
Upstream of Lower Warm Creek confluence	14.65	*	*	7,594	*
--[2]	10.4	1,200	3,100	4,750	10,000
WASH A AT NEEDLES					
At Needles Flood Control Channel	0.59	70	340	600	1,500
At Lillyhill Drive	0.28	40	190	340	1,000
At southerly boundary of Section 36	0.11	20	90	170	500
WASH B AT NEEDLES					
At U.S. Highway 95	6.00	400	2,000	3,500	10,000

*Data not available
[1]Based on an updated study for the lower reach of Twin Creek Channel. See section 10.10 of this report for details.
[2]Because values were taken from frequency/discharge curves, no specific location information has been determined

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
WASH B					
At the City of Barstow eastern corporate limits	0.5	60	300	530	1,600
At the City of Barstow southern corporate limits	0.4	50	250	450	1,300
WASH C					
At the City of Barstow eastern corporate limits	0.9	90	460	830	2,500
At the City of Barstow southern corporate limits	0.8	80	420	760	2,300
WASH D					
At the City of Barstow eastern corporate limits	1.3	120	620	1,100	3,300
At the City of Barstow southern corporate limits	1.0	100	500	900	2,700
WATERMAN CANYON					
--[1]	3.0	400	900	1,300	2,200
--[1]	1.2	150	450	650	1,100
WEST BARSTOW CHANNEL					
At Atchison, Topeka & Santa Fe Railway	0.8	80	420	700	1,600
At Main Street	0.5	60	300	400	470
At Interstate Highway 15	0.4	50	250	250	250
WEST CUCAMONGA CREEK					
At Cucamonga Creek confluence	11.1	2,100	2,350	2,350	2,350
At Francis Street	5.6	*	*	4,218	*
At Mission Blvd	4.2	*	*	3,592	*
At Holt Blvd	2.2	*	*	2,849	*
At G Street	0.8	*	*	2,244	*
At Grove Street	0.6	*	*	2,217	*
At 4th Street	0.4	*	*	2,189	*
At Interstate Highway 10	0.3	*	*	2,174	*

*Data not available

[1]Because values were taken from frequency/discharge curves, no specific location information has been determined

TABLE 7 - SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
WEST FONTANA CHANNEL					
At Cherry Avenue	12.6	*	*	8,580	*
At Beech Avenue	7.4	*	*	6,120	*
At Citrus Avenue	4.1	*	*	3,990	*
At Oleander Avenue	2.6	*	*	2,460	*
WILDWOOD CHANNEL					
--[1]	8.5	400	2,200	4,000	10,500
--[1]	7.4	250	1,800	3,000	7,500
YERMO FLOOD CHANNEL					
--[1]	24.0	900	3,400	5,900	16,000
YUCAIPA CREEK					
--[1]	3.1	400	9,900	1,490	3,200
--[1]	1.2	200	490	700	1,500
YUCCA CREEK					
Upstream of confluence with Coyote Creek Wash	174.0	5,500	22,000	30,000	75,000
Upstream of confluence with Joshua Tree Creek	61.1	2,100	9,800	15,000	45,000
Downstream of Sunburst Road	59.9	1,800	9,800	12,600	43,000
Upstream of Sunset Road	59.4	1,800	9,800	12,600	42,000
Downstream of Cemetery Creek	56.1	1,800	9,500	12,000	40,700
Upstream of Cemetery Creek	53.6	1,700	8,500	11,000	39,000
Downstream of Covington Creek	50.3	1,400	8,500	10,000	37,000
Downstream of Avalon Road Extension	31.6	1,400	5,800	9,600	26,000
	2.0	100	500	1,000	2,400

*Data not available

[1]Because these values were taken from frequency/discharge curves, no specific location information has been determined

TABLE 8 - SUMMARY OF ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet NGVD*) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Ponding Area on Magnolia Avenue Drain	821	*	824	825

*Data not available

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.

Water-surface elevations of floods of the selected recurrence intervals were computed for the majority of flooding sources throughout San Bernardino County through use of the USACE HEC-2 step-backwater computer program (USACE, 1982).

Processes of erosion and deposition that cannot be modeled in the HEC-2 analyses or by other computation methods are often the most damaging effects of major floods in San Bernardino County. On streams where these factors are of major importance, heavy reliance was placed on historical flood limits (particularly the 1938 and 1969 storms) to establish flood boundaries.

In the original study for the City of San Bernardino, overflow area maps prepared by the USACE, where available, were used as guides in determining areas subject to flooding. Flood profiles for the Santa Ana River were calculated using a computerized backwater program.

San Bernardino is situated on an alluvial cone formed by debris deposited by streams originating in the San Bernardino Mountains. Today, the very heavy debris load is confined to constructed channels and is usually deposited there by flood waters. The SBCFCD has a continuing maintenance program to remove this debris. This analysis has assumed that debris will be removed prior to storms and that, during the peak of the storm, no significant debris deposition will occur in channels. If significant deposition occurs, higher stages than calculated may be experienced and overflow may occur at less than a design flow. For the revised study, water-surface elevations for the 1-percent annual chance flood were computed using the USACE HEC-2 step-backwater computer program (USACE, 1982).

Water-surface elevations for East Adelanto Channel were determined by normal depth analysis at selected cross sections. Water-surface elevations of floods of the selected recurrence intervals were computed through use of the USACE HEC-2 step-backwater computer program (USACE, 1982) for reaches of Colton

Southwest Storm Drain, 11th Street Storm Drain, Highgrove Channel, the Santa Aria River, and San Timoteo Wash. In the upper portion of the Colton Southwest Storm Drain below the Atchison, Topeka & Santa Fe Railway crossing, and Reche Canyon Channel downstream of Hunts Lane crossing, flood boundaries were generated through a synthesis of hand calculations with engineering judgment based on topography, field investigations, and historical flooding patterns. Water- surface profiles for Warm Creek were calculated using the direct step method to determine the water-surface immediately upstream from the Southern Pacific Railroad bridge (U.S. Department of Transportation, 1970).

For the majority of the flooding sources covered within the City of Needles, hydraulic analyses were accomplished through a synthesis of manual hydraulic calculations with engineering judgment based on topography, field investigation, and historical flooding patterns. This method of treatment of the hazards generated in the City of Needles was warranted by the nature of the flooding. In most portions of the city, the flood hazard consists either of flooding contained within an improved channel or of sheet flooding on the alluvial plain upon which the city is situated. In these cases, analysis by standard step-backwater curves to generate flood boundaries and water-surface elevations is not warranted or not applicable in the respective cases.

The tributary within the City of Needles for which analysis was accomplished by way of the USACE HEC-2 step-backwater computer program (USACE, 1982) is the Needles Flood Channel. The HEC-2 program was used to determine water-surface elevations of floods of the selected recurrence intervals for reaches of this channel. Cross sections for the majority of the streams throughout the county were taken from topographic maps at a scale of 1:2,400, with contour intervals of 4 feet and 5 feet (San Bernardino County Flood Control District, undated). Several of the smaller streams in the San Bernardino mountain area and some streams in the desert areas were field surveyed.

Cross-section data for Little Sand Creek and Sand Creek were determined by field survey and information taken from the SBCFCD 4-foot contour maps (San Bernardino County Flood Control District, undated) with a scale of 1:2,400. Cross sections for the Del Rosa Channel, Warm Creek Channel, and the Twin Creek Channel were taken from as-built plans obtained from the SBCFCD. The plans were supplemented with information taken from the SBCFCD 4-foot contour maps, scale 1:2,400 (San Bernardino County Flood Control District, undated).

Cross-section data for the analysis for East Adelanto Channel are the result of field surveys. The cross-section data for the Lenwood Creek, Armory Channel, and Mojave River for the hydraulic analysis were obtained from field surveys. All bridges and culverts were surveyed to obtain elevation data and structural geometry.

The cross-section data beyond the limits of field cross-section survey were interpolated from the USGS topographic maps (U.S. Department of the Interior, 1971, et cetera).

For the Mojave River at Barstow, the cross-section data beyond the limits of field cross-section survey were interpolated from San Bernardino County’s 2-foot contour topographic maps (USACE, April 1984). Improvement plans for the new Atchison, Topeka & Santa Fe Railway Barstow Hump Yard located near the western (upstream) end of the study were obtained and incorporated into the study.

Cross sections for a majority of the hydraulic analyses through the City of Colton were taken from topographic maps at a scale of 1:4,800, with a contour interval of 4 feet (Toups Corporation, 1976, et cetera).

Overland cross-section data for San Timoteo Wash were taken from a 1985 topographic map with 2-foot contour intervals and a scale of 1:80 (USACE, 1985). In areas where there had been substantial cross-sectional changes due to developments that were not reflected on the existing topographic mapping, improvement plans were used to supplement the mapping. Improvement plans supplied by the SBCFCD were used in the analysis of the 11th Street Storm Drain, Highgrove Channel, Santa Ana River, Reche Canyon Channel, and Lytle Creek Channel.

Cross sections for the majority of the hydraulic analyses for the City of Fontana were taken from topographic maps at a scale of 1:2,400, with a contour interval of 4 feet (San Bernardino County Flood Control District, undated). Substantial cross-sectional changes that have taken place due to development are not reflected on the existing topographic mapping. In these areas, field cross sections and improvement plans supplied by the City of Fontana and the SBCFCD were used in the analysis. For the West Fontana Channel, the elevation data of the railroad embankment were based on actual survey data by the City of Fontana dated May 1989. The data of the West Fontana Channel were taken from the SBCF’CD drawings dated 1975, 1978, and 1984. Cross sections of streetways were measured based on street maps provided by the City of Fontana and field checks. Cross sections for the majority of the streams through the City of Highland were taken from topographic maps at a scale of 1:2,400, with contour intervals of 4 feet and 5 feet (San Bernardino County Flood Control District, undated).

The majority of the cross sections used in the hydraulic analyses for the City of Loma Linda were taken from topographic maps furnished by the SBCFCD (San Bernardino County Flood Control District, undated). However, substantial cross-sectional changes have occurred due to development that are not reflected on the existing topographic mapping. In these areas, field cross sections and improvement plans supplied by the city and the SBCFCD were used in the analysis.

Cross sections for all detailed-study areas in the City of Loma Linda were located at close intervals above and below bridges and culverts to compute the significant backwater effects of these structures. The structures at Interstate 10 and at Colton Avenue are located outside the study area. No structures were modeled within the corporate limits of Loma Linda. The bridges and culverts at Interstate 10 and at Colton Avenue were surveyed to obtain elevation data and structural geometry.

Cross sections for the majority of the hydraulic analyses for the City of Needles were taken from topographic maps at a scale of 1:2,400, with a contour interval of 4 feet (Toups Corporation, 1976, et cetera). Cross sections for the majority of the hydraulic analysis for the City of Ontario were taken from topographic maps at a scale of 1:2,400 reduced to a scale of 1:4,800, with a contour interval of 4 feet (Toups Corporation, 1976, et cetera). In areas where substantial cross-sectional change due to development not reflected on the existing topographic mapping occurred, field cross sections and improvement plans were used to supplement the mapping. Improvement plans supplied by the city and the SBCFCD were used in the analysis of the following improved channels: West Cucamonga Creek, Deer Creek, San Antonio Drain, Old Deer Creek, and Cucamonga Creek.

Cross sections for the streams studied by detailed methods through the City of Rancho Cucamonga were taken from topographic maps at a scale of 1:2,400, with contour intervals of 4 feet and 5 feet (San Bernardino County Flood Control District, undated). Cross sections for the majority of the hydraulic analyses in the City of Twentynine Palms were taken from 1:2,400 scale topographic maps with a 4-foot contour interval (San Bernardino County Flood Control District, undated). The majority of the topographic maps were prepared by photogrammetry through recent aerial and ground surveys (Pictorial Sciences, Inc., 1984). Some of the maps were furnished by the SBCFCD. Where there have been substantial cross-sectional changes due to development that are not reflected on the existing topographic mapping, field cross sections and improvement plans supplied by the City of Twentynine Palms and the SBCFCD were used in the analysis.

In most cases, starting elevations for detailed analyses throughout the county were determined by the standard slope/area method and by normal depth; however, every effort was made to obtain previously published data to check accuracy. The starting water-surface elevation for Little Sand Creek, Sand Creek, and Warm Creek Channel is critical depth. On the Twin Creek Channel, the starting water-surface elevation is the 1-percent annual chance flood elevation in the Santa Ana River. The starting water-surface elevation for the Del Rosa Channel is the 1-percent annual chance water-surface elevation in the Warm Creek Channel.

Channel roughness factors (Manning's "n") for these computations were assigned on the basis of field inspection of floodplain areas, previous studies by the USACE and the SBCFCD, and analyses of the 1969 floods. Roughness values were assigned to the following bases:

Type of Service	Manning's "n" Value Range
Fully developed concrete-lined channels	0.014
Green Belt Channels	0.020 - 0.060
Leveed channels; USACE levees, reinforced concrete levees, and riprap	0.025 - 0.040
Smooth sandy bottom channels	0.025 - 0.040
Rocky-canyon type natural channels	0.035 - 0.060
Natural channels with heavy vegetation	0.040 - 0.080

Type of Service	Manning's "n" Value Range
Sparsely developed overbank areas[1]	0.030 - 0.060
Moderately developed overbank areas[1]	0.060 -0.100
Fully developed residential overbank areas	0.100 - 0.125

[1]The same range applied to overbank areas that were covered by vegetation of varying densities.

For the Mojave River at Barstow, the "n" value for the corrugated metal pipe crossing Lenwood Road has been used as 0.021. The flow is conducted through a 16-48 inch corrugated metal pipe at Lenwood Crossing.

Due to the nature of alluvial fan flooding, the overflow from East Adelanto Channel Tributary A, East Adelanto Channel Tributary B, and the various unnamed tributaries attains an average depth of less than 1 foot and inundates the City of Adelanto. No profiles were prepared for portions of the Oro Grande River and Mojave River through the City of Victorville due to the scope of study for the previous City of Victorville FIS.

No profiles were developed for flooding sources throughout the City of Barstow that generate shallow sheetflow, or for which flooding other than sheetflow or overflow is contained in the channel. These were the East Barstow Channel; Kitchen Wash; Lenwood Creek; Washes B, C, and D; and the West Barstow Channel. Water-surface elevations for these sources were determined by a synthesis of hand calculations with engineering judgments based on topography (U.S. Department of the Interior, 1971, et cetera; Toups Corporation, 1976, et cetera), and field investigation. Debris potential was considered in analysis throughout the general area of San Bernardino County and specifically in the City of Barstow. The current policies of several agencies with expertise in hydraulic analysis were researched, including the USACE, Hydrologic Engineering Center at Davis, California, their Los Angeles District Office; the SBCFCD; and the Riverside County Flood Control District.

Based on these data and the original study contractor's own experience, criteria were developed for consideration of debris in each stream, based on a classification of its debris potential as either high, medium, or low. In the vicinity of Barstow, potential for all flooding sources was considered to be low and no provision for debris was made in the hydraulic analysis.

East Barstow Channel was studied and water-surface elevations determined from a synthesis of manual hydraulic calculations and analysis of topography, in conjunction with field investigations. From the upstream limit of detailed study downstream of Eighth Street, flood elevations were determined strictly by topography as flooding is very shallow, evenly distributed across the sloping alluvium, and without distinct flow path. From Eighth Street downstream, elevations were determined from normal depth calculations at selected cross sections along the channel reach, and energy head and pressure flow calculations at culverts. Once it reaches the improved channel, the 1-percent annual chance discharge is fully contained until it reaches Riverside Drive, at which point it crosses the road and enters the Mojave River.

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 9, "Summary of Manning's "n" Values."

TABLE 9 –SUMMARY OF MANNING'S "n" VALUES

Stream	Channel “n”	Overbank “n”
11th Street Storm Drain	*	*
Armory Creek	0.013-0.030	0.030-0.045
City Creek	0.015-0.025	0.015-0.025
Colorado River	0.030	0.030
Colton Southwest Storm Drain	0.020-0.130	*
Cucamonga Creek	0.012-0.014	0.030-0.060
Day Creek	0.030-0.035	0.035-0.050
Deer Creek	0.012-0.014	0.030-0.060
Del Rosa Channel	0.030-0.035	0.100-0.300
Eagle Pass Wash	0.015-0.030	0.030
East Adelanto Channel	0.040	0.060-0.080
East Barstow Channel	0.015-0.035	0.030-0.035
Etiwanda/San Sevaine System	0.014-0.015	0.03
Highgrove Channel	0.015-0.050	0.050-0.090
Kitchen Wash	0.030	0.030-0.100
Lenwood Creek	0.015-0.050	0.030-0.050
Lillyhill Wash	0.030	0.030
Little Sand Creek	0.030-0.050	0.030-0.050
Twin Creek Channel	0.030-0.040	0.030-0.040
Mojave River (at Barstow)	0.040-0.045	0.040-0.050
Needles Flood Channel	0.015-0.030	0.030
Old Deer Creek	0.015-0.050	0.035-0.050
Ontario Motor Speedway Drain	0.015-0.050	0.015-0.080
Rathbun Creek	0.140-0.040	0.020-0.100
Reche Canyon	0.022-0.030	0.030-0.125
Road Runner Wash	0.030	0.030
San Antonio Drain	0.015-0.040	0.030-0.125
San Timoteo Creek	0.025-0.035	0.035-0.100
Sand Creek	0.038	0.038
Santa Ana River	0.030-0.250	0.040-0.100
SBCFCD Channel A	0.030	0.030
Southwest Barstow Channel A	0.015-0.030	0.030-0.180
The Zanja	0.020-0.100	0.040-0.100
Tributary to East Barstow Channel	0.030	0.030
Twentynine Palms Channel	0.025	0.025
Warm Creek	0.030-0.035	0.100-0.300

TABLE 9 –SUMMARY OF MANNING'S "n" VALUES (continued)

Stream	Channel "n"	Overbank "n"
Wash A at Needles	0.015-0.030	0.030
Washes B, C, and D at Barstow	0.030	0.030
West Barstow Channel	0.015	0.030
West Cucamonga Creek	0.014-0.030	0.018-0.030
Yucca Creek	0.025	0.050

*Data not available

The 0.2-percent annual chance discharge fails to pass the culvert under Interstate 15 and, due to the height of the freeway embankment, the 2,600 cfs breakout is lost to the east. It does not return to the channel but runs under the freeway at Montana Road and easterly out of the corporate limits.

Kitchen Wash has a drainage area of less than 1 square mile and consequently was studied by approximate methods. Water-surface elevations were determined by topography (U.S. Department of the Interior, 1971, et cetera; and Toups Corporation, 1976, et cetera) and field investigations.

Lenwood Creek is located on an alluvial plain that was studied for shallow potential, with flood hazard limits being determined by topography and historical data.

Southwest Barstow Channel A water-surface elevations, from the upstream limit of study down to Sioux Street, were determined by manual hydraulic calculations and, therefore, a profile was not developed for this stream segment. The culvert under H Street at Interstate 15 will not contain the 1- or 0.2-percent annual chance discharge. The overflow runs down H Street under Interstate 15 and then follows the topography to run back into the channel at Sioux Street. From the new collector channel at the upstream side of the Barstow Hump Yard upstream to Sioux Street, water-surface elevations were determined by the HEC-2 program (USACE, 1982). The collector channel behind the Barstow Hump Yard contains the 1-percent annual chance discharge and conveys it down to the Mojave River. However, the 0.2-percent annual chance flow overtops the channel and fails to make the 90° bend immediately downstream of the old railroad crossing. The resultant overflow sheetflows across the railroad yard and into the Mojave River.

Tributary to East Barstow Channel is an approximate study (drainage area less than 1 square mile) with water-surface elevations determined by topography (U.S. Department of the Interior, 1971, et cetera; Toups Corporation, 1976, et cetera) in conjunction with normal depth calculations at selected cross sections and capacity checks of culverts.

Washes B, C, and D are tributaries without defined flow paths and share a common sloping alluvial plain. Consequently, the flows intermingle without predictability. Flood hazard limits were determined by topography (U.S. Department of the Interior, 1971, et cetera; Toups Corporation, 1976, et cetera).

West Barstow Channel has insufficient drainage area, resulting in delineation as an approximate study. Water-surface elevations were determined by capacity checks of the improved channel using Manning's equation from normal depth, and by capacity checks of culverts at street and highway crossings along the channel.

In the case of the lower reach of Reche Canyon Channel downstream of Hunts Lane, flow is lost due to a lack of channel and culvert capacity upstream. From Hunts Lane downstream, the flood profile for Reche Canyon Channel was based on normal depth calculations for the discharge remaining in the channel. In the case of the Colton Southwest Storm Drain, where the flooding consists of shallow sheetflow, no profile was plotted. For Warm Creek, no profiles were plotted, since flooding is due to ponding at a constant elevation.

Two of the improved channels studied are of standard project design: Warm Creek Channel and Lytle Creek. Floodflows for these two creeks are contained in the channel; therefore, no profile was drawn. Reference is made to the Lytle and Warm Creeks Supplement to Design Memorandum No. 1, dated April 1984 (USACE, April 1984). Warm Creek was designed originally to contain the SPF. As a result of the floods in 1978 and 1980, significant amounts of sediment were deposited in the flood control channel of both Warm Creek and the Santa Ana River. Under SPF conditions, Warm Creek itself does not create a flood problem. However, the combined Santa Ana River arid Warm Creek flows do create a flood problem because of the backwater from the Southern Pacific Railroad Bridge. The USACE has plans to improve this reach of the Santa Ana River and lessen the severity of flooding. Reference 9 indicates that the SPF water depth in the overbanks is about 3 feet higher than the 1-percent annual chance flood depth. The proposed USACE project is located right at the confluence of Santa Ana River and Warm Creek and is expected to be built in 1986. The USACE project consists of adjusting the invert gradient of the Santa Ana River by lowering the concrete chute just upstream from the Interstate 10 overcrossing and lowering the stabilizer at the downstream end of the project. In addition, a floodwall and side drain channel would be built at the northeast intersection of the Santa Ana River and the Southern Pacific Railroad overcrossing.

Several dentates at and near the confluence of Warm Creek and Santa Ana River would be removed as well. The proposed floodwall on the east and the side drain channel will intercept the San Timoteo Wash overflow from the east and convey the sheetflow under the railroad tracks through a side drain channel into the Santa Ana River.

Debris potential was considered in analysis throughout the general area of San Bernardino County, especially in the City of Colton. The current policies of several agencies with expertise in hydraulic analysis were reached. These included the USACE, Hydrologic Engineering Center at Davis, California, District Office; SBCFCD; and the Riverside County Flood Control District. Based on these data and the study contractor's experience, the following criteria were adopted for consideration of the debris potential in the streams studied. The debris potential for each stream was classified as either high, medium, or low. This classification was based on historic flood data, an analysis of the characteristics of the drainage area, and a field investigation of the flooding source by hydraulic engineers. On streams with low debris potential, no provision for debris was made in the analysis. For stream reaches where the debris potential was determined to be medium, the bridge geometry coding in the hydraulic analyses was altered using the following criteria:

1. At all reinforced concrete box culverts and bridge crossings where the cross-sectional end area was 100 square feet or less, the pier widths were doubled. Where the crossing consisted of two or more circular pipes, the end area was reduced by 20 percent.

2. At all bridge crossings with end areas between 100 and 250 square feet, 1 foot of width was added to each pier.

3. At all bridges with end areas greater than 250 square feet, 2 feet of width were added to each pier.

For stream reaches where the debris potential was determined to be high, the bridge geometry was adjusted by the same criteria listed above, and, in addition, peak discharges were bulked by a factor of from 1.1 to 1.5 based on an individual analysis of the flooding source. Debris potential for flooding sources studied in detail in the City of Colton are given as follows:

Flooding Source	Debris Potential	Bulking Factor
Colton Southwest Storm Drain	Low	N/A
11th Street Storm Drain	Low	N/A
Highgrove Street Storm Drain	Medium	N/A
Santa Ana River	Medium	N/A
Reche Canyon Channel	High	N/A
Cucamonga Creek	High	1.35
West Cucamonga Creek	High	1.20
Ontario Motor Speedway Drain	Low	N/A
Old Deer Creek	Low	N/A
Deer Creek	High	1.20
Day Creek	High	1.20
East Etiwanda Creek	High	1.20
San Antonio Drain	Low	N/A

The following is an enumeration of the flooding sources studied and specific information used for the hydraulic analyses.

Colton Southwest Storm Drain

The upper portion of this flooding source was treated as a sheetflow analysis while the lower portion was analyzed using the HEC-2 program. From E Street downstream to H Street, most of the flow will be in Pennsylvania Avenue. This street was used as an effective flow model to determine depths of flow from which ultimate flood boundaries were determined. Downstream of Valley Boulevard near Interstate 10, the flow has no outlet; consequently, ponding occurs until it weirs between the Interstate 10 embankment and an adjacent commercial building, and over the Southern Pacific Railroad at Valley Boulevard. Weir calculations were done to determine ponding elevations. Downstream of this point the discharge weirs over the Southern Pacific Railway mainline, being divided by the Atchison, Topeka & Santa Fe Railway mainline, with 60 percent on the east and 40 percent on the west side of the tracks. These two divided flows were studied as independent sheetflows. These two flows rejoin on the eastern side of the tracks at N Street and travel as overland sheetflow from that point downstream to La Cadena Drive. Flood boundaries for the above reaches were determined by manual calculations, topography, and field investigation. From the intersection of La Cadena Drive with the Union Pacific Railroad overcrossing downstream to the Santa Ana River, the HEC-2 computer program was used to determine flood elevations.

11th Street Storm Drain

A field investigation indicated that the street and drainage pattern upstream of Valley Boulevard directed a substantial amount of runoff eastward toward Warm Creek Channel. Therefore, the tributary area to the upstream limit of the study reach is subject to change with each frequency of storm. This limiting effect on the tributary drainage area, and the recent computation of a new concrete-riprap channel has significantly reduced the flood hazard associated with this flooding source.

Highgrove Channel

The HEC-2 computer program was effectively used to analyze this flooding source throughout the study reach. At La Cadena Drive, significant storage exists. To best reflect the impact of this storage on the flood boundaries and flood profiles, a storage-discharge and routing analysis was undertaken. The HEC-1 computer program was used to investigate the possible reduction in peak discharges and the resulting ponding elevations for each of the selected recurrence frequencies.

Lytle Creek Channel and Warm Creek Channel

Both of these watercourses are fully improved channels designed to contain the SPF. Normal-depth calculations were made to verify the containment of the 1-percent annual chance flood.

Santa Ana River

The entire study reach of the Santa Ana River lent itself to the use of the HEC-2 computer program. In reaches where the area adjacent to the channel is not effective for conveyance, an effective flow model was used to develop flood profiles and boundaries. The improvement plans provided by both the SBCFCD and the USACE were used in the analysis. The recent improvements completed by the USACE, from approximately the Warm Creek Channel confluence to upstream of E Street, are of standard project design and contain the 1-percent annual chance flood.

Reche Canyon Channel

This flooding source has two very different and distinctive hydraulic reaches within the study limits. The study reach includes the well-defined canyon area and an active alluvial fan that begins at the canyon mouth (Barton Road) and continues downstream to the floodplains of the Santa Aria River.

Several hydraulic assumptions were made that helped the analyses provide more realistic results. Due to the high debris potential, all frequency discharges were bulked by a factor of 1.2, and all culvert crossings in the canyon area were considered as complete obstructions to the major floodflows. Hand calculations were used to provide a water-surface profile for the 10-percent annual chance flood (low-flow) through each culvert. The result of these assumptions and hydraulic calculations provided flood elevations that were in concurrence with historical flooding in this area.

From the mouth of the canyon upstream, the HEC-2 computer program was effective in providing flood profiles from which the flood boundaries were plotted. It also provided an analysis of the flow distribution at the canyon mouth which had an important impact on determination of the flow elevations downstream of the canyon mouth, on the alluvial cone.

Downstream from Barton Road, the channel has the capacity to carry the flow that is left in the channel at the canyon mouth. The major portion of the flow is diverted by the configuration of the intersection of Reche Canyon Road and Barton Road to the east to a low point in the road where it continues to weir across Barton Road. The hydraulic conditions at the canyon mouth, topographic mapping, historical data, field investigation by hydraulic engineers, and normal-depth and weir-flow calculations were all considered in determining the flood elevations downstream of the canyon mouth to the eventual overflows of the Santa Ana River and San Timoteo Creek.

Portions of Reche Canyon Channel have been zoned “A” based on the channel capacity to contain the 1-percent annual chance discharge. Profiles, however, are included in this study to provide additional information.

San Timoteo Wash

Flows reaching the Reche Canyon Channel levee near the confluence of Santa Aria River pond to the top of the levee. San Timoteo Creek will flow over this levee, causing major erosion, and ultimately breach the north levee of Reche Creek Canyon. The south levee was not breached because, if the north levee is assumed breached, the existing entrenched channel has enough capacity to carry the 1-percent annual chance flows.

Results of the hydraulic analyses indicate that shallow flooding occurs in the area between the San Sevaine Channel and the Pacific Electric Railroad to the south. The average flooding depth was determined using normal-depth calculations and computer programs.

Shallow flooding occurs adjacent to the West Fontana Channel and the Atchison, Topeka & Santa Fe Railway, from Juniper Avenue westward to Banana Basin and southward from the Oleander, Citrus, and Beach Street culverts.

For San Timoteo Creek, the USACE HEC-2 computer program provided the hydraulic analysis methodology. A series of supercritical computer runs were conducted to determine the capacity of the existing channel, with debris potential. The computer program was begun upstream of the corporate limits with starting water-surface elevations estimated from normal-depth computations. The capacity of San Timoteo Creek is approximately 9,000 cfs before it overflows near Anderson Street.

Subcritical runs were conducted to provide backwater effects of bridges and overbank flow. The 1-percent annual chance peak discharge at the upstream corporate limit for the City of Loma Linda is 20,400 cfs, with losses occurring as San Timoteo Creek flows through the city. Widespread flooding occurs within the City of Loma Linda corporate limits, with approximately 6,500 cfs of the 1-percent annual chance floodflow leaving the watercourse over Interstate 10 between the downstream corporate limits and a point just upstream of Richardson Street. A 1-percent annual chance peak discharge of 13,900 cfs occurs at the downstream corporate limits, reflecting these diversion losses.

The HEC-2 computer program analysis was begun downstream of Interstate 10, outside the corporate boundaries and upstream of the confluence with Santa Ana River. The starting water-surface elevation for the subcritical runs was estimated from critical-depth computations. These runs modeled the culverts at the Interstate 10 and Colton Avenue crossings, which limit the capacity of the channel to 8,000 cfs downstream of these structures. Approximately 6,000 cfs of the 13,900-cf s discharge at the downstream corporate limits are diverted west along the freeway as overbank flow, away from San Timoteo Creek. By using the supercritical model, it was determined that floodwater in the overbank areas resulting from insufficient channel capacity tended to flow away from the channel banks. Therefore, the study contractor’s hydraulic modeling without consideration of the bridges was considered reasonable because of the shallow flooding in the overbank.

<u>Mission Zanja Channel</u>

For Mission Zanja Channel, the HEC-2 computer program was used to conduct a hydraulic analysis from Redlands Boulevard to Interstate 10. The bridge crossing at Bryn Mawr Avenue cannot convey the 1-percent annual chance flood. Shallow flooding less than 1 foot deep occurs along this reach. This overflow joins the San Timoteo Creek overflow downstream of the corporate limits.

SBCFCD Channel A

SBCFCD Channel A was studied by approximate methods for the upstream study limit near the southern boundary of Section 31, downstream to a point approximately 250 feet upstream from the crossing with Interstate 40. The upstream limit of the study was determined by the size of the drainage area, which is 0.1 square mile at the point of termination of the study. The backwater ponding area created behind the Interstate 40 crossing was determined by a series of manual hydraulic calculations.

Buzzard, Coyote, Fox, and Lemming Washes

Buzzard, Coyote, Fox, and Lemming Washes were studied by approximate methods. Upstream from Interstate 40, floodflows from these washes generated a flood hazard area due to sheetflow with flood hazard limits defined by topography. These flows are collected by a series of levees and ditches which direct them into a series of six bridges under Interstate 40.

Wash C

Wash C was studied by approximate methods with flood hazard limits determined by topography.

Eagle Pass Wash

Eagle Pass Wash was studied by detailed methods upstream from the Colorado River to the east-west line between Sections 36 and 1 using both normal depth and critical depth calculations. The upstream reaches of Eagle Pass Wash and its tributaries were treated as approximate studies with boundaries determined by topography. In their farthest upstream reaches, flooding from these sources represents a general flood hazard area with indeterminate flow paths on the alluvial fan. This is indicated by the flood hazard limits shown. From the outlet of the debris basin downstream to the Colorado River, the channel is fully lined and its capacity was checked using normal depth calculations. The 1-percent annual chance discharge is fully contained in this reach but the 0.2-percent annual chance flow fails to pass the River Road and Bush Street bridges, resulting in weir flow over the roadways. Pressure flow and weir flow calculations were done to determine the overflow boundaries and amounts.

Needles Flood Control Channel

Needles Flood Control Channel was studied by detailed methods from the Colorado River upstream to Basin No. 3 using the HEC-2 step-backwater computer program. The channel was modeled using improvement plans provided by the SBCFCD. Upstream from Basin No. 3, ponding elevations for Basin Nos. 1 and 2 were determined from manual calculations of the energy grade line assuming that the flow passes through critical depth as it crosses over the spillway.

The upstream energy grade line then represents the ponding elevation. Overflows at Spillways 1 and 2 were studied by detailed methods and were terminated at the point where they enter the street system. The 1-percent annual chance flow at this point is small enough to be fully contained by the streets and presents minor hazard.

Road Runner Wash

Road Runner Wash was studied by detailed methods from the concentration points created by bridges under the Atchison, Topeka & Santa Fe Railway downstream to the Colorado River. Downstream from the railway, the flooding consists of sheetflow, which is directed into the Interstate 40 bridges by a north-south levee defining the eastern limit of flooding. North of Interstate 40, an east-west levee from a northerly limit to floodflows, directing them east across River Road and thence downstream to the Colorado River. Upstream from the railway, flooding from this source was treated as an approximate study with flood hazard limits determined by topography.

Wash B

Wash B was studied in detail with flood elevations being determined by normal depth calculations at selected cross sections. In the downstream reaches of this wash, all discharges are contained by the well-incised channel. The 1- and 0.2-percent annual chance discharges will result in high velocities within the channel.

Flood profiles were not developed for the streams studied by detailed methods in this report. In all cases where the capacity of the channel is exceeded, there is sheetflow flooding. Flood elevations plotted along the centerline of the channel in this situation have little relevance to the condition of flooding in the overbank areas in segments where sheetflooding is the result of loss of channel capacity. This is particularly true in Ontario where the topography slopes at approximately 1.5 percent from north to south but is relatively flat in the east-west direction, and the majority of the channels do not have 1-percent annual chance capacity.

These floodflows are unpredictable, being determined by local topography and not lending themselves to HEC-2 step-backwater analysis. The HEC-2 computer program was used in the hydraulic analysis. Effective flow models were developed to determine channel capacities, velocities of flow, and backwater effects at major culvert crossings. Once overflow occurs, the topography of the alluvial plain, the development on the plain, the velocity of flow, field investigations by hydraulic engineers, and historical data are all used to determine flood boundaries, depths of flow, and flood hazards.

Ontario has several large watercourses that originate in the San Gabriel Mountains and flow through the city on their way down the alluvial plain toward the Santa Ana River. The major watercourses include Day Creek, Deer Creek, East Etiwanda Creek, West Cucamonga Creek, and the largest of these, Cucamonga Creek. Most of the drainage system lacks 1-percent annual chance capacity for upstream control. This situation is a major reason for the approach used in the hydraulic analysis of the flooding sources in the City of Ontario. A more detailed discussion of the analysis of each individual watercourse is provided below. It should be noted that the following reports were researched and used in the hydraulic analysis of the City of Ontario: Hydrology Design Memorandum No.1, Cucamonga Creek; Design Memorandum No. 2, General Design for Flood Control and Recreation, Cucamonga Creek; and Flood of January 1969 Near Cucamonga, California (USACE, 1973; USACE, June 1973; U.S. Department of the Interior, 1971, respectively).

Cucamonga Creek

On Cucamonga Creek, an effective flow model utilizing the HEC-2 step-backwater computer program, was used to determine channel capacities, velocities of flow, and backwater effects at major culvert crossings. Once overflow occurs, the topography of the alluvial plain, the velocity of flow, the development on the plain, field investigations, and historic data were all utilized to determine the flood elevations.

West Cucamonga Creek

On West Cucamonga Creek, the channel section generally has capacity for the 1-percent annual chance flood. It has numerous percolation basins, but the majority of all street crossings are inadequate and, due to lack of channel section at these crossings, a significant amount of the discharge is lost. Once this situation occurs, and due to the overall topographic character of the alluvial plain that these watercourses transverse, the overflow elevations are based on the following criteria: topography, velocity of flow, field investigations, and historic data. The sheetflow area adjacent to the channel just upstream of the Union Pacific Railroad was determined by containing the entire flow within those limits and determining the resulting depth of flow in the model.

Deer Creek

On Deer Creek at the northern corporate limits of the City of Ontario and the intersection of the Deer Creek Channel, a situation of sheetflow existed due to an upstream overflow condition. The overflow entering the city was collected by the diversion swale that collected sheetflow above the Ontario Motor Speedway Drain and directed it into the Old Deer Creek Channel. A combination of improvement plans, topography, field investigations, HEC-2 analysis, and historical data was used to determine the overflow elevations and channel capacities.

San Antonio Drain

The major problem of San Antonio Drain is one of concentration of the flow. A detailed study and field investigation was conducted to verify the potential of the flow concentrating in San Antonio Avenue, at the Interstate 10 overpass. The average slope in this area is 1.5 percent. There are asphaltic, concrete-lined, 3-

foot-high berms on the north side of Interstate 10 directing the flow back to San Antonio Avenue. The bridge crossing over Interstate 10 has 3-foot-high concrete sides that provide an adequate section for the 1-percent annual chance flow to cross Interstate 10 and continue downstream.

The existing reinforced-concrete pipe drain is grossly inadequate, and the excess results in street flow where the property-line-to-property-line section has capacity, and shallow flooding when the carrying capacity of the property-line-to-property-line section diminishes.

The berms of the Union Pacific and Southern Pacific Railroads running east-west between Hold Boulevard and State Street cause a ponding area where the depths are greater than 1 foot. In all cases, the HEC-2 computer program was used to determine channel capacities, velocities of flow, and backwater effects at all crossings. In addition, the HEC-1 computer program (USACE, 1987 and 1990) was used to analyze the routing and storage effects of some major culvert restrictions that had substantial storage capacity behind the limited culvert outlet. For the Ontario Motor Speedway Drain, this situation occurs at the Interstate 10 highway berm. For both Day Creek and East Etiwanda Creek, this occurs at the main east-west Union Pacific Railroad line. In all cases, a BFE based on storage and reduced outflow was determined.

For both East Etiwanda Creek and Ontario Motor Speedway Drain, the channel lacks capacity downstream from these restrictions and results in shallow flooding. On Day Creek, the channel section is adequate but is highly susceptible to high-velocity attack and erosion and is therefore unstable. Field investigation provided evidence that major sections of the adjacent land area were eroded by runoff from recent rainstorms that were significantly less than a 1-percent annual chance frequency level. Therefore, the 300 feet adjacent to each side of the existing channel were designated as a shallow flooding area.

<u>Magnolia Avenue Drain</u>

A ponding area on Magnolia Avenue Drain is located just upstream of State Highway 60, outside the corporate limits. The ponding is created by an inadequate storm drain that restricts the flow and creates ponding behind the highway embankment to a depth of approximately 6 feet.

The remainder of Magnolia Avenue drain has a drainage area of less than 1 square mile and consequently was studied by approximate methods. Approximate flood boundaries were determined by topography and field investigation. For Day Creek, the channel lacks capacity and results in shallow flooding. Therefore, both sides of the existing channel were designated as shallow flooding areas. Depths of shallow flooding in Rancho Cucamonga were using topographic data and historical information.

The Zanja and Morey Wash

Hydraulic analyses were performed to determine the channel capacity for The Zanja and Morey Wash and the depth of overbank flooding from the 1-percent annual chance frequency flood.

The channels of The Zanja and Morey Wash are, for the most part, man-made drainage channels that do not consistently follow a natural or pre-existing watercourse. The Zanja and Morey Wash flow over a broad and sloping alluvial plain. Although the topography is such that flows would tend to concentrate along the channels in some areas, for the most part the surrounding terrain is of low topographic relief with a poorly defined drainage pattern. The Zanja and Morey Wash follow the gradient of the terrain and flows that exceed the channel capacity will generally flow in the direction of these streams. Overland flows, however, do not necessarily reenter the channels immediately as the capacity increases, and in some cases may leave the system, such as in the reach between California Street and the Interstate 10 Freeway on The Zanja.

This relatively independent behavior between channel and overland flows precludes a traditional riverine type of analysis such as that performed by the USACE HEC-2 computer program. Consequently, flows along The Zanja and Morey Wash were treated as riverine flow in the channel and shallow flooding (sheetflow) in the overbanks. A HEC-2 model was developed for the channel only, and the channel capacity was determined at various reaches. The Manning equation was used to determine the 1-percent annual chance floodplain along The Zanja and Morey Wash. The discharge in the overbanks was computed by subtracting the channel capacity from the total flood discharge.

The flood widths in the overbanks were computed by assuming a depth of 1 foot where the resistance to flow is relatively small and 1.5 feet where it is relatively large. The overbank flood limits were then adjusted according to observations of past floods, the general topography, and effects of obstructions such as railroad and freeway embankments. The adjustments were made to achieve a reasonable relationship between the flow depths and floodplain widths for the shallow flow conditions that will prevail.

An exception to the procedure described above was made for The Zanja in the area between the Interstate 10 crossing on the east and Tennessee Avenue on the west. In this reach the overflow limits were computed directly with the USACE HEC-2 computer program because the overflow is confined by the well-defined topographic relief of the freeway embankment on the north and high ground on the south. Obstructions were accounted for in the downtown area by increasing the roughness (Manning's "n") values.

Alluvial Fans

Areas subject to alluvial fan flooding were delineated based on field investigation, topographic maps (San Bernardino County Flood Control District, undated), and aerial photographs dated December 23, 1989, and April 12, 1991. The FEMA methodology for analyzing flood risks in areas subject to alluvial fan flooding was used to determine the 1-percent annual chance flood depths and velocities in these areas.

Donnell Hill, although not itself subject to alluvial fan flooding, is situated in an area determined to be subject to alluvial fan flooding from Basin 3. In analyzing this area, the percentage of the width of inundation from Basin 3 that ends up on the eastern side of the hill was treated as a random variable. The expected value of this random variable was taken to be 70. In analyzing the risks due to flooding from Basins 8 through 11, a point was identified below which flows will be contained within one of two overlapping areas depending on whether the flows pass to the east or to the west of the point. This point is situated near the Utah Trail approximately 2,000 feet south of the southern corporate limits. The percentage of the width of inundation from any of the four basins that ends up to the east of this point was treated as a random variable and the expected value taken to be 50.

A Manning's "n" value of 0.025 was used in the analyses of flood risks for the areas subject to alluvial fan flooding. Values for slopes were estimated using topographic maps (San Bernardino County Flood Control District, undated). A levee along the western side of Fortynine Palms Channel was taken as the western boundary of areas subject to flooding from Basin 1 based on its structural integrity. No other levees were considered in the analyses of flood risks for the areas subject to alluvial fan flooding.

Streams Studied Using Approximate Methods

Elevations for streams studied by approximate methods were determined either by detailed methods but classified as approximate, because the BFEs could not be determined to the required accuracy, or on the basis of approximate hydrologic and hydraulic calculations in conjunction with field investigations. An unnamed tributary to Reche Canyon Channel was studied by approximate methods, due to its drainage area of less than 1 square mile. Approximate elevations were determined through field investigation.

Areas of approximate flooding along the old San Sevaine Channel were determined using the USACE HEC-2 computer program with starting water-surface elevations estimated from normal-depth calculations.

Lillyhill Wash and Wash A were treated as approximate studies from the upstream corporate limits of the City of Needles downstream to their respective retention basins. Flood elevations for these sources were determined using normal depth and critical depth calculations. In the farthest upstream reach, above the limit of 4-foot contour interval mapping (Toups Corporation, 1971, et cetera), a larger flooding area representing the flood hazard limits was delineated because of the limitations of the topographic mapping and the indeterminate flow paths on the alluvial fan. 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 Flood Insurance Rate Map (Exhibit 2).

The hydraulic analyses for this study 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.

3.3 Vertical Datum

All FISs 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 was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the finalization of the North American Vertical Datum of 1988 (NAVD 88), many FISs are being prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown on the FIRM for San Bernardino County are referenced to NAVD 88. Structure and ground elevations in the county must, therefore, be referenced to NAVD 88. It is important to note that FISs for adjacent communities may be referenced to NGVD 29. This may result in BFE differences across political boundaries between the communities.

Prior versions of this FIS were referenced to NGVD 29. When a datum conversion is effected for an FIS, the Flood Profiles, BFEs, and bench marks reflect the new datum values. To compare structural and ground elevations to 1-percent annual chance flood elevations shown in this FIS, the subject structural and ground elevations must be referenced to the new datum values.

As noted above, the elevations shown in this FIS 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 2.27 feet and 3.59 feet for this county. Accordingly, due to the statistically significant range in conversion factors, an average conversion factor could not be established for the entire county. 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. The conversion factor for each flooding source in the county may be found in Table 10, “Vertical Datum Offset Table,” shown below.

TABLE 10 – VERTICAL DATUM OFFSET TABLE

Flooding Source	Vertical Datum Offset (feet)	Flooding Source	Vertical Datum Offset (feet)
11th Street Storm Drain	2.56	Middle Fork Lytle Creek	2.76
Antelope Valley Wash	2.81	Mojave River (At Barstow)	2.44

TABLE 10 – VERTICAL DATUM OFFSET TABLE (continued)

Flooding Source	Vertical Datum Offset (feet)	Flooding Source	Vertical Datum Offset (feet)
Armory Channel	2.47	Mojave River (Upper Narrows and Below Victorville)	2.72
Arrowhead Channel	2.41	North Fork Lytle Creek	2.74
Cable Creek	2.58	Pinyon Creek	2.76
Carbon Canyon Creek	2.45	Quail Wash	2.61
Chicken Springs Creek	2.75	Rathbun Creek	3.54
Chino Creek	2.45	Reche Canyon	2.58
City Creek	2.51	San Sevaine Channel	2.51
Colorado River	2.30	San Timoteo Creek	2.59
Del Rosa Channel	2.54	San Timoteo Wash A	2.56
Desert Knolls Wash	2.75	San Timoteo Wash B	2.57
East Adelanto Channel	2.78	Sand Creek	2.62
East Etiwanda Creek	2.54	Santa Ana River	2.57
East Rialto Storm Drain	2.60	Soapmine Creek	2.42
Grout Creek	3.59	Southwest Barstow Channel A	2.45
Highgrove Channel	2.51	The Zanja	2.68
Hooke Creek		Twentynine Palms Channel	2.38
Houston Creek	2.93	Warm Creek	2.46
Joshua Tree Creek	2.60	Waterman Canyon	2.76
Kuffel Canyon Creek	3.17	Wildwood Channel	2.74
Lenwood Creek	2.54	Wilson Creek	2.72
Little Chino Creek	2.47	Yermo Flood Channel	2.27
Little Mountain Channel and Devil Creek and Western Ave. Drain	2.63	Yucaipa Creek	2.75
Little Sand Creek	2.59	Yucca Creek (at Joshua Tree)	2.63
Twin Creek Channel	2.52	Yucca Creek (at Yucca Valley)	2.73
Lytle Creek and South Fork Lytle Creek	2.76		

The BFEs shown on the FIRM represent whole-foot rounded values. For example, a 1% annual chance water-surface elevation of 102.4 feet will appear as 102 on the FIRM and 102.6 feet will appear as 103. Therefore, users who wish to convert the elevations in this FIS to NAVD 88 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*, or contact the Vertical

Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Rockville, Maryland 20910 (http://www.ngs.noaa.gov).

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-percent annual chance 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 flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the community. 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 scales of 1:2,400, 1:4,800, and 1:24,000, with contour intervals of 2, 4, 5, 20, and 40 feet (San Bernardino County Flood Control District, undated; U.S. Department of the Interior, 1971, et cetera; Toups Corporation, 1976, et cetera; USACE, 1985; Pictorial Sciences, Inc., 1984; Boyle Engineering Corporation, undated).

The 1- and 0.2-percent annual chance floodplain boundaries are shown on the Flood Insurance Rate Map (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, AH, and AO); 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.

For most of the streams studied by approximate methods, the boundary of the 1-percent annual chance flood was taken from the most reliable information available, including floodplain boundary information by the SBCFCD (San Bernardino Flood Control District, <u>Flood Plain Zoning Maps</u>; San Bernardino County Flood Control District, <u>Overflow Limits, February 1969 Storm</u>). The sources included FPI Studies by the USACE (USACE, 1973, USACE, 1972, USACE, 1968), a USGS study of Apple Valley Dry Lake (U.S. Department of the Interior, Flood Frequency Analysis), and flood boundary information by the SBCFCD (San Bernardino Flood Control District, Flood Plain Zoning Maps; San Bernardino County Flood Control District, Overflow Limits, February 1969 Storm). On streams for which no reliable floodplain boundary information was available, floodplain boundaries were determined on the basis of approximate hydrologic and hydraulic calculations in conjunction with field investigations by hydraulic engineers. The floodplain boundaries for some streams shown as approximate were determined by detailed study methods, but classified as approximate when BFEs could not be determined to the required accuracy.

Approximate floodplain boundaries along the old San Sevaine Channel were delineated as coincident with the channel banks. The alluvial fan analysis for Lytle Creek was used only to determine the limits of the approximate 1-percent annual chance flooding near Lytle Creek. This approach was used due to the unknown effects of the structures, such as highway bridges and groins, on the alluvial fan plain.

In areas of the county where the flood hazard consists of shallow flooding on alluvial sloping plains, flood boundaries were determined by a combination of extensive field investigation, analysis of the latest topography (U.S. Department of the Interior, 1971, et cetera; Toups Corporation, 1976, et cetera), normal depth calculations, and historical flooding data.

The 1-percent annual chance flood boundaries for approximate studies were determined by utilizing existing topographic mapping (U.S. Department of the Interior, 1971, et cetera; Toups Corporation, 1976, et cetera) and by approximate hydraulic calculations.

In addition, the flood boundaries for the probable SPF presented in Design Memorandum No. 1 (USACE, 1973) were utilized to develop the 0.2-percent annual chance overflow boundaries presented in this study. These boundaries were modified to reflect existing conditions within the study area.

The 1-percent annual chance frequency flood boundaries for approximate studies were determined by utilizing existing topographic mapping (Toups Corporation, 1976, et cetera) and by approximate hydraulic calculations.

For most of the watercourses throughout the City of Rancho Cucamonga, 1-percent annual chance flood boundaries were delineated using the most reliable information available. This included information by the SBCFCD and a report on a comprehensive storm drain plan for the City of Rancho Cucamonga (San Bernardino Flood Control District, Flood Plain Zoning Maps; San Bernardino County Flood Control District, Overflow Limits, February 1969 Storm; L. D. King, Inc., 1981). On watercourses for which no reliable information was available, flood boundaries were determined on the basis of approximate hydrologic and hydraulic calculations in conjunction with investigations by hydraulic engineers.

In areas of the City of Rancho Cucamonga where the flood hazard consists of shallow flooding, flood boundaries were determined by a combination of analysis of the latest topography and historical flooding data.

For stream channels through the City of Rancho Cucamonga designated as “Zone A contained in channel,” the 1-percent annual chance flood boundaries are based on the existing channel alignment and right-of-way.

For The Zanja and Morey Wash, only the 1-percent annual chance floodplain boundaries have been delineated, using topographic maps prepared by the USACE, Los Angeles District (USACE, August 17, 1984; USACE, 1986; USACE, August 27, 1984). For the streams studied by approximate methods, only the 1-percent annual chance floodplain boundary is shown on the Flood Insurance Rate Map (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.

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 1.

The floodways presented in this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. 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 11). In cases where the floodway and 1-percent annual chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

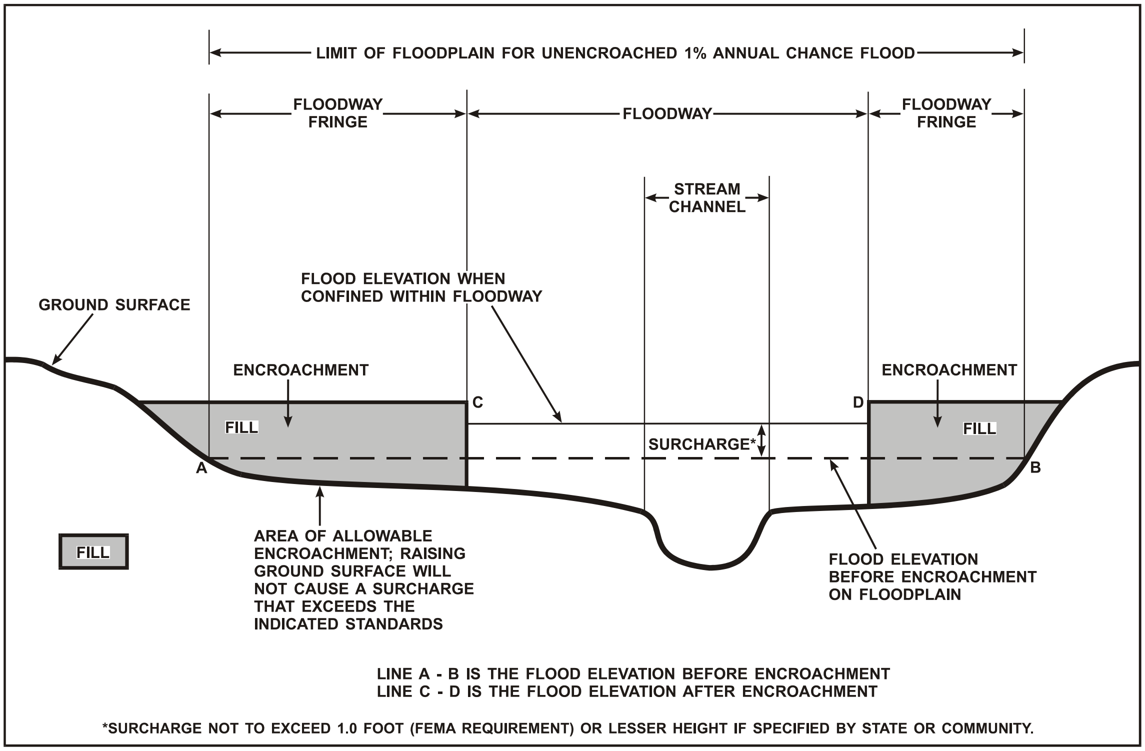

Figure 1: FLOODWAY SCHEMATIC

The floodways presented in this report were developed through a series of procedural steps that included:

1. Evaluation of equal conveyance reduction from each side of the floodplain
2. Negotiation and coordination with local and regional agencies
3. Review of existing hydraulic data
4. Analysis of existing "floodway" zoning by the community
5. Evaluation of design criteria of existing and proposed structural improvements
6. Consideration of the natural topography and the practicality of access to flood fringe areas

A brief description of the floodway analysis process used to determine the floodways presented in this report is required to fully understand the resulting designated floodways.

A floodway has been established by San Bernardino County for the Mojave River. The adopted floodway is generally wider than required to meet the above criteria. Therefore, the floodway presented in this study conforms to the limits of the adopted floodway, with the exception of a few locations where additional width was required to meet Federal Insurance Administration (FIA) criteria. As shown on the Flood Insurance Rate Map (Exhibit 2), the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the floodway and 1-percent annual chance flood boundaries are close together, only the floodway boundary has been shown. Floodways are not applicable for Cucamonga Creek; Sand Creek; Twentynine

Palms Channel, from mile 1.4 to mile 4.95 above Amboy Road; and Wildwood Channel, because the major flood hazards along these streams are due to sheetflow, bank erosion, shifting channels, and deposition of debris that would not be limited by establishing a floodway meeting FIA criteria. Due to the type of analysis employed, the calculation of a floodway for East Adelanto Channel was not within the scope of this study. Floodways were not determined for East Adelanto Channel Tributary A and East Adelanto Channel Tributary B because the flooding associated with them is shallow, with depths less than 1 foot.

No floodways were computed for flooding sources in the City of Bear Lake studied by detailed methods because the floodway was not in the scope of work.

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
11th Street Storm Drain								
A	5,600[1]	40	72	6.8	938.1	938.1	938.4	0.3
B	6,350[1]	32	85	5.8	946.2	946.2	946.8	0.6
C	6,900[1]	66	118	4.2	949.9	949.9	950.7	0.8
D	7,500[1]	22	54	9.0	958.6	958.6	958.6	0.0
E	7,900[1]	22	55	9.0	962.7	962.7	962.7	0.0
F	8,235[1]	16	137	3.6	969.4	969.4	969.6	0.2
G	8,500[1]	61	266	1.8	970.9	970.9	971.1	0.2

[1]Feet above confluence with Santa Ana River

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

11TH STREET STORM DRAIN

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
Antelope Valley Wash								
A	0	555	1,507	4.2	2,902.7	2,902.7	2,903.7	1.0
B	500	543	2,004	3.2	2,904.2	2,904.2	2,904.8	0.6
C	1,000	405	1,241	5.2	2,904.8	2,904.8	2,905.7	0.9
D	1,500	410	797	8.0	2,909.7	2,909.7	2,910.2	0.5
E	2,000	405	1,010	6.3	2,916.3	2,916.3	2,916.8	0.5
F	2,500	410	818	7.8	2,922.2	2,922.2	2,922.3	0.1
G	3,000	500	1,064	6.0	2,928.4	2,928.4	2,928.7	0.3
H	3,500	550	922	6.9	2,934.7	2,934.7	2,935.0	0.3
I	4,000	520	962	6.7	2,942.8	2,942.8	2,943.7	0.9
J	4,500	420	981	6.5	2,950.2	2,950.2	2,951.0	0.8
K	5,000	314	868	7.4	2,956.8	2,956.8	2,957.8	1.0
L	5,500	230	712	9.0	2,963.7	2,963.7	2,963.8	0.1
M	6,000	210	690	9.3	2,969.6	2,969.6	2,970.4	0.8
N	6,500	190	687	9.3	2,976.1	2,976.1	2,976.7	0.6
O	7,000	180	580	11.0	2,982.0	2,982.0	2,982.6	0.6
P	7,500	215	618	10.4	2,988.1	2,988.1	2,988.2	0.1
Q	8,000	104	506	12.6	2,995.8	2,995.8	2,995.8	0.0
R	8,500	113	521	12.3	3,002.8	3,002.8	3,003.7	0.9
S	9,000	126	539	11.9	3,008.6	3,008.6	3,008.6	0.0
T	9,500	148	574	11.2	3,013.0	3,013.0	3,013.0	0.0
U	10,000	129	545	11.7	3,019.6	3,019.6	3,019.6	0.0
V	10,500	145	570	11.2	3,028.7	3,028.7	3,029.2	0.5
W	11,000	160	620	10.3	3,034.6	3,034.6	3,034.9	0.3
X	11,500	230	698	9.2	3,041.3	3,041.3	3,041.5	0.2
Y	12,000	310	829	7.7	3,048.1	3,048.1	3,048.5	0.4
Z	12,500	325	892	7.2	3,056.6	3,056.6	3,057.1	0.5

[1]A point approximately 1,030 feet upstream of confluence with Mojave River

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

ANTELOPE VALLEY WASH

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
Antelope Valley Wash (continued)								
AA	13,000	350	905	7.1	3,063.3	3,063.3	3,064.2	0.9
AB	13,500	290	799	8.0	3,070.4	3,070.4	3,071.0	0.6
AC	14,000	340	874	7.3	3,075.9	3,075.9	3,076.6	0.7
AD	14,500	300	557	11.5	3,082.9	3,082.9	3,082.9	0.0
AE	15,010	260	740	8.6	3,090.5	3,090.5	3,091.4	0.9
AF	15,500	280	793	8.1	3,096.3	3,096.3	3,097.1	0.8
AG	16,000	250	712	9.0	3,103.1	3,103.1	3,103.2	0.1
AH	16,500	235	566	11.3	3,109.4	3,109.4	3,109.7	0.3
AI	17,000	204	545	11.7	3,116.3	3,116.3	3,117.1	0.8
AJ	17,500	175	511	12.5	3,122.8	3,122.8	3,123.6	0.8
AK	18,000	179	561	11.4	3,129.7	3,129.7	3,129.7	0.0
AL	18,500	186	549	11.7	3,137.3	3,137.3	3,137.3	0.0
AM	19,000	179	517	12.4	3,143.4	3,143.4	3,143.6	0.2
AN	19,500	177	524	12.2	3,151.2	3,151.2	3,151.2	0.0
AO	20,000	230	663	9.7	3,156.6	3,156.6	3,156.7	0.1
AP	20,500	270	644	9.9	3,163.7	3,163.7	3,164.5	0.8
AQ	21,000	220	578	11.1	3,170.3	3,170.3	3,171.2	0.9
AR	21,500	240	658	9.7	3,176.7	3,176.7	3,177.5	0.8
AS	22,000	210	565	11.3	3,183.5	3,183.5	3,183.5	0.0
AT	22,500	174	603	10.6	3,189.7	3,189.7	3,190.1	0.4
AU	23,000	200	693	9.2	3,196.2	3,196.2	3,196.3	0.1
AV	23,500	270	903	7.1	3,201.1	3,201.1	3,201.7	0.6
AW	24,000	390	809	7.9	3,208.9	3,208.9	3,209.0	0.1

[1]A point approximately 1,030 feet upstream of confluence with Mojave River

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

ANTELOPE VALLEY 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
Arrowhead Channel								
A	2,746[1]	330	1,157	2.2	2,110.6	2,110.6	2,111.6	1.0
B	3,326[1]	140	413	5.8	2,120.8	2,120.8	2,121.8	1.0
C	3,749[1]	170	445	5.4	2,133.7	2,133.7	2,134.7	1.0
D	4,277[1]	160	449	5.3	2,150.8	2,150.8	2,151.8	1.0
Carbon Canyon Creek								
A	1,150[2]	30	198	8.6	639.3	639.3	639.3	0.0
B	3,300[2]	63	236	7.2	657.2	657.2	657.7	0.5
C	8,820[2]	120	368	2.2	704.7	704.7	705.7	1.0
D	12,610[2]	86	185	2.9	737.7	737.7	738.1	0.4
Chicken Springs Creek								
A	264[3]	150	310	2.5	2,121.6	2,121.6	2,122.6	1.0
B	950[3]	110	200	3.9	2,145.1	2,145.1	2,146.1	1.0
C	1,742[3]	60	160	4.9	2,172.9	2,172.9	2,173.9	1.0
D	2,323[3]	60	157	4.7	2,196.9	2,196.9	2,197.9	1.0
E	2,851[3]	50	143	5.2	2,229.1	2,229.1	2,230.1	1.0
F	3,960[3]	70	162	4.3	2,262.9	2,262.9	2,263.9	1.0
G	4,910[3]	130	229	3.1	2,300.1	2,300.1	2,301.1	1.0
H	5,755[3]	80	168	3.9	2,335.8	2,335.8	2,336.8	1.0
I	6,366[3]	80	156	4.8	2,353.9	2,353.9	2,354.9	1.0
J	7,075[3]	40	81	7.6	2,380.8	2,380.8	2,381.8	1.0
K	7,656[3]	20	78	7.7	2,406.7	2,406.7	2,407.7	1.0
L	8,976[3]	20	74	7.8	2,449.8	2,449.8	2,450.8	1.0
M	9,610[3]	40	98	5.6	2,481.0	2,481.0	2,482.0	1.0
N	10,296[3]	30	83	6.6	2,502.3	2,502.3	2,503.3	1.0

[1]Feet above confluence with Mojave River
[2]Feet above confluence with Chino Creek
[3]Feet above confluence with Wilson Creek

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

ARROWHEAD CHANNEL - CARBON CANYON CREEK - CHICKEN SPRINGS 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
Chino Creek								
A	0[1]	80	498	16.0	719.4	719.4	719.4	0.0
B	290[1]	120	687	13.0	721.2	721.2	721.2	0.0
C	597[1]	300	2,301	3.0	722.3	722.3	723.3	1.0
D	966[1]	230	947	3.0	722.4	722.4	723.4	1.0
E	1,294[1]	230	1,700	3.5	722.5	722.5	723.5	1.0
F	1,637[1]	90	748	8.5	722.5	722.5	723.5	1.0
G	2,397[1]	90	613	9.0	723.9	723.9	724.7	0.8
H	2,893[1]	40	409	15.6	728.9	728.9	729.9	1.0
City Creek								
A	950[2]	25	165	10.5	1,042.9	1,042.9	1,042.9	0.0
B	2,323[2]	36	149	11.7	1,050.6	1,050.6	1,050.6	0.0
C	3,168[2]	40	154	11.3	1,055.8	1,055.8	1,055.8	0.0
D	5,438[2]	44	151	9.3	1,073.1	1,073.1	1,073.1	0.0
E	7,762[2]	45	139	10.0	1,089.2	1,089.2	1,089.2	0.0
F	17,107[2]	25	167	7.8	1,155.2	1,155.2	1,155.2	0.0
G	20,434[2]	38	62	7.3	1,191.3	1,191.3	1,191.3	0.0
H	21,806[2]	44	66	6.8	1,210.1	1,210.1	1,210.1	0.0

[1]Feet above confluence with San Antonio Channel

[2]Feet above confluence with Twin/Warm Creek Channel

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CHINO CREEK - CITY CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Colorado River								
	166.0	310/147	*	*	338.3	338.3	338.3	0.0
	167.0	711/300	*	*	340.2	340.2	340.2	0.0
	168.0	585/474	*	*	341.9	341.9	341.9	0.0
	169.0	332/142	*	*	343.2	343.2	343.2	0.0
	170.0	314	*	*	344.7	344.7	344.7	0.0
	171.0	426	*	*	346.2	346.2	346.2	0.0
	172.0	504/205	*	*	347.8	347.8	347.8	0.0
	173.0	570/316	*	*	349.2	349.2	349.2	0.0
	174.0	808/651	*	*	350.8	350.8	350.8	0.0
	175.0	767/488	*	*	352.6	352.6	352.6	0.0
	176.0	491/290	*	*	354.5	354.5	354.5	0.0
	177.0	487/190	*	*	356.4	356.4	356.4	0.0
	178.0	2362/1005	*	*	366.9	366.9	366.9	0.0
	179.0	608/304	*	*	368.2	368.2	368.2	0.0
	180.0	581/459	*	*	368.6	368.6	368.6	0.0
	181.0	727/334	*	*	369.8	369.8	369.8	0.0
	182.0	666/351	*	*	370.6	370.6	370.6	0.0
	183.0	921/411	*	*	371.1	371.1	371.1	0.0
	184.0	874/363	*	*	371.8	371.8	371.8	0.0
	185.0	654/292	*	*	372.7	372.7	372.7	0.0
	186.0	768/455	*	*	373.6	373.6	373.6	0.0
	187.0	364/203	*	*	374.2	374.2	374.2	0.0
	188.0	541/270	*	*	374.9	374.9	374.9	0.0
	189.0	529/311	*	*	376.0	376.0	376.0	0.0
	190.0	371/195	*	*	377.3	377.3	377.3	0.0
	191.0	350	*	*	378.6	378.6	378.6	0.0

[1]Miles above U.S - Mexico Border
[2]Total width/width within county
*Data not available

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

COLORADO RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Colorado River (continued)								
	192.0	329/164	*	*	379.1	379.1	379.1	0.0
	234.0	776/165	*	*	463.9	463.9	463.9	0.0
	235.0	569/150	*	*	463.9	463.9	463.9	0.0
	236.0	612/117	*	*	464.8	464.8	464.8	0.0
	237.0	560/0	*	*	465.6	465.6	465.6	0.0
	238.0	423/273	*	*	466.6	466.6	466.6	0.0
	239.0	384/198	*	*	467.7	467.7	467.7	0.0
	240.0	376/252	*	*	469.1	469.1	469.1	0.0
	241.0	519/321	*	*	470.8	470.8	470.8	0.0
	242.0	509/284	*	*	470.5	470.5	470.5	0.0
	243.0	501/247	*	*	471.3	471.3	471.3	0.0
	244.0	418/235	*	*	472.4	472.4	472.4	0.0
	245.0	525/340	*	*	473.4	473.4	473.4	0.0
	246.0	525/506	*	*	474.1	474.1	474.1	0.0
	247.0	450/231	*	*	475.0	475.0	475.0	0.0
	248.0	530/283	*	*	476.1	476.1	476.1	0.0
	249.0	498/220	*	*	477.2	477.2	477.2	0.0
	250.0	400/291	*	*	478.0	478.0	478.0	0.0
	251.0	434/248	*	*	480.2	480.2	480.2	0.0
	252.0	437/230	*	*	480.2	480.2	480.2	0.0
	253.0	472/314	*	*	480.9	480.9	480.9	0.0
	254.0	419/171	*	*	482.0	482.0	482.0	0.0
	255.0	577/314	*	*	483.1	483.1	483.1	0.0
	256.0	647/301	*	*	483.8	483.8	483.8	0.0
	257.0	501/216	*	*	484.5	484.5	484.5	0.0

[1]Miles above U.S - Mexico Border
[2]Total width/width within county
*Data not available

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

COLORADO 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
Desert Knolls Wash								
A	0[1]	120	428	6.3	2,770.4	2,770.4	2,771.4	1.0
B-C[2]								
D	3,538[1]	160	475	5.7	2,816.7	2,816.7	2,817.7	1.0
E	4,646[1]	70	312	9.1	2,829.1	2,829.1	2,830.1	1.0
F	5,808[1]	110	330	5.5	2,843.9	2,843.9	2,844.9	1.0
G	6,178[1]	110	330	5.5	2,849.9	2,849.9	2,850.9	1.0
H	6,494[1]	100	285	4.2	2,854.8	2,854.8	2,855.8	1.0
I	7,286[1]	100	229	3.9	2,872.8	2,872.8	2,873.8	1.0
J	8,078[1]	120	268	3.4	2,892.7	2,892.7	2,893.7	1.0
K	8,976[1]	120	275	3.3	2,919.2	2,919.2	2,920.2	1.0
L	9,821[1]	40	136	6.6	2,937.3	2,937.3	2,938.3	1.0
M	10,190[1]	130	235	3.8	2,944.9	2,944.9	2,945.9	1.0

[1]Feet above Limit of Detailed Study*

*The Limit of Detailed Study is 533 feet upstream of Owatonna Road

[2]Cross sections removed as a part of LOMR case number 12-09-1907P

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

DESERT KNOLLS WASH

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
Grout Creek								
A	95	70	477	6.7	6,748.2	6,748.2	6,749.2	1.0
B	1,056	80	505	6.3	6,760.0	6,760.0	6,761.0	1.0
C	1,441	160	1,066	3.3	6,762.4	6,762.4	6,763.4	1.0

[1]Feet above Big Bear Lake

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

GROUT 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
Highgrove Channel								
A	7,000[1]	43	427	4.7	853.7	853.7	854.3	0.6
B	8,200[1]	40	269	7.4	873.0	873.0	873.0	0.0
C	8,800[1]	63	306	6.5	876.0	876.0	876.5	0.5
D	9,450[1]	79	444	4.2	885.5	885.5	885.5	0.0
E	10,100[1]	80	271	6.8	887.2	887.2	887.5	0.3
F	10,930[1]	40	508	3.3	907.5	907.5	907.5	0.0
G	11,360[1]	116	1,086	1.1	907.5	907.5	907.6	0.1
H	11,850[1]	41	281	4.3	914.4	914.4	914.4	0.0
I	12,620[1]	13	83	14.4	914.4	914.4	914.4	0.0
Hooke Creek								
A	1,351[2]	59	367	11.3	4,924.0	4,924.0	4,924.9	0.9
B	2,794[2]	91	483	15.5	4,973.7	4,973.7	4,974.0	0.3
C	4,280[2]	57	287	11.5	5,017.4	5,017.4	5,017.5	0.1
D	5,687[2]	75	346	13.1	5,086.0	5,086.0	5,086.0	0.0
E	7,301[2]	45	407	9.5	5,152.8	5,152.8	5,153.5	0.7
F	8,115[2]	40	257	13.6	5,210.0	5,210.0	5,210.0	0.0
Houston Creek								
A	53[3]	20	83	7.7	4,533.1	4,533.1	4,534.1	1.0
B	1,051[3]	30	99	6.4	4,544.8	4,544.8	4,545.8	1.0
C	1,352[3]	30	106	6.1	4,548.5	4,548.5	4,549.5	1.0
D	1,748[3]	20	80	7.3	4,555.4	4,555.4	4,556.4	1.0
E	2,297[3]	50	185	5.2	4,572.7	4,572.7	4,573.7	1.0
F	2,798[3]	10	35	5.9	4,582.5	4,582.5	4,583.5	1.0
G	3,348[3]	50	191	1.1	4,598.9	4,598.9	4,599.9	1.0

[1]Feet above confluence with Santa Ana River
[2]Feet above confluence with Fern Canyon
[3]Feet above Lake Gregory

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

HIGHGROVE CHANNEL – HOOKE CREEK- HOUSTON 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
Joshua Tree Creek								
A	2,070[1]	570	2,060	9.7	2,603.0	2,603.0	2,603.9	0.9
B	5,970[1]	151	307	8.1	2,657.2	2,657.2	2,657.2	0.0
C	8,490[1]	80	250	10.0	2,690.1	2,690.1	2,690.1	0.0
D	9,075[1]	80	340	6.5	2,697.1	2,697.1	2,698.1	1.0
E	10,157[1]	170	539	4.1	2,706.9	2,706.9	2,707.9	1.0
F	10,976[1]	360	1,008	2.2	2,713.8	2,713.8	2,714.8	1.0
G	11,974[1]	800	945	2.3	2,725.5	2,725.5	2,726.5	1.0
H	12,977[1]	200	565	3.9	2,742.9	2,742.9	2,743.9	1.0
I	14,028[1]	60	229	9.6	2,768.1	2,768.1	2,769.1	1.0
Kuffel Canyon Creek								
A	0[2]	40	106	4.7	5,117.5	5,117.5	5,118.5	1.0
B	660[2]	10	69	6.6	5,142.7	5,142.7	5,143.7	1.0
C	1,056[2]	5	32	11.2	5,178.6	5,178.6	5,179.6	1.0
Middle Fork Lytle Creek								
A	470[3]	287	1,472	13.6	2,915.7	2,915.7	2,915.9	0.2
B	1,825[3]	230	1,596	12.5	2,979.7	2,979.7	2,980.7	1.0
C	3,400[3]	159	711	11.7	3,056.7	3,056.7	3,057.5	0.8
D	4,900[3]	125	675	12.3	3,150.8	3,150.8	3,151.8	1.0

[1]Feet above confluence with Yucca Creek
[2]Feet above Lake Arrowhead
[3]Feet above confluence with South Fork Lytle Creek

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

JOSHUA TREE CREEK - KUFFEL CANYON CREEK - MIDDLE FORK LYTLE 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
Mojave River (At Barstow)								
A	0	800	2,196	8.2	1,999.7	1,999.7	2,000.7	1.0
B	1,478	800	3,689	4.9	2,004.7	2,004.7	2,005.7	1.0
C	6,320	750	3,422	5.3	2,019.3	2,019.3	2,020.3	1.0
D	8,078	1,090	4,888	3.7	2,023.5	2,023.5	2,024.5	1.0
E	10,090	1,120	3,279	5.5	2,028.8	2,028.8	2,029.8	1.0
F	12,128	1,265	4,936	3.8	2,034.7	2,034.7	2,035.7	1.0
G	14,652	1,116	4,367	4.3	2,043.1	2,043.1	2,043.1	0.0
H	17,878	1,557	5,004	3.8	2,052.2	2,052.2	2,052.3	0.1
I	20,069	1,126	4,196	4.5	2,058.3	2,058.3	2,058.6	0.3
J	24,341	869	2,793	6.7	2,071.5	2,071.5	2,071.5	0.0
K	26,791	795	3,542	5.3	2,078.5	2,078.5	2,079.5	1.0
L	27,477	829	3,502	5.4	2,080.9	2,080.9	2,081.9	1.0
M	29,188	759	3,802	4.9	2,086.8	2,086.8	2,087.2	0.4
N	33,713	313	2,101	9.0	2,099.5	2,099.5	2,099.7	0.2
O	36,353	656	4,162	4.5	2,106.4	2,106.4	2,107.1	0.7
P	40,212	969	4,153	4.5	2,117.4	2,117.4	2,117.4	0.0
Q	45,957	840	2,516	7.5	2,131.1	2,131.1	2,131.1	0.0
R	46,633	940	4,376	4.3	2,134.3	2,134.3	2,134.6	0.3
S	48,148	1,098	4,037	4.7	2,138.7	2,138.7	2,138.7	0.0
T	50,540	994	4,308	4.4	2,145.5	2,145.5	2,145.7	0.2
U	55,176	1,079	4,112	4.6	2,159.0	2,159.0	2,159.0	0.0
V	63,144	893	3,871	4.9	2,178.6	2,178.6	2,179.5	0.9

[1]Feet above Limit of Detailed Study*

*The Limit of Detailed Study is located 195 feet downstream of Lenwood Road

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

MOJAVE RIVER (AT BARSTOW)

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
Mojave River (At Hesperia and Apple Valley)								
A	8,474	1,482	5,283	5.9	2,847.7	2,847.7	2,847.7	0.0
B	9,655	1,523	5,338	5.8	2,852.0	2,852.0	2,852.0	0.0
C	12,468	866	3,639	8.4	2,860.9	2,860.9	2,861.2	0.3
D	14,268	820	4,380	7.2	2,867.5	2,867.5	2,867.8	0.3
E	16,844	803	3,306	11.4	2,875.5	2,875.5	2,875.6	0.1
F	21,683	893	4,766	6.7	2,891.1	2,891.1	2,891.6	0.5

[1]Feet above Bear Valley Road

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

MOJAVE RIVER (AT HESPERIA AND APPLE VALLEY)

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
Mojave River (Below Victorville)								
A	194[1]	1,370	5,447	5.7	2,407.8	2,407.8	2,408.7	0.9
B	3,719[1]	1,439	5,809	5.3	2,418.5	2,418.5	2,419.4	0.9
C	6,955[1]	797	6,484	4.8	2,431.3	2,431.3	2,432.3	1.0
D	10,867[1]	725	3,481	8.9	2,440.9	2,440.9	2,441.7	0.8
E	14,556[1]/11,289[2]	1,440	6,874	4.5	2,454.8	2,454.8	2,454.9	0.1
F	14,488[2]	1,420	5,060	3.6	2,463.3	2,463.3	2,463.5	0.2
G	17,672[2]	1,500	4,468	4.0	2,472.9	2,472.9	2,473.0	0.1
H	20,872[2]	1,600	5,050	3.9	2,481.2	2,481.2	2,481.4	0.2
I	24,351[2]	1,550	5,200	3.5	2,492.6	2,492.6	2,493.6	1.0
J	26,849[2]	1,500	4,276	4.2	2,501.2	2,501.2	2,501.8	0.6
K	30,402[2]	1,600	4,604	3.9	2,511.5	2,511.5	2,512.3	0.8
L	33,069[2]	1,100	4,386	4.1	2,521.2	2,521.2	2,521.9	0.7
M	37,398[2]	1,400	5,175	3.5	2,533.5	2,533.5	2,533.8	0.3
N	40,075[2]	1,500	3,994	4.5	2,541.8	2,541.8	2,541.9	0.1
O	43,043[2]	1,230	3,379	5.3	2,552.3	2,552.3	2,552.3	0.0
P	45,588[2]	1,500	4,188	4.3	2,562.5	2,562.5	2,562.7	0.2
Q	49,188[2]	1,500	3,865	4.7	2,574.7	2,574.7	2,575.0	0.3
R	52,657[2]	1,300	4,699	3.8	2,587.0	2,587.0	2,587.8	0.8
S	55,361[2]	1,020	3,876	4.6	2,596.4	2,596.4	2,596.4	0.0
T	58,893[2]	1,000	3,790	4.7	2,608.7	2,608.7	2,609.2	0.5
U	62,029[2]	980	3,473	5.2	2,620.0	2,620.0	2,620.1	0.1
V	65,150[2]	950	3,780	4.8	2,631.3	2,631.3	2,631.4	0.1
W	68,101[2]	960	4,074	4.4	2,641.7	2,641.7	2,641.9	0.2
X	70,631[2]	1,000	3,681	4.9	2,650.5	2,650.5	2,651.4	0.9

[1]Feet above Limit of Detailed Study located 6,200 feet downstream of the Vista Road Bridge

[2]Feet above Limit of Detailed Study*

*The Limit of Detailed Study is located 2,261 feet downstream of Vista Road

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

MOJAVE RIVER (BELOW VICTORVILLE)

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
Mojave River (Upper Narrows)								
A	860	198	2,938	10.6	2,731.2	2,731.2	2,731.6	0.4
B	1,120	834	12,660	2.5	2,732.6	2,732.6	2,733.6	1.0
C	2,992	2,225	14,062	2.2	2,733.1	2,733.1	2,734.1	1.0
D	4,475	1,348	7,775	4.0	2,734.9	2,734.9	2,735.8	0.9
E	5,442	1,761	8,496	3.7	2,737.7	2,737.7	2,738.6	0.9
F	6,873	1,917	6,745	4.6	2,742.7	2,742.7	2,743.3	0.6
G	7,943	1,425	6,834	4.5	2,746.4	2,746.4	2,747.4	1.0
H	9,122	1,384	6,973	4.5	2,752.3	2,752.3	2,752.6	0.3
I	9,933	1,549	7,617	4.1	2,753.8	2,753.8	2,754.4	0.6
J	11,124	1,400	6,587	4.7	2,759.0	2,759.0	2,760.0	1.0
K	12,684	990	5,880	5.3	2,764.7	2,764.7	2,765.7	1.0
L	13,630	738	4,676	6.6	2,768.1	2,768.1	2,769.0	0.9

[1]Feet above upstream limit of State Highway 18

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

MOJAVE RIVER (UPPER NARROWS)

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
North Fork Lytle Creek								
A	1,373	280	1,896	9.6	3,019.1	3,019.1	3,020.1	1.0
B	2,392	200	1,371	11.9	3,052.4	3,052.4	3,053.4	1.0
C	3,374	160	1,214	12.9	3,085.1	3,085.1	3,086.1	1.0
D	4,382	200	1,686	9.6	3,131.0	3,131.0	3,132.0	1.0
E	5,222	250	1,591	9.7	3,160.6	3,160.6	3,161.6	1.0
F	6,336	100	815	15.0	3,211.8	3,211.8	3,212.8	1.0
G	7,339	270	1,781	9.2	3,261.3	3,261.3	3,262.3	1.0
H	8,342	110	1,064	14.2	3,311.8	3,311.8	3,312.8	1.0
I	9,309	150	1,300	11.7	3,364.6	3,364.6	3,365.6	1.0
J	10,454	60	711	16.9	3,429.3	3,429.3	3,430.3	1.0
K	11,299	100	863	13.9	3,472.2	3,472.2	3,473.2	1.0

[1]Feet above confluence with Middle Fork Lytle Creek

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

NORTH FORK LYTLE 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
Pinyon Creek								
A	211[1]	40	138	6.9	3,326.4	3,326.4	3,327.4	1.0
B	686[1]	30	103	9.2	3,349.9	3,349.9	3,350.9	1.0
C	1,214[1]	50	157	6.1	3,377.4	3,377.4	3,378.4	1.0
D	1,901[1]	40	137	6.9	3,429.2	3,429.2	3,430.2	1.0
E	2,798[1]	40	126	5.1	3,492.7	3,492.7	3,493.7	1.0
F	3,485[1]	40	92	3.8	3,540.1	3,540.1	3,541.1	1.0
Quail Wash								
A	1,055[2]	939	2,205	8.2	2,664.6	2,664.6	2,665.3	0.7
B	4,165[2]	810	2,864	6.3	2,742.8	2,742.8	2,743.4	0.6
C	7,205[2]	121	1,130	15.9	2,825.3	2,825.3	2,826.2	0.9

[1]Feet above Limit of Detailed Study*
*The Limit of Detailed Study is located 740 feet downstream of Camino Del Cielo
[2]Feet above confluence with Joshua Tree Creek

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

PINYON CREEK - QUAIL 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
San Sevaine Channel[1]								

[1]Base flood is contained in channel and floodway regulation is removed due to restudy of channelization of Etiwanda and San Sevaine channel

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SAN SEVAINE CHANNEL

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
Santa Ana River								
A	290,200	1,260	14,849	11.0	865.3	865.3	866.2	0.9
B	292,185	975	12,278	12.2	872.4	872.4	873.3	0.9
C	294,090	910	7,985	17.5	877.2	877.2	877.2	0.0
D	294,740	880	10,508	13.3	881.9	881.9	881.9	0.0
E	295,960	1,370	15,816	10.6	891.5	891.5	892.5	1.0
F	296,910	980	11,831	11.8	894.3	894.3	895.0	0.7
G	298,230	1,010	11,574	12.1	901.4	901.4	901.4	0.0
H	299,555	490	8,149	17.2	907.8	907.8	907.9	0.1
I	300,295	825	12,089	11.6	913.1	913.1	913.8	0.7
J	300,890	1,085	20,375	8.3	922.2	922.2	922.5	0.3
K	301,980	1,093	19,973	7.2	923.5	923.5	923.7	0.2
L	303,320	1,290	19,415	8.1	925.3	925.3	925.9	0.6
M	305,605	998	12,578	11.1	929.1	929.1	930.1	1.0
N	307,168	882	9,456	14.8	936.9	936.9	937.2	0.3
O	308,820	790	9,288	15.1	944.7	944.7	944.7	0.0
P	310,226	700	8,255	8.5	951.3	951.3	951.6	0.3
Q	312,034	481	5,707	12.3	952.9	952.9	953.8	0.9
R	313,417	534	6,457	10.8	972.0	972.0	972.0	0.0
S	315,172	565	6,036	11.6	979.8	979.8	979.8	0.0
T	316,292	649	7,777	9.0	983.7	983.7	984.2	0.5
U	318,294	849	5,307	9.8	990.6	990.6	990.6	0.0
V	320,277	649	5,127	7.1	1,001.0	1,001.0	1,001.9	0.9
W	321,547	506	3,228	11.3	1,009.3	1,009.3	1,009.3	0.0
X	322,835	518	5,597	5.9	1,021.2	1,021.2	1,021.2	0.0
Y	323,903	505	3,606	9.2	1,023.3	1,023.3	1,023.3	0.0
Z	325,315	630	3,968	8.3	1,031.7	1,031.7	1,031.7	0.0

[1]Feet above Pacific Ocean

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SANTA ANA 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
Santa Ana River (continued)								
AA	327,405	645	4,115	8.0	1,044.5	1,044.5	1,044.5	0.0
AB	328,148	594	3,488	9.5	1,049.9	1,049.9	1,049.9	0.0
AC	328,975	613	3,373	9.8	1,055.0	1,055.0	1,055.0	0.0
AD	329,984	609	3,354	9.8	1,061.6	1,061.6	1,061.6	0.0
AE	332,061	571	3,137	10.5	1,075.9	1,075.9	1,075.9	0.0
AF	333,034	686	3,620	9.1	1,082.9	1,082.9	1,082.9	0.0
AG	334,089	774	3,738	8.8	1,089.5	1,089.5	1,089.8	0.3
AH	335,464	967	4,413	7.5	1,097.8	1,097.8	1,098.3	0.5
AI	336,474	1,202	3,989	8.3	1,106.8	1,106.8	1,106.8	0.0
AJ	338,130	1,080	3,927	8.4	1,118.4	1,118.4	1,118.4	0.0
AK	339,980	1,310	3,782	8.7	1,135.6	1,135.6	1,135.6	0.0
AL	341,360	1,940	4,110	8.0	1,148.4	1,148.4	1,148.4	0.0
AM	342,380	2,180	3,042	9.2	1,158.4	1,158.4	1,158.6	0.2
AN	344,185	1,530	2,727	14.8	1,182.8	1,182.8	1,183.6	0.8
AO	346,175	775	2,723	10.3	1,198.9	1,198.9	1,198.9	0.0
AP	347,495	800	2,768	10.1	1,216.0	1,216.0	1,216.0	0.0
AQ	348,735	1,015	5,660	5.0	1,235.6	1,235.6	1,235.6	0.0
AR	350,115	1,025	5,081	5.5	1,253.4	1,253.4	1,253.4	0.0
AS	351,125	800	3,728	9.3	1,271.6	1,271.6	1,272.7	1.0
AT	352,825	350	4,235	6.6	1,298.7	1,298.7	1,298.8	0.1
AU	354,495	680	3,672	7.6	1,318.9	1,318.9	1,318.9	0.0
AV	355,635	1,850	2,899	9.7	1,338.7	1,338.7	1,338.9	0.2
AW	357,175	2,060	4,555	6.2	1,369.4	1,369.4	1,369.5	0.1
AX	358,465	2,250	5,151	5.1	1,394.7	1,394.7	1,394.7	0.0
AY	359,655	1,900	3,486	7.2	1,417.2	1,417.2	1,417.9	0.7
AZ	361,255	2,170	3,529	7.1	1,454.1	1,454.1	1,454.1	0.0

[1]Feet above Pacific Ocean

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SANTA ANA 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
Santa Ana River (continued)								
BA	363,475	2,680	5,538	3.8	1,499.3	1,499.3	1,499.3	0.0
BB	365,375	2,760	5,601	5.6	1,539.5	1,539.5	1,539.7	0.2
BC	367,405	1,660	3,824	7.3	1,582.9	1,582.9	1,582.9	0.0
BD	369,305	1,570	2,414	10.4	1,629.7	1,629.7	1,630.3	0.6
BE	370,885	2,150	3,031	8.3	1,670.6	1,670.6	1,670.7	0.1
BF	372,685	1,730	900	6.1	1,724.4	1,724.4	1,724.7	0.3
BG	374,195	1,050	1,898	1.2	1,777.6	1,777.6	1,777.7	0.1
BH	375,585	780	892	7.3	1,815.4	1,815.4	1,815.4	0.0
BI	376,655	1,500	912	6.0	1,845.6	1,845.6	1,845.6	0.0
BJ	377,975	330	974	5.7	1,878.8	1,878.8	1,878.8	0.0
BK	379,380	260	675	8.1	1,921.8	1,921.8	1,921.8	0.0
BL	380,225	500	996	5.5	1,945.0	1,945.0	1,945.0	0.0
BM	382,543	260	883	6.2	2,012.2	2,012.2	2,012.2	0.0

[1]Feet above Pacific Ocean

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SANTA ANA 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
San Timoteo Creek								
A	41,130[1]	255	1,489	13.7	1,483.0	1,483.0	1,483.0	0.0
Soapmine Creek								
A	0 [2]	70	263	7.6	2,088.1	2,088.1	2,089.1	1.0
B	634 [2]	90	242	8.3	2,097.1	2,097.1	2,098.1	1.0
C	1,426 [2]	60	249	8.0	2,109.4	2,109.4	2,110.4	1.0
D	2,096 [2]	70	258	7.8	2,118.1	2,118.1	2,119.1	1.0
E	2,798 [2]	60	254	7.9	2,134.5	2,134.5	2,135.5	1.0
F	3,379 [2]	60	255	7.9	2,148.3	2,148.3	2,149.3	1.0

[1]Feet above San Timoteo Canyon Road Bridge
[2]Feet above Limit of Detailed Study*
*The Limit of Detailed Study is located 504 feet downstream of Soapmine Road

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SAN TIMOTEO CREEK - SOAPMINE 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
Twentynine Palms Channel								
A	1,410[1]	395	2,099	10.2	1,736.0	1,736.0	1,737.0	1.0
B	4,850[1]	500	2,015	10.7	1,756.8	1,756.8	1,757.1	0.3
C	7,940[1]	450	2,374	9.1	1,775.9	1,775.9	1,776.4	0.5
D	11,500[1]	1,190	3,198	6.3	1,799.0	1,799.0	1,799.3	0.3
E	13,899[1]	1,940	5,984	6.5	1,824.6	1,824.6	1,825.6	1.0
F	14,892[1]	1,240	4,607	7.4	1,832.9	1,832.9	1,833.9	1.0
G	15,900[1]	1,010	3,834	8.7	1,842.6	1,842.6	1,843.6	1.0
H	17,099[1]	1,120	4,416	8.2	1,856.9	1,856.9	1,857.6	0.7
I	18,102[1]	860	3,814	8.2	1,865.4	1,865.4	1,866.4	1.0
J	18,699[1]	1,090	4,360	8.2	1,873.0	1,873.0	1,874.0	1.0
K	19,702[1]	2,020	8,293	3.2	1,884.5	1,884.5	1,885.5	1.0
Warm Creek								
A	0[2]	50	445	17.1	1,059.8	1,059.8	1,059.8	0.0
B	475[2]	50	515	14.8	1,064.1	1,064.1	1,064.1	0.0
C	1,584[2]	50	634	12.0	1,070.8	1,070.8	1,070.9	0.1
D	2,270[2]	61	833	9.1	1,074.3	1,074.3	1,074.4	0.1
E	5,966[2]	40	330	14.3	1,101.7	1,101.7	1,102.7	1.0
F	7,392[2]	200	790	6.5	1,108.9	1,108.9	1,109.9	1.0
G	7,894[2]	110	480	9.6	1,111.1	1,111.1	1,112.1	1.0
H	8,342[2]	80	510	9.2	1,114.0	1,114.0	1,115.0	1.0

[1]Feet above Limit of Detailed Study*
*The Limit of Detailed Study is located 446 feet downstream of Bullion Mountain Road
[2]Feet above confluence with East Twin Creek

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

TWENTYNINE PALMS CHANNEL - WARM 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
Waterman Canyon								
A	100	50	173	7.5	2,784.7	2,784.7	2,785.7	1.0
B	1,299	20	130	10.0	2,884.2	2,884.2	2,885.2	1.0
C	1,901	50	182	7.1	2,940.0	2,940.0	2,941.0	1.0
D	2,503	50	183	7.1	3,000.0	3,000.0	3,001.0	1.0
E	3,152	20	85	8.3	3,045.7	3,045.7	3,046.7	1.0
F	3,659	20	85	8.2	3,100.1	3,100.1	3,101.1	1.0
G	4,261	50	126	5.6	3,138.8	3,138.8	3,139.8	1.0
Wilson Creek								
A	0	80	578	13.3	2,011.2	2,011.2	2,012.2	1.0
B	1,241	1,250	7,984	0.8	2,040.4	2,040.4	2,041.4	1.0
C	2,165	980	1,724	4.5	2,048.4	2,048.4	2,049.4	1.0
D	3,062	1,180	2,825	2.7	2,063.7	2,063.7	2,064.7	1.0
E	4,224	1,570	4,996	1.4	2,087.4	2,087.4	2,088.4	1.0
F	5,312	1,450	3,245	2.2	2,106.8	2,106.8	2,107.8	1.0
G	6,415	1150	1,547	4.6	2,131.6	2,131.6	2,132.6	1.0
H	7,292	1050	1,323	5.4	2,152.4	2,152.4	2,153.4	1.0
I	8,026	740	1,120	6.4	2,173.4	2,173.4	2,174.4	1.0
J	8,807	89	519	13.7	2,196.2	2,196.2	2,196.2	0.0
K	9,636	221	699	10.2	2,223.2	2,223.2	2,223.2	0.0

[1]Feet above Limit of Detailed Study*

*The Limit of Detailed Study for Waterman Canyon is located 1,954 feet upstream of Old Waterman Canyon Road

*The Limit of Detailed Study for Wilson Creek is located 278 feet downstream of Frontage Road

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

WATERMAN CANYON - WILSON 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
Yermo Flood Channel								
A	475 [1]	270	808	8.1	1,912.2	1,912.2	1,913.2	1.0
B	1,346 [1]	1,470	4,783	1.5	1,919.3	1,919.3	1,920.3	1.0
C	2,693 [1]	150	736	8.0	1,920.5	1,920.5	1,921.5	1.0
D	3,854 [1]	160	825	7.2	1,929.3	1,929.3	1,930.3	1.0
E	4,594 [1]	160	816	7.2	1,930.8	1,930.8	1,931.8	1.0
F	5,966 [1]	170	1,690	3.5	1,937.5	1,937.5	1,938.5	1.0
G	7,339 [1]	440	2,495	2.8	1,937.5	1,937.5	1,938.5	1.0
H	9,398 [1]	180	1,188	5.0	1,940.3	1,940.3	1,941.3	1.0
I	10,613 [1]	160	872	6.8	1,941.5	1,941.5	1,942.5	1.0

[1]Feet above Limit of Detailed Study*

*The Limit of Detailed Study is located 1,015 feet downstream of Union Pacific Railroad

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

YERMO FLOOD CHANNEL

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
Yucaipa Creek								
A	132	300	585	2.5	2,106.0	2,106.0	2,107.0	1.0
B	818	200	1,252	1.2	2,127.8	2,127.8	2,128.8	1.0
C	1,030	170	559	2.6	2,129.8	2,129.8	2,130.8	1.0
D	2,983	240	583	2.5	2,186.1	2,186.1	2,187.1	1.0
E	3,353	80	167	8.7	2,198.4	2,198.4	2,199.4	1.0
F	4,609	60	179	8.1	2,245.5	2,245.5	2,246.5	1.0
G	6,088	60	184	5.7	2,293.4	2,293.4	2,294.4	1.0
H	7,260	70	219	4.9	2,325.4	2,325.4	2,326.4	1.0
I	7,973	80	244	4.4	2,347.5	2,347.5	2,348.5	1.0
J	8,781	60	134	8.0	2,366.9	2,366.9	2,367.9	1.0
K	9,636	100	237	4.5	2,391.6	2,391.6	2,392.6	1.0
L	10,164	50	162	6.6	2,405.7	2,405.7	2,406.7	1.0
M	10,850	70	194	5.5	2,427.2	2,427.2	2,428.2	1.0
N	11,553	30	112	6.3	2,445.6	2,445.6	2,446.6	1.0
O	12,540	30	100	7.0	2,466.9	2,466.9	2,467.9	1.0
P	13,015	50	138	5.1	2,484.6	2,484.6	2,485.6	1.0
Q	13,860	40	115	6.1	2,506.6	2,506.6	2,507.6	1.0
R	15,286	30	108	6.5	2,547.9	2,547.9	2,548.9	1.0
S	15,708	40	114	6.2	2,563.9	2,563.9	2,564.9	1.0
T	16,495	30	108	6.5	2,588.0	2,588.0	2,589.0	1.0

[1]Feet above confluence with Wildwood Channel

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

YUCAIPA 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
Yucca Creek at Joshua Tree								
A	910 [1]	2,050	4,003	7.5	2,531.3	2,531.3	2,532.3	1.0
B	4,190 [1]	1,480	4,173	7.2	2,571.8	2,571.8	2,572.4	0.6
C	9,250 [1]	374	1,422	10.5	2,657.1	2,657.1	2,657.6	0.5
D	13,270 [1]	354	1,196	10.5	2,726.5	2,726.5	2,727.0	0.5
E	18,480 [1]	523	1,365	9.2	2,820.7	2,820.7	2,821.4	0.7
F	23,630 [1]	691	1,415	8.5	2,912.1	2,912.1	2,912.2	0.1
G	29,180 [1]	577	1,212	8.3	3,016.6	3,016.6	3,016.9	0.3
H	32,700 [1]	395	1,167	8.6	3,084.5	3,084.5	3,085.3	0.8
I	34,930 [1]	166	913	11.0	3,124.5	3,124.5	3,125.1	0.6
J	38,390 [1]	125	767	12.5	3,170.0	3,170.0	3,170.4	0.4
K	41,520 [1]	125	817	11.7	3,194.5	3,194.5	3,195.0	0.5

[1]Feet above Sunever Road (at Joshua Tree)

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

YUCCA CREEK (AT JOSHUA TREE)

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
Yucca Creek at Yucca Valley								
A	0 [1]	160	1,052	9.0	3,197.3	3,197.3	3,198.3	1.0
B	1,003 [1]	160	975	9.7	3,200.8	3,200.8	3,201.8	1.0
C	3,490 [1]	170	872	8.8	3,213.8	3,213.8	3,214.8	1.0
D	4,282 [1]	80	624	13.0	3,221.8	3,221.8	3,222.8	1.0
E	5,280 [1]	330	1,759	6.8	3,226.3	3,226.3	3,227.3	1.0
F	6,801 [1]	70	570	12.6	3,238.8	3,238.8	3,239.8	1.0
G	8,300 [1]	90	613	11.8	3,248.5	3,248.5	3,249.5	1.0
H	9,979 [1]	270	1,027	5.6	3,260.8	3,260.8	3,261.8	1.0
I	11,722 [1]	220	690	7.5	3,276.2	3,276.2	3,277.2	1.0
J	13,221 [1]	60	148	5.5	3,286.1	3,286.1	3,287.1	1.0
K	14,488 [1]	50	148	5.5	3,301.3	3,301.3	3,302.3	1.0
The Zanja								
A	53 [2]	40	219	13.3	1,620.7	1,620.7	1,620.7	0.0
B	1,072 [2]	90	265	9.9	1,643.9	1,643.9	1,644.9	1.0
C	2,022 [2]	160	319	5.6	1,663.8	1,663.8	1,664.8	1.0
D	3,432 [2]	110	359	5.0	1,693.3	1,693.3	1,694.3	1.0
E	4,303 [2]	120	373	4.8	1,715.4	1,715.4	1,716.4	1.0
F	5,829 [2]	230	826	3.2	1,754.0	1,754.0	1,755.0	1.0
G	6,859 [2]	320	758	1.7	1,785.1	1,785.1	1,786.1	1.0
H	7,873 [2]	300	630	2.1	1,817.9	1,817.9	1,818.9	1.0
I	8,712 [2]	300	738	1.8	1,842.2	1,842.2	1,843.2	1.0
J	9,641 [2]	110	272	3.7	1,868.3	1,868.3	1,869.3	1.0

[1]Feet above Paxton Road (at Yucca Valley)
[2]Feet above Wabash Avenue

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

YUCCA CREEK (AT YUCCA VALLEY) - THE ZANJA

The Santa Ana River floodway was initially developed using equal conveyance reduction. This resulted in a floodway fringe area at the base of the steep slopes of the southern banks. It was decided that it would be an impractical application of floodplain management to leave areas of defined floodway fringe below the steep slopes. It would have created problems of access, of narrowness of the developable strip, and of potentially hazardous bank velocities. Consequently, the floodway presented here uses the southern 1-percent annual chance flood boundary as the southern boundary for the floodway for a major reach of the river. The exceptions to this generalization are where major improvements have been built that would be the basis for future improvements that would contain the 1-percent annual chance flood. Examples of this situation are: 1) the SBCFCD levee at the refuse disposal site, and 2) the earth levee from La Cadena Drive upstream to the new USACE improvements that begin at the Union Pacific Railroad Bridge. This process of establishing a southern boundary of the floodway entails letting the northern boundary be established by encroachment until either the water-surface elevation increase has been reached or the velocities become excessive so that no further encroachment would be advisable.

The floodway for Highgrove Channel was developed by equal conveyance reduction utilizing the HEC-2 computer program for the entire study reach. For Colton Southwest Storm Drain, a floodway is shown from its confluence with the Santa Ana River to just above Fogg Street. This floodway was based on equal conveyance reduction. No floodway data were developed for this flooding source. The entire floodway is located within the floodway fringe area of the Santa Ana River. All elevation requirements in this area will be related to those associated with the Santa Ana River. The boundaries are shown to indicate the corridor necessary to pass the 1-percent annual chance flood without a substantial increase in flood heights (1 foot or less). Above Fogg Street, most of the flooding consists of sheetflow and shallow ponding. In both situations it is impossible and inappropriate to designate a floodway based on FEMA criteria. The concept of a floodway does not apply to Warm Creek, Reche Canyon Creek, or San Timoteo Wash. If Reche Canyon Creek flows were totally conveyed to the channel downstream of Barton Road, then the existing channel limits would become the floodway for Reche Canyon Creek. With the present shallow flooding conditions, there are no applicable floodways for Reche Canyon Creek. Downstream of the canyon mouth, the flooding is on an alluvial fan resulting in indeterminate flow paths and shallow flooding boundaries. The delineation of a floodway in this type of area is not appropriate. The backwater flooding outside of Warm Creek is zoned AH as a ponded floodplain with no floodway application. The San Timoteo Wash flow, in this study reach, causes sheet flooding with no defined channel and several breakouts.

A floodway is not shown downstream of Cross Section A on 11th Street Storm Drain because it is within the 1-percent annual chance floodplain of the Santa Aria River.

The USACE HEC-2 program was used in establishing floodway boundaries for San Timoteo Creek within the City of Loma Linda corporate limits. A floodway analysis based on equal conveyance reduction from each creek bank was unsuccessful because of the hydraulic complexities associated with supercritical flows. The floodway upstream of Cross Section A, therefore, was delineated by trial-and-error adjustments of conveyance. From downstream of Cross Section A to the downstream corporate limits, no floodway could be defined that would meet the criteria of increasing the water-surface elevations by no more than 1 foot. Consequently, no floodway is shown downstream of Cross Section A, and it must be recognized that any encroachment into the floodplain in this reach is hazardous and can increase hazards to sites upstream of Cross Section A.

For all flooding sources in the City of Needles other than the Colorado River, delineation of a floodway is either inappropriate or impossible. Three distinct types of situations that preclude the necessity of development of a floodway exist in the City of Needles. These are well-incised natural channels containing the 1-percent annual chance discharge, improved channels containing the 1-percent annual chance frequency flood, and uncontrolled sheet flooding on the alluvial plain upon which the city is located.

With respect to the first case, the well-incised natural channels in the City of Needles have sufficient definition and are narrow enough so as to naturally preclude development within their banks. Thus, delineation of a floodway would serve no additional practical purpose for floodplain management or land use controls and is, therefore, inappropriate. This situation occurs in segments of Eagle Pass Wash, Lillyhill Wash, SBCFCD Channel A, Wash A, and Wash B.

The same reasoning applies to the case of improved channels. These are reserved as flood control rights-of-way with no development allowed within their limits. Thus, no additional restriction in the form of a floodway is needed. This case can be seen in reaches of Eagle Pass Wash, the Needles Flood Channel, and Wash B.

In the case of shallow flooding on an alluvial plain, flow paths are highly unpredictable, and subject to sudden changes in direction. Because this type of flooding is overland without a stable and consistent flow path to serve as a point of orientation around which to establish land use controls, and because depths of flow are highly variable and unpredictable, delineation of a floodway meeting FIA criteria is impossible. This case is indicated by reaches of Buzzard, Coyote, Eagle Pass, Fox, Lemming, Lillyhill, and Road Runner Washes, and by the upper reach of Wash B.

Due to the nature of flooding in the City of Ontario, delineation of floodways meeting FEMA criteria is impossible. All flooding generated in the city is in the nature of shallow flooding on an alluvial plain. Flow paths and overflow depths generated by such flooding are highly unpredictable and subject to substantial variation across the flooded area. Where 1-percent annual chance flooding is contained in a channel, a floodway is inappropriate.

No floodway was determined for Cucamonga, Demens, Deer, or Hillside Creeks because 1-percent annual chance flooding is contained within the channel banks. No floodway was developed for portions of the Mojave River through the City of Victorville.

A floodway is not applicable for Day Creek because the major flood hazard along this stream is due to sheetflow that would not be limited by establishing a floodway meeting FEMA criteria.

A floodway was not delineated for The Zanja and Morey Wash because only shallow flooding is delineated. Due to the flat terrain in the overbanks, obstructing the flow, as would occur in a floodway fringe area, could cause flows to be diverted away from the channel or floodway. Thus, delineating a floodway fringe area and allowing unconstrained development there may result in flows being diverted to otherwise unaffected areas instead of toward the floodway as would occur in a riverine area. Therefore, the concept of a floodway was not considered appropriate for The Zanja and Morey Wash.

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 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 San Bernardino 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 12, "Community Map History."

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within San Bernardino 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 San Bernardino County.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Adelanto, City of	November 7, 1978	None	April 15, 1980	None
Apple Valley, Town of	March 18, 1996	None	March 18, 1996	None
Barstow, City of	January 17, 1975	None	February 1, 1980	March 16, 1995
Big Bear Lake, City of	September 29, 1978	None	September 29, 1978	June 23, 1981 July 2, 1991
Chino, City of	March 18, 1996	None	March 18, 1996	None
Chino Hills, City of	March 18, 1996	None	March 18, 1996	None
Colorado River Indian Reservation	May 4, 1987	None	May 4, 1987	None
Colton, City of	September 17, 1980	None	September 17, 1980	January 6, 1988
Fontana, City of	June 21, 1974	None	June 4, 1987	May 3, 1993
Fort Mohave Indian Reservation	March 18, 1996	None	March 18, 1996	None

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Grand Terrace, City of	March 18, 1996	None	March 18, 1996	None
Hesperia, City of	September 29, 1989	None	September 29, 1989	None
Highland, City of	September 29, 1989	None	September 29, 1989	September 30, 1993
Loma Linda, City of	March 2, 1973	December 26, 1975	July 16, 1987	None
Montclair, City of	March 18, 1996	None	March 18, 1996	None
Needles, City of	June 14, 1974	December 31, 1976	July 16, 1979	None
Ontario, City of	August 9, 1974	November 12, 1976	December 2, 1980	August 15, 1983 June 19, 1985
Rancho Cucamonga, City of	September 5, 1984	None	September 5, 1984	None
Redlands, City of	May 17, 1974	November 21, 1975	January 3, 1979	December 21, 1982

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Rialto, City of	March 18, 1996	None	March 18, 1996	None
San Bernardino, City of	June 28, 1974	None	July 16, 1979	February 2, 1994
San Bernardino County	September 29, 1978	None	September 29, 1978	June 23, 1981 January 18, 1983 September 28, 1990 February 2, 1994 June 2, 1995
Twentynine Palms, City of	September 29, 1978	None	September 29, 1978	April 17, 1995
Upland, City of	June 28, 1974	None	March 18, 1996	None
Victorville, City of	September 21, 1973	None	September 21, 1973	May 1, 1974 August 5, 1977
Yucaipa, City of	March 18, 1996	None	March 18, 1996	None
Yucca Valley, Town of	March 18, 1996	None	March 18, 1996	None

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

SAN BERNARDINO COUNTY, CA AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

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.

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10.0 REVISION DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To ensure that the user is aware of all revisions, it is advisable to contact the county repository of flood hazard data located at the Land Development Section, 385 North Arrowhead Avenue, San Bernardino, California 92415, or the individual community repositories as listed on the Flood Insurance Rate Map Index.

10.1 First Revision

This study was revised in 1989 to incorporate newly studied areas in the unincorporated areas of San Bernardino County, California.

The hydrologic and hydraulic analyses for this 1989 revision were performed by P&D Technologies for FEMA, under Contract No. EMW-83- C-1198. This study was completed in January 1985.

Study areas requiring different levels of study were identified at a meeting attended by representatives of the study contractor; FEMA; the USACE, Los Angeles District; and the SBCFCD. Other meetings were held with these same representatives throughout the course of the study for the purpose of data collection, and to relay and review data regarding flood elevations, flood boundaries, and floodway delineations.

The results of the study were reviewed at the final coordination meeting held on January 18, 1990, attended by a representative of FEMA, the study contractor, and the community. All corrections necessary as a result of the meeting have been incorporated in the study.

Watercourses contracted to be studied in detail for the 1989 revision (with floodway) are as follows: Carbon Canyon Creek from Chino Creek to 700 feet upstream of English Road, Joshua Tree Creek from Yucca Creek to Sunburst Avenue, Little Chino Creek from Carbon Canyon Creek to 1.1 miles upstream of the confluence, Lytle Creek and South Fork Lytle Creek from Lytle Creek to 1.0 mile upstream of the confluence, Middle Fork Lytle Creek from Lytle Creek to 0.8 mile upstream of the confluence, Quail Wash from Yucca Creek to Sunburst Avenue, San Timoteo Creek from California Street to corporate boundary, and Yucca Creek from Sunever Road to Paxton Road.

Watercourses studied by approximate methods for the 1989 revision are as follows: Little Chino Creek from 1.1 miles upstream of Carbon Canyon Creek to 1.5 miles upstream of Carbon Canyon Creek, Wilson Creek from Jefferson Street to 2.1 miles upstream, Oak Glen Creek from Jefferson Street to 2.2 miles upstream, Wildwood Creek from Jefferson Street to 1.8 miles upstream, Mojave River from Camp Cody to 9.6 miles upstream, Covington Creek from Twentynine Palms Highway to 0.9 mile upstream, Cemetery Creek from Twentynine Palms Highway to 0.7 mile upstream, Coyote Creek Wash from Sunever Road to Coyote Lake, and Wounder Valley Wash from Twentynine Palms Channel to Dale Lake.

Peak discharge-drainage area relationships for each stream in the 1989 revision study are presented in Table 7. Stream gage data for the areas investigated are extremely limited, especially for those streams located in the South Lahontan-Colorado Desert region. As a result, peak discharges identified in Table 7 were calculated based upon the guidelines established in the USGS Publication 77-21, Magnitude and Frequency of Floods in California (U.S. Department of the Interior, 1977).

Historical recorded peak flows for available stream gage data including San Timoteo Creek, Wilson Creek, and Carbon Canyon Creek are shown in Table 5. Where available, hydrologic analyses from the USACE and previous FISs were utilized for watercourses in this investigation.

Water-surface elevations for floods of the selected recurrence intervals were computed through the use of the USACE HEC-2 step backwater computer program (USACE, 1982).

Cross sections for the great majority of the hydraulic analyses were taken from 1:2,400 scale topographic maps with a 4-foot contour interval (San Bernardino County Flood Control District, undated). The majority of the topographic maps were prepared by photogrammetry through recent aerial and ground surveys (Pictorial Sciences, Inc., 1984). Some of the maps were furnished by the SBCFCD. Where there have been substantial cross-sectional changes due to developments that are not reflected on the existing topographic mapping, field cross sections and improvement plans supplied by the City of San Bernardino and the SBCFCD were used in the analysis.

Subcritical runs for Carbon Canyon Creek were conducted to provide backwater effects of bridges and overbank flows. The computer model began at its confluence with Little Chino Creek. The starting water-surface elevations were estimated from normal depth computation. Carbon Canyon Creek enters an underground 3-foot-diameter culvert west of Peyton Drive and north of Eucalyptus Avenue that limits flow. The capacity of the culvert is less than 50 cfs and, during a storm, the culvert is likely to be plugged by debris.

Consequently, overbank flooding occurs in this region on the order of 810 cfs for the 1-percent annual chance flood. Overbank flooding also occurs west of Pipeline Avenue. The flow in the creek crosses Pipeline Avenue via a four-pipe, corrugated metal pipe culvert; however, it has insufficient capacity. As a result, 685 cfs is diverted to the overbanks during the 1-percent annual chance flood. This flow ultimately is conveyed back to the channel. Downstream of Pipeline Avenue, the existing channel cannot convey the 0.2-percent annual chance flood, and approximately 2,100 cfs is permanently diverted away from the channel.

The computer analysis of Joshua Tree Creek began upstream of its confluence with Yucca Creek, with starting water-surface elevations estimated from normal depth computation. The 1-percent annual chance runoff is generally contained within the channel banks and any overbank flooding is contained within the canyon walls. Water depths range from 3 to 5 feet and velocities average around 8 feet per second (fps).

Subcritical runs for Little Chino Creek were conducted to provide backwater effects of bridges and overbank flows. The computer program began at its confluence with Chino Creek. The starting water-surface elevations were estimated from normal depth computations. The 1-percent annual chance flood is contained within the channel with the exception of the area upstream of Feldspan Avenue. Approximately 200 cfs is diverted to the right overbank, and ultimately rejoins the main channel flow.

Subcritical runs for Lytle Creek were conducted to provide backwater effects of bridges and overbank flows. The computer program began downstream of the confluence of Middle Fork and South Fork Lytle Creeks with starting water-surface elevations estimated from normal depth computation. Because these streams are located in a steep mountainous area, channel velocities for the 1-percent annual chance flood typically average 12 fps or greater. Consequently, the stream path can meander from season to season. The channel and overbanks consist of large rocks and boulders and a Manning's "n" value of 0.045 was used in the analysis. Although overbank flooding occurs in this region, the flow is contained by the canyon walls. Flood elevations agree with previous studies for North Fork Lytle Creek and Lytle Creek.

Quail Wash is a tributary of Joshua Tree Creek. Subcritical runs were conducted to determine the capacity of the channel and backwater effects, and it was determined that the capacity of the channel cannot convey the 1-percent annual chance flow and flooding of the overbanks occurs along the entire reach under detailed study. Water depths range from 8 to 12 feet and channel velocities vary from 4 to 15 fps.

A series of subcritical runs for San Timoteo Creek were conducted to provide backwater effects of bridges and overbank flows and to determine the capacity of the channel. The computer program began just upstream of the San Bernardino/Riverside County line, with starting water-surface elevations estimated from normal depth computations. The capacity of the creek is approximately 12,000 cfs before considerable flooding of the overbanks occurs. The 1-percent annual chance flow of 20,000 cfs is contained within the channel at Allesandro Bridge Crossing. However, at San Timoteo Canyon Road Bridge, the capacity of the channel is limited to 16,000 cfs and an overflow of approximately 4,000 cfs will flood the right overbank. Because of the low channel capacity at Beaumont Street (6,000 cfs), approximately 14,000 cfs is diverted east of the channel way over the right overbank. Because of the generally mountainous nature of the area, channel velocities for the 1-percent annual chance flood typically average 10 to 12 fps or greater. The channel consists of some large rocks and weeds. A Manning's "n" value of 0.03 was used for the stream, and a value of 0.04 used for the overbanks in the analysis.

The HEC-2 program was utilized to determine the capacity of the channel and backwater effects of Yucca Creek from Sunever Road to Paxton Road, including its two tributaries, Joshua Tree Creek and Quail Wash. The channel runs at an average capacity of 8,000 to 10,000 cfs with shallow flooding occurring between La Contenta Road and Sunburst Avenue, along the less elevated overbanks. Increased flooding of the overbanks begins approximately 3,500 feet upstream of the channel's confluence with Joshua Tree Creek, increasing in width until reaching the end of detailed study area at Sunever Road Channel velocities for the 1-percent annual chance flood typically fall into the 9 to 12 fps range. A Manning's "n" value of 0.025 was used for the channel, and a value of 0.050 used for the overbanks.

The floodways presented in this 1989 update were developed through a series of procedural steps that included: 1) evaluation of equal conveyance reduction from each side of the floodplain; 2) review of existing hydraulic data; and 3) consideration of the topography and channel right-of-way. The results of these computations were tabulated at selected cross sections for each stream reach for which a floodway was computed (Table 7).

10.2 Second Revision

This study for the City of Highland was revised on September 30, 1993, to modify the floodway, BFEs, and floodplain delineations for City Creek and Sand Creek, and to revise the floodplain delineations for Plunge Creek. All research and analyses for this revision were performed by BSI Consultants, Inc. (BSI), of Santa Ana, California, for FEMA, under Contract No. ENW-90-C-3109. On August 17, 1989, an initial CCO meeting was held with representatives of FEMA, San Bernardino County, the City of San Bernardino, and the study contractor. At this meeting, the limits of the various streams and the level of detail were designated.

An intermediate CCO meeting was held on October 31, 1991, to present preliminary results for City Creek and Sand Creek to the affected communities. This meeting was attended by representatives of FEMA, the Cities of San Bernardino and Highland, San Bernardino County, and the study contractor. In addition, an intermediate CCO meeting was held on August 17, 1992, to discuss data regarding the floodplain boundaries of Plunge Creek. The meeting was attended by representatives of FEMA, the City of Highland, San Bernardino County, and the study contractor.

On October 14, 1992, the results of this restudy were reviewed at a final CCO meeting attended by representatives of the City of Highland, FEMA, and the study contractor.

City Creek has been diverted from its historical channel at the percolation basin near Third Street and Church Avenue. The diverted flows are directed south approximately 4,000 feet to the Santa Ana River. Improvements made to the City Creek Channel include crib walls, riprap, and concrete lining in various places. Improvements to Sand Creek include crib walls and a percolation basin between Highland Avenue and Date Street.

The restudy for Plunge Creek extends from gaging station number 11055500 to approximately 2,500 feet downstream of Greenspot Road, in the City of Highland.

The USACE HEC-1 computer program (USACE, 1989) was used to determine the 1-percent annual chance discharges for City Creek and Sand Creek. The point rainfall used in the HEC-1 program for the 1-percent annual chance return frequency was extracted from the SBCHM (San Bernardino County Flood Control District, 1986). The unit hydrographs were calculated using LAPRE-i which converts S-Graphs into unit hydrograph ordinates, and the Muskingum Channel routing method was used to route the hydrographs through the various channel reaches.

Peak discharge-drainage area relationships for City Creek and Sand Creek are shown in Table 7. The Frequency-Discharge, Drainage Area Curves for City Creek have been eliminated due to the restudy. The USACE HEC-2 step-backwater computer program (USACE, 1982) was used to compute the water-surface elevations. Cross-sectional data for City Creek and Sand Creek were determined by a field survey and supplemented with information taken from the

SBCFCD 4-foot contour maps, scale 1:2,400 (San Bernardino County Flood Control District, undated). All bridges and culverts were surveyed to obtain elevation data and structural geometry.

The channel and overbank roughness factors (Manning's "n") used in the hydraulic computations ranged from 0.015 to 0.025 for the City Creek channel and was 0.038 for Sand Creek. The starting water-surface elevations were based on critical depth. The analysis of the hydraulic characteristics of Plunge Creek were studied by approximate methods.

During the field inspection of City Creek, it was noted that it is not leveed as shown on the previous Flood Insurance Rate Map (FEMA, 1993). The reach between 3rd and 5th Streets has been excavated below the existing datum. For the upper reach that was restudied, above 5th Street, there are access roads on either side of the channel that are elevated about 1 foot above the datum.

The 1-percent annual chance floodplain boundaries for Plunge Creek were delineated using USGS topographic maps at a scale of 1:24,000, with a contour interval of 20 feet (U.S. Department of the Interior, 1971, et cetera) and the San Bernardino County topographic maps at a scale of 1:2,400, with a contour interval of 2 feet (San Bernardino County Flood Control District, undated).

The floodway for City Creek was computed on the basis of equal conveyance reduction from each side of the floodplain.

10.3 Third Revision

This study for the unincorporated areas of San Bernardino County was revised on February 2, 1994, to modify the floodway, BFEs, and floodplain delineations because of improvements made to City Creek and Little Sand Creek. All research and analyses for the revisions to these streams were performed by BSI for FEMA, under FEMA Contract No. EMW-90-C-3109. The hydrologic and hydraulic analyses for the restudy of the West Fontana Channel were performed by Aqua Resources, Inc., for FEMA, under Contract No. EMW-89-C-2844.

On August 17, 1989, an initial CCO meeting for City Creek and Little Sand Creek was held with representatives of FEMA, San Bernardino County, the City of San Bernardino, and the study contractor. At this meeting, the limits of the various streams and the level of detail were designated. An intermediate CCO meeting was conducted on October 31, 1991, to present preliminary results to the affected communities. This meeting was attended by representatives of FEMA, the Cities of San Bernardino and Highland, San Bernardino County, and the study contractor.

For the restudy of the West Fontana Channel, an initial meeting was held in June 1988, and was attended by representatives of FEMA, the county, and the study contractor.

On February 16, 1993, the results of this restudy were reviewed at a final CCO meeting attended by representatives of San Bernardino County, FEMA, and the study contractor.

The improvements to the streams include crib walls, riprap, and concrete lining in various places along City Creek, and crib walls and a percolation basin at Marshall Boulevard on Little Sand Creek.

The 1-percent annual chance flood discharges for the restudied streams were computed using the USACE HEC-1 computer program (USACE, 1987 and 1990), and criteria based on the SBCHN (San Bernardino County Flood Control District, 1986). Peak discharge-drainage area relationships for the restudied streams are included in Table 7.

Water-surface elevations for the 1-percent annual chance flood were computed using the USACE HEC-2 step-backwater computer program (USACE, 1982). Cross-section data for City Creek and Little Sand Creek were determined by field survey and information taken from the SBCFCD 4-foot contour, 1:2,400-scale maps (San Bernardino County Flood Control District, undated).

For the West Fontana Channel, the elevation data of the railroad embankment were based on actual survey data by the City of Fontana dated May 1989. The data of the West Fontana Channel were taken from the SBCFCD drawings dated 1975, 1978, and 1984. Cross sections of streetways were measured based on street maps provided by the City of Fontana and field checks.

Shallow flooding occurs adjacent to the West Fontana Channel and the Atchison, Topeka & Santa Fe Railway, from Juniper Avenue westward to Banana Basin and southward from the Oleander, Citrus, and Beach Street culverts.

The channel and overbank roughness factors (Manning's "n") used in the hydraulic computations ranged from 0.015 to 0.025 for City Creek, and 0.03 to 0.05 for Little Sand Creek.

The starting water-surface elevations for City Creek and Little Sand Creek were based on critical depth. The floodway for City Creek Channel was based on equal conveyance reduction from both sides of the channel. A floodway for Little Sand Creek was not computed because the 1-percent annual chance flood is conveyed inside the channel.

10.4 Fourth Revision

This study was revised on June 2, 1995, to modify the floodplain delineations for the Mojave River and Lenwood Creek and to provide flood hazard information for Sheep Creek and Horse Canyon Creek. The analyses for this study were performed by BSI for FEMA, under FEMA Contract No. EMW-90-C-3109.

On August 17, 1989, an initial CCO meeting was held with representatives of FEMA, San Bernardino County, the City of Barstow, and the study contractor. At this meeting, the project officer designated the limits of the various streams to be studied, along with the level of detail of the various communities to be included in the proposed FIS. In addition, intermediate CCO meetings were held August 1, 1991, to present preliminary results for Mojave River (at Barstow) and Lenwood Creek, and on August 17, 1992, to discuss the floodplain boundaries of the Mojave River (vicinity of Victorville), Sheep Creek, and Horse Canyon Creek.

The August 1, 1991, meeting was attended by representatives of FEMA, the City of Barstow, and the study contractor. The August 17, 1992, meeting was attended by representatives of FEMA, the City of Barstow, San Bernardino County, and the study contractor.

On March 2, 1994, the results of this restudy were reviewed at a final CCO meeting attended by representatives of San Bernardino County, FEMA, and the study contractor.

The restudy covers Sheep Creek and Horse Canyon Creek in the Phelan area between Antelope Highway and the California Aqueduct; the Mojave River between Helendale and Wild Crossing and from the eastern corporate limit of the City of Barstow to Lenwood Road; and Lenwood Creek from Atchison, Topeka & Santa Fe Railway to approximately 0.25 mile east of Main Street in the unincorporated areas of San Bernardino County. Approximate analyses were used to study the Mojave River for the reach between Helendale Road and Wild Crossing. Sheep Creek and Horse Canyon Creek were studied using the FEMA methodology for analyzing areas subject to alluvial fan flooding.

Several channel improvements have been made in the study areas, but few provide complete protection from the 1-percent annual chance flood. These protection measures are described below.

Most of the length of the Mojave River has not been improved. However, there are a number of levees, rail and wire revetments, and other bank stabilization measures along the Mojave River to protect bridges, highways, and various other facilities adjacent to the river.

The natural stream flow of the Mojave River has been modified by the construction of two dams. In 1971, the USACE completed the construction of the Forks Dam, a flood-control structure located below the confluence of Deep Creek and the west fork of the Mojave River, where the river debouches from the San Bernardino Mountains. The outlet structure consists of a tunnel at about channel level. The tunnel has a maximum capacity of approximately 25,000 cfs at the maximum reservoir capacity of 300,000 acre-feet.

Based upon the available FPI Report (USACE, 1968) for Mojave River, in the vicinity of Victorville, prepared by the USACE, dated October 1968, the proposed intermediate regional flood (1-percent annual chance peak flood) at Helendale was estimated at 23,000 cfs for 866 square miles of drainage area.

The analysis of the hydraulic characteristics of the Mojave River in the vicinity of Victorville was conducted by approximate methods.

The hydrologic analysis for Mojave River, in the vicinity of Barstow, is based on the available FPI Report prepared by the USACE, dated October 1968 (USACE, 1968). The intermediate regional floodflow (1-percent annual chance peak flood) at old U.S. Highway 66 is 18,500 cfs for a 1,290-square-mile area. The same document indicates that the intermediate regional flood for Mojave River at Lenwood Creek is 19,500 cfs for 1,233 square miles of drainage area. The 1-percent annual chance peak flows of Mojave River at Barstow have been modified to include the effects of urbanization up to the present time.

For the hydraulic analysis in the vicinity of the City of Barstow, cross-sectional data were obtained from field surveys. All bridges and culverts were surveyed to obtain elevation data and appropriate structural geometry.

The Manning's "n" values for Mojave River at Barstow ranged from 0.040 to 0.045, and the overbank "n" values ranged from 0.040 to 0.050. The "n" value for the corrugated metal pipe crossing Lenwood Road has been used as 0.021. The flow is conducted through a 16-inch by 48-inch corrugated metal pipe at Lenwood Crossing. The downstream control elevation was obtained from the previous FIS. The cross-section data beyond the limits of the field cross-section survey were interpolated from San Bernardino County's 2-foot contour topographic maps (San Bernardino County Flood Control District, undated). HEC-2 (USACE, 1982) was used to compute water-surface elevations.

Hydrologic analyses were performed for the 1-percent annual chance flood using HEC-1 (USACE, 1987 and 1990) for Lenwood Creek. The point rainfall data for the 1-percent annual chance frequency were extracted from the SBCHM. The soils group classifications for the drainage area were obtained from the soil map for the Mojave River area, Soil Survey of San Bernardino County, California, issued February 1986, by the NRCS. The curve numbers with the respective soil groups were selected from the SBCHM.

The cross-sectional data for the Lenwood Creek hydraulic analysis were obtained from the field survey performed for this study.

The Manning's "n" values for the Lenwood Creek range from 0.015 to 0.050, and the overbank "n" values ranged from 0.030 to 0.050. A hydraulic analysis was performed from the Atchison, Topeka & Santa Fe Railway crossing at the downstream end to the main street crossing (beginning of the study reach) to establish the downstream control for the study reach.

The cross-sectional data beyond the limits of field cross-section survey were interpolated from USGS topographic maps (U.S. Department of Agriculture, 1986).

The 1-percent annual chance floodplain boundaries for Mojave River below Victorville and Mojave River at Barstow and Lenwood Creek were delineated using USGS topographic maps at a scale of 1:24,000, with a contour interval of 20 feet (U.S. Department of the Interior, 1971, et cetera), and San Bernardino County topographic maps at a scale of 1:2,400, with a contour interval of 2 feet (San Bernardino County Flood Control District, undated).

The flood-frequency curves for Sheep and Horse Canyon Creeks were derived using gage data from Lone Pine Creek. Estimates of peak discharges on Lone Pine Creek were adjusted using methods described in "Magnitude and Frequency of Floods in California" (U.S. Department of the Interior, 1977). The adjusted values were fit to a log-Pearson Type III distribution by the method of least squares. Discharges for selected recurrence interval floods are presented in Table 7, "Summary of Discharges."

1-percent annual chance flood depths and velocities presented for Sheep and Horse Canyon Creeks were determined using the FEMA methodology for analyzing areas subject to alluvial fan flooding.

The areas subject to alluvial fan flooding on Sheep and Horse Canyon Creeks were delineated using information shown on topographic maps, USGS quadrangle maps, and soil classification maps (San Bernardino County Flood Control District, undated; U.S. Department of the Interior, 1971, et cetera; U.S. Department of Agriculture, 1986) and information obtained from field inspection. BSI determined that levees on either side of Sheep Creek above Antelope Highway would focus flood waters to a point where flow would pass under the highway. Therefore, the apex was taken to be a point just downstream of Antelope Highway.

It should be noted that areas subject to alluvial fan flooding where the 1-percent annual chance flood depth is, on average, less than 1 foot, are labeled Zone X. When realized, the hazards associated with alluvial fan flooding are just as severe in areas designated Zone X as those designated Zone AO. The distinction between the zones should be regarded as a distinction between flooding potential and not a distinction between the severity of damages to be expected in the event of a flood.

10.5 Fifth Revision

This study for San Bernardino County and its incorporated areas was revised on March 18, 1996, combining the FIRMs and FIS reports of the county and incorporated cities into the FEMA Countywide format.

Under the Countywide format, FIRM panels have been produced using a single layout format for the entire geographic area within the county instead of separate layout formats for each community. The single layout format facilitates the matching of adjacent panels and depicts the Flood Hazard Areas within the entire panel border, even in areas beyond a community corporate limit. In addition, under the Countywide format, this single FIS report provides all information and data for the entire county area.

Road and highway name and centerline data have been obtained from the TIGER files of the U.S. Department of Commerce, Bureau of the Census. The TIGER data are a digital street map. The TIGER horizontal positioning was adjusted to match the horizontal positioning of physical features such as roads as shown on the USGS quadrangle maps of the county area. The adjusted TIGER centerline data were then computer plotted with the digitized floodplain data to produce the countywide FIRM.

In addition to the countywide format conversion, format revisions have been made to the effective FIS report and FIRM in compliance with current FIS specifications as established by FEMA in April 1985. Flood hazard factor information has been eliminated from the profiles, maps, and report. Flood insurance zone designations have been revised and are shown in Section 5.0 and on each map panel legend.

This update also includes the addition of flood hazard data produced as a result of the “Colorado Floodway Protection Act” passed by Congress in 1986. The act was passed to establish a floodway along the Colorado River from Davis Dam to the U.S.-Mexican border. The hydrologic and hydraulic analyses were prepared by the USBR.

The hydrologic analysis was performed to determine the 1-percent annual chance peak discharges at all points along the Colorado River for the study reach. Runoff from above Hoover Dam is typically the dominant contributing factor of floodflows, although combinations of releases from Davis and Parker Dams with flash floods originating from the watersheds contributing flows into the Colorado River, are significant in determining the peak 1-percent annual chance discharges. A peak discharge of 40,000 cfs was determined to flow along the Colorado River from Davis Dam to the northern San Bernardino County line. Further details regarding the methods used to produce the peak discharges along the Colorado River are outlined in the report entitled “Flood Frequency Determinations for the Lower Colorado River,” Volume I, Supporting Hydrologic Documents of the Colorado River Floodway Protection Act of 1986, dated March 1989, prepared by the USBR.

The BFEs along the Colorado River were determined by using the HEC-2 hydraulic computer model. The hydraulic analysis was based only on effective flow areas. A floodway was determined by setting the floodway boundaries at the limits of the effective flow model. The BFEs shown on the FIRM area are both the 1-percent annual chance natural and floodway elevations. The floodway fringe area (1-percent annual chance floodplain) was determined using the computed water- surface elevations and topographic mapping. BFEs for the Colorado River are provided on the FIRM.

The Colorado River Floodway data were revised by a LOMR issued April 29, 1994, for the City of Needles. Additional LOMRs and Letters of Map Amendment *(*LOMAs and Letters of Map Revision based on Fill*)* that have been included in this revision are described in Table 14.

The LOMR issued December 5, 1986, for the City of Rancho Cucamonga, to reflect channel improvements along Alta Loma Channel, was included in this update. The FIRM was revised to modify the 1-percent annual chance flood boundaries along Alta Loma Channel, between Highland Avenue and 19th Street.

The LOMR issued August 4, 1988, for the City of Colton, to reflect channel improvements along Reche Canyon Creek, was included in this update. The FIRM was revised to modify the 1-percent annual chance flood boundary delineations and zone designations along Reche Canyon Creek. This revision is based on the channelization project along Reche Canyon Creek from a point approximately 3,350 feet downstream of Mobile Home Road to a point approximately 1,700 feet downstream of Mobile Home Road. The 1-percent annual chance flood is contained within the channel in this reach of Reche Canyon Creek.

The LOMA issued August 3, 1990, for the City of Rancho Cucamonga, Lots 13-17, Tract No. 12362, was included in this update. The FIRM was revised to modify the 1-percent annual chance floodplain boundary delineations.

The LOMR issued February 4, 1991, for the City of Rancho Cucamonga, to show the effects of a storm drain that extends along the western edge of Fir Drive for about 1,300 feet from the intersection of Arrow Route and Fir Drive, was included in this update. The FIRM was revised to modify the floodplain delineations and to show that the 1-percent annual chance flood discharge is contained within the storm drain.

The LOMR issued February 26, 1991, for the City of Rancho Cucamonga, to show the effects of the storm drain system between the Southern Pacific Railroad and Cucamonga Creek Channel, was included in this update. The FIRM was revised to modify the 1-percent annual chance floodplain boundary delineations and to show the 1-percent annual chance discharge as contained within the storm drain system.

The LOMRs issued March 1, 1991, for the City of Ontario and the unincorporated areas of San Bernardino County, to reflect the construction of several projects affecting Lower Deer Creek, Old Deer Creek, and the Ontario Motor Speedway Drain, were included in this update. The construction projects included a concrete-lined channel along Lower Deer Creek, from Chris Basin to just downstream of the Pomona Freeway (Highway 60), the construction of an underground conduit along Ontario Motor Speedway Drain from the Pomona Freeway to the San Bernardino Freeway (Interstate 10), and the construction of an underground conduit along Old Deer Creek from its confluence with Lower Deer Creek to Mission Boulevard. The FIRM was revised to modify the 1-percent annual chance floodplain boundaries along these flooding sources. The 1-percent annual chance flood discharge is contained within the identified channel banks of Lower Deer Creek and the underground conduit systems from Chris Basin to the San Bernardino Freeway and along Old Deer Creek from its confluence with Lower Deer Creek to Mission Boulevard.

The LOMA issued April 17, 1991, for the City of San Bernardino, to remove a parcel from the 1-percent annual chance floodplain, was included in this update. The FIRM was revised to modify the 1-percent annual chance floodplain boundary delineations.

The LOMRs issued August 19, 1991, for the City of Rancho Cucamonga and the unincorporated areas of San Bernardino County, to reflect the construction of a debris basin and a channelization project along Deer Creek were included in this update. The channelization project extends approximately 6,700 feet along Deer Creek downstream from the basin to the confluence with Hillside Channel. The FIRM was revised to modify the 1-percent annual chance flood boundary delineations along Deer Creek. The 1-percent annual chance flood discharge is contained within the identified channel banks of Deer Creek from the debris basin downstream to the confluence with Hillside Channel.

The LOMRs issued August 28, 1991, for the City of Rancho Cucamonga and the unincorporated areas of San Bernardino County, to show the effects of the completed portion of the Day Creek Channel Flood Control Project, were included in this update. The Flood Control Project consisted of the Day Canyon Debris Dam; a concrete-lined channel from Base Line Road to the Debris Dam; Day Creek Basin, located south of Highland Avenue; and the Spreading Grounds Channel, a series of five intercept basins that extend from the confluence with Day Creek Channel west across the entire width of the spreading grounds. The FIRM was revised to modify the 1-percent annual chance flood boundary delineations and zone designations along Day Creek Channel from Base Line Road to approximately 3,200 feet downstream of the Day Creek Debris Dam. The 1-percent annual chance flood discharge is contained within the identified channel banks of Day Creek Channel from Base Line Road to the Spreading Grounds Channel and within Day Creek Basin.

The LOMR issued July 24, 1992, for the City of Rancho Cucamonga, to show the effects of construction along Jasper Street, was included in this update. The project included the construction of a 54-inch storm drain along Jasper Street from approximately 170 feet north of Highland Avenue to approximately 360 feet south of Highland Avenue. A channel, extending approximately 200 feet downstream from the outlet of the 54-inch storm drain, was also constructed as part of this project. The FIRM was revised to modify the 1-percent annual chance flood discharge as contained within the storm drain and channel.

The LOMR issued August 24, 1992, for the unincorporated areas of San Bernardino County, to show the effects of a revised hydrologic and hydraulic analysis along the Santa Ana River was included in this update. The FIRM was revised to modify the 1-percent annual chance floodplain boundary delineations along the Santa Ana River from approximately 1,000 feet downstream of Orange Street to approximately 700 feet upstream of Church Street.

The LOMR issued August 24, 1992, for the City of Redlands, to show the effects of a revised hydrologic and hydraulic analysis along the Santa Ana River, was included in this update. The FIRM was revised to modify the 1-percent annual chance floodplain boundary delineations along the Santa Ana River from approximately 1,700 feet downstream to approximately 700 feet upstream of Church Street, and from approximately 1,000 feet downstream to approximately 700 feet downstream of Orange Street. The 1-percent annual chance floodplain has been reduced along this stream reach.

The LOMA issued November 23, 1992, for the unincorporated areas of San Bernardino County in the vicinity of the City of Yucaipa, to revise flooding along Wilson Creek, was included in this update. The FIRM was revised to modify the 1-percent annual chance floodplain boundary delineations.

The LOMA issued January 28, 1993, for the City of Rancho Cucamonga, for Lot 1, Tract No. 11915, was included in this update. The FIRM was revised to modify the 1-percent annual chance floodplain boundary delineations and stream location along Deer Creek.

The LOMR issued April 23, 1993, for the City of Rancho Cucamonga, to show the effects of modifications to Alta Loma Channel, was included in this update. The FIRM was revised to modify the 1-percent annual chance floodplain boundary delineations along Alta Loma Channel from approximately 550 feet downstream to just upstream of Lemon Avenue. The 1-percent annual chance flood is contained within the identified channel banks of Alta Loma Channel for the revised reach.

The LOMRs issued May 6, 1993, for the Cities of Ontario and Rancho Cucamonga, to show the effects of the construction of a concrete- lined channel along Day Creek Channel from the Riverside Basin to Base Line Road, were included in this update. The FIRM was revised to modify the 1-percent annual chance flood boundary delineations along Day Creek Channel. The 1-percent annual chance flood discharge is contained within the channel for the entire revised reach, and within the Wineville Percolation and Retention Basin.

The LOMR issued March 4, 1994, for the City of Highland, to show the effects of the construction of a floodwall along the north side of Greenspot Road, which is parallel to the overflow from Plunge Creek, from approximately 200 feet upstream to approximately 1,700 feet upstream of the intersection of Greenspot Road and Santa Aria Canyon Road, was Included in this update. As a result of this revision, the SFHA has been decreased for the entire revised reach.

The LOMR issued April 12, 1994, for the unincorporated areas of San Bernardino County, to show the effects of the San Antonio Heights Intercept, which was built to divert runoff north of 26th Street into Cucamonga Creek, was included in this update. The FIRM was revised to remove the 1-percent annual chance floodplain boundary delineations and modify the zone designations in the area west of Cucamonga Creek, north of 24th Street, and south of 26th Street in San Antonio Heights. As a result of this revision, the Zone AO designation of this area was changed to Zone X.

The LOMR issued January 18, 1995, for the City of Victorville, to show the effects of the construction of a 120-inch-diameter cast-in-place (CIP) concrete pipe from just downstream of Placida Road to just upstream of Mojave Drive along West Fork Ossom Wash, was included in this update. As a result of this revision; the 1-percent annual chance flood is contained within the 120-inch-diameter CIP concrete pipe from just downstream of Placida Road to just upstream of Mojave Drive.

The LOMR issued March 6, 1995, for the City of Rancho Cucamonga, to show the effects of channel improvements along Alta Loma Channel from just upstream to approximately 1,400 feet upstream of Lemon Avenue, and construction of the Archibald/Liberty Storm Drain from the confluence with Alta Loma Channel to approximately 300 feet upstream of the intersection of Archibald Avenue and Banyan Street, was included in this update. As a result of this revision, the 1-percent annual chance flood is contained within the identified channel banks of Alta Loma Channel and within the Archibald/Liberty Storm Drain for the revised reach.

The LOMR issued on May 22, 1995, for the City of Rancho Cucamonga, to show the effects of road improvements just west of and along Hermosa Avenue from just upstream to approximately 700 feet upstream of the intersection of Hermosa Avenue and Base Line Road, and just north of and along Base Line Road from just upstream to approximately 700 feet upstream of the same intersection, was included in this update. As a result of this revision, the base flood is contained within the road improvements along the revised reach. The width of the SFHA has decreased by approximately 150 feet along the revised reach.

The following LOMRs were incorporated into the May 3, 1993, FIS for the City of Fontana: The LOMR issued September 28, 1990, for the City of Fontana, to show the effects of revised hydrologic and hydraulic analyses along Declez Channel from Cypress Avenue to Live Oak Avenue, performed by ASL Consulting Engineers, was included in this update. The LOMR issued August 23, 1991, for the City of Fontana, to show the effects of revised hydrologic and hydraulic analyses along the newly constructed Etiwanda and San Sevaine Channels between Victoria Avenue and Foothill Boulevard, performed by Hall & Forman, Inc., was included in this update.

The LOMR issued February 27, 1992, for the City of Fontana, to show the effects of revised hydrologic and hydraulic analyses for an adjacent reach of the Declez Channel from Live Oak Avenue to the corporate limits, performed by McCutchan Company, Inc., was included in this update.

10.6 Sixth Revision

This countywide study for San Bernardino County was revised on January 17, 1997, to incorporate detailed flooding on Antelope Valley Wash (previously known as Antelope Valley Creek) from the confluence with the Mojave River to approximately 700 feet upstream of Ranchero Road. The total length of the area studied along Antelope Valley Wash is 4.5 miles. The hydrologic and hydraulic analyses for Antelope Valley Wash were prepared by Ensign & Buckley, Consulting Engineers, for FEMA, under Contract No. EMW-90-C-415l. This study also incorporates flood-control improvements along San Sevaine Wash from Summit Avenue upstream to the mouth of the San Sevaine Canyon. The hydrologic and hydraulic analyses for San Sevaine Wash were prepared by Rivertech, Inc., and the hydraulic analyses for the Mid-East and San Sevaine Culverts under Summit Avenue were prepared by Fuscoe, Williams, Lundgren & Short, Inc., for FEMA.

On February 2, 1993, an initial CCO meeting was held with representatives from the City of Hesperia Department of Public Works, the San Bernardino County Transportation/Flood Control Department (SBCTFCD), FEMA, and the study contractor. The stream to be studied and the limits of study were identified at the meeting. Available mapping and other data were also identified at the meeting. On March 1, 1995, an intermediate meeting was held with representatives of FEMA, the city, and the SBCTFCD.

The localized overbank areas adjacent to the low-flow channel of the Antelope Valley Wash were reported to be subject to shallow flooding during the January 1995 storm event. There have been other occurrences of local flooding and erosion damage caused by tributaries to Antelope Valley Wash. Antelope Valley Wash has been modified and is essentially manmade. There are remnants of intermittent embankments adjacent to the channel. These embankments are not continuous and were not considered as levees.

The 1-percent annual chance peak discharges used in this study were determined using the USACE computer program HEC-1 (USACE, 1987 and 1990). This model was developed based on the SBCTFCD Hydrology Model (San Bernardino County Transportation, 1992) and the data developed for the SBCTFCD Hesperia Master Plan of Drainage (MPD).

The Master Plan hydrology was developed for the SBCTFCD based on projected future developed conditions using a rational-method computer program. The HEC-l model was developed using the same fully developed land-use conditions as used for the MPD. Watershed roughness values and resulting lag times were adjusted until the peak discharge agreed with the MPD values. The land uses represented by the model were then modified to represent existing land-use conditions based on aerial photographs provided by the SBCTFCD. The data and parameters used for the model included the following:

1. Watershed areas were determined using the SBCTFCD MPD watershed boundary map that was developed from USGS quadrangle mapping (San Bernardino County Transportation, Untitled and Undated Watershed Boundary Map, undated).

2. Land uses were defined based on available aerial map information (San Bernardino County Transportation, 1991) and field reconnaissance.

3. Watershed soil types were determined from NRCS soil survey maps (U.S. Department of Agriculture, 1986), which are consistent with maps included in the SBCTFCD Hydrology Model.

4. The total 6- and 24-hour precipitation values were determined from National Oceanic and Atmospheric Administration isohyetal maps (National Oceanic and Atmospheric Administration, 1972), which are consistent with the SBCTFCD Hydrology Model.

5. Rainfall distribution was determined for a synthetic storm pattern by plotting an intensity-duration curve in accordance with the SBCTFCD Hydrology Model. A 24-hour nested storm pattern was used with time increments of 5 minutes through 24 hours.

6. Infiltration losses were determined using the NRCS Curve Number (CN), with CN values determined based on watershed soil types, NRCS guidelines (U.S. Department of Agriculture, June 1986), and the SBCTFCD Hydrology Model.

7. In accordance with the SBCTFCD Hydrology Model, the unit hydrographs were developed based on the USACE Valley S-Graph. Lag times for undeveloped conditions were determined using the USACE empirical formula. The unit hydrographs were determined using the USACE unit hydrograph and S-Graph programs (USACE, 1976).

8. In the study area where detailed topographic data were available, channel routing was performed using the HEC-l Modified Puls method. The storage-discharge relationships were determined using multiple-discharge hydraulic computations. For upstream areas, the normal-depth storage routing method was used based on the approximated channel sections. The discharges are summarized in Table 7, "Summary of Discharges." Since the difference in discharge between the lower and upper study limits is less than 5 percent, a discharge of 6,400 cfs was used over the entire study area.

Water-surface elevations were computed using the USACE HEC-2 computer program (USACE, 1990). Channel and overbank cross sections were determined using aerial survey models (Aero Tech Surveys, Inc., Digital Cross-Section Model, 1993). When necessary, the sections were extended using topographic mapping at a scale of 1"=500', with 4-foot contour intervals, developed for this study (Aero Tech Surveys, Inc., Topographic Map, 1993).

The Manning's "n" roughness values were established by field observation using Chow's guidelines, examination of aerial photographs, and USACE and USGS guidelines (USACE, 1976; Chow, V. T., 1959; U.S. Department of the Interior, 1987). Channel and overbank roughness values of 0.04 were used. In accordance with USACE guidelines, contraction and expansion coefficients of 0.1 and 0.3 were used for open-channel sections.

The culvert constructed at I Street was modeled based on construction drawings provided by the city (CASC Engineering Group, Inc., 1994). The crossing was modeled using the HEC-2 special bridge routine. The downstream starting water-surface elevation was based on the HEC-2 slope/area method.

The floodway was calculated using the USACE HEC-2 computer program, and the results are shown in Table 10. Water-surface profiles were also computed for Antelope Valley Wash.

The revision of San Sevaine Wash incorporates flood-control improvements that protect a portion of Tract 13750 of the Hunter Ridge Development from the existing San Sevaine Spreading Grounds. Tract 13750 is located north of Summit Avenue in the City of Fontana, San Bernardino County, California. It is bordered by the San Sevaine Wash Spreading Grounds to the west and by Bullock Canyon, Rich Basin, and Hawker-Crawford Channel to the east. This work was completed on June 30, 1995.

The modifications are based on flood-control improvements along San Sevaine Wash. Portions of the existing east levee of the San Sevaine Spreading Grounds from Summit Avenue to 2,665 feet upstream of Summit Avenue have been improved, and a new levee has been constructed from 2,665 feet upstream to 7,000 feet upstream of Summit Avenue. The levee does not tie into the natural high ground near the mouth of the San Sevaine Canyon in the San Gabriel Mountains. Two sets of interceptor channels and training dikes were built to guide the San Sevaine Wash floodflow through the MidEast and San Sevaine Culverts under Summit Avenue and pass it to Spreading Basin No. 1, one of five basins located south of Summit Avenue. The east part of the project includes modification of the existing Rich Basin for the purpose of debris management and mitigation against increased peak runoff resulting from the Hunter Ridge Development. Also, the Hawker-Crawford Channel has been improved for the reach extending from the spillway of the Rich Basin upstream, to the culvert under Summit Avenue downstream.

The 1-percent annual chance peak discharges were revised using the SBCHM and the Rational Method Hydrology Computer Program. The hydraulic analyses for this revision were performed using the USACE HEC-2 step-backwater hydraulic computer model. The revised hydraulic analyses were performed to develop 1-percent annual chance floodplain boundaries along San Sevaine Wash.

10.7 Seventh Revision

The study for San Bernardino County and incorporated areas was revised on August 28, 2008, to incorporate detailed flooding on Hooke Creek and the Colorado River.

On July 13, 2006, an initial CCO meeting was held with representatives from the San Bernardino County, FEMA, and the study contractor. The streams to be studied and the limits of study were identified at the meeting. Available mapping and other data were also identified at the meeting. On October 28, 2007, the results of this restudy were reviewed at a final CCO meeting attended by representatives of San Bernardino County, FEMA, and the study contractor.

The total length studied along Hooke Creek is 1.6 miles from the confluence with Fern Canyon to approximately 500 feet upstream of Hooke Road. The hydrologic and hydraulic analysis for Hooke Creek was prepared by Schaaf & Wheeler, Consulting Civil Engineers, for FEMA, under Contract No. EMF-2003-RP-001. The Colorado River was revised from the United States-Mexico border to the upstream limit of the Colorado River within San Bernardino County. The hydrologic and hydraulic analyses and floodway mapping for the Colorado River were prepared by the Colorado River Floodway Task Force and the USBR.

The hydrologic analyses for Hooke Creek used HEC-HMS (USACE, 2006) and the San Bernardino County Hydrology Manual (Hromadka, 1983) to determine the 10-, 2-, and 1-percent annual chance flood events. The 0.2-percent annual chance flood event was calculated using the log-Pearson Type III method described in the Guidelines for Determining Flood Flow Frequency, Bulletin 17B (U.S. Department of the Interior, 1982).

Backwater computations were performed using the HEC-RAS computer program (USACE, November 2006). The cross-section geometry was based on a TIN terrain model created from LIDAR mass points (vegetation removed, but foundations in place). Cross sections were exported to HEC-RAS using HEC-GeoRAS. Locations of selected cross sections used in the updated hydraulic analyses are shown on the Flood Profiles (Exhibit 1) and the revised FIRM. Preliminary roughness coefficients (Manning's "n" values) for overland flow conditions were estimated by field inspection of the area under investigation. The coefficients were then adjusted using the Cowan method described in Chow (Reference 74), which takes into account irregularity, cross-section variation, effect of obstruction, vegetation, and degree of meandering. The channel Manning's *n* values ranged from 0.02 to 0.057. The lowest Manning's "n" of 0.02 was used for the brick lined channel located between Bridge #1 and #2 in the HEC-RAS model (station 2642 to 2976). The overbank "n" values ranged from 0.058 to 0.077. The downstream boundary condition of Hooke Creek at the confluence with Fern Creek was determined from a normal depth calculation using the average slope of the downstream channel. Bridge and culvert data for Hooke Creek were taken from field measurements.

The floodway was calculated using the USACE HEC-RAS computer program, and the results are shown in Table 10. Water-surface profiles were also computed for Hooke Creek.

The FIRM for San Bernardino County and incorporated areas reflects flood hazard data produced as a result of the Colorado Floodway Protection Act passed by Congress in 1986 (Public Law 99-450). The act was passed to establish a floodway along the Colorado River from Davis Dam to the U.S. – Mexico border. The hydrologic and hydraulic analyses and floodway mapping for the Colorado River were prepared by the Colorado River Floodway Task Force and the USBR.

A hydrologic analysis was performed to determine 1% annual chance peak discharges at points along the Colorado River from Davis Dam to the U.S. – Mexico border. Runoff from above Hoover Dam is typically the dominant contributing factor for flood flows, although combinations of releases from Davis and Parker Dams with flash floods originating from downstream watersheds also contribute to flood flows into the Colorado River and are significant in determining peak 1-percent annual chance discharges. Details regarding the methods used to calculate the peak discharges along the Colorado River are outlined in the USBR report titled "Flood Frequency Determinations for the Lower Colorado River," Volume I, Supporting Hydrologic Documents of the Colorado River Floodway Protection Act of 1986, dated March 1989.

Hydraulic routing was completed using the DWOPER computer program. The BFEs along the Colorado River were computed by assuming that the floodway fringe would not convey any portion of the flood flow. Cross sections used in the hydraulic computer model include both channel and overflow areas and reflect hydrographic surveys taken by USBR. The DWOPER hydraulic model was calibrated using known hourly flow values from Davis and Parker Dams and the observed gage records below the two dams resulting from the known flows. Final maps of the Colorado River Floodway were published by USBR at a scale of 1"=2,000' with 1-percent annual chance flood elevations in NGVD 29. These flood elevations have been converted to NAVD 88 for the FIRM and this report using a conversion offset of 2.2 foot.

The flood hazard data produced as part of Public Law 99-450 is summarized for river mile markers in the Floodway Data Table for the Colorado River. Peak discharges are listed in Table 7. Flood profiles for the Colorado River are not included because the available flood elevation data is included in the Floodway Data tables. Flood insurance is not available for structures in the Colorado River Floodway built or substantially improved on or after April 8, 1987.

Levee Failure Analysis

Flood hazard information presented on the previously effective FIRM and in the FIS report is based, in some areas, on flood protection provided by the levees identified on the enclosure. Based on the information available and on the mapping standards of the National Flood Insurance Program (NFIP) at the time that the FIS was performed, FEMA accredited the levees with providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year. For FEMA to continue to accredit the identified levees with providing protection from the base flood, the levees must meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled "Mapping of Areas Protected by Levee Systems".

FEMA and the communities coordinated to compile a list of levees (see Table 13, "List of Levees") based on information from the FIRM and community information.

TABLE 13 - LIST OF LEVEES

Community	Flood Source	Levee Inventory ID	USACE Levee
City of Barstow	Mojave River*	1a	No
City of Barstow	Mojave River	1b	No
City of Barstow	Mojave River	1c	No
City of Barstow	Lenwood Creek	2	No
City of Chino	Chino Creek	3	Yes
City of Chino	Chino Creek	4	Yes
City of Colton	Santa Ana River	5	No
City of Colton	Santa Ana River	6	No
City of Colton	Reche Canyon Channel	7	No
City of Fontana	Etiwanda and San Sevaine Channels	8	No
City of Fontana	Unknown	9	No
City of Fontana	Unknown	10	No
City of Highland	City Creek*	11	Yes
City of Highland	Patton Basin	12	No
City of Highland	Plunge Creek*	13a	No
City of Highland	Plunge Creek	13b	No
City of Highland	Plunge Creek*	13c	No
City of Highland	Plunge Creek*	14	No
City of Highland	Bledsoe Gulch	16	No
City of Highland	Sand Creek Channel	17	No
City of Highland	Plunge Creek	18	No
City of Highland	Plunge Creek	19	No
City of Highland	City Creek Spreading Grounds	20	No
City of Needles	Buzzard Wash	22	No
City of Needles	Coyote Wash	23	No
City of Needles	Leming Wash	24	No
City of Needles	Unnamed Stream	25	No
City of Needles	Colorado River	26	No
City of Needles	Fox Wash	27	No
City of Ontario	Cucamonga Channel*	28a	No
City of Ontario	Lower Cucamonga Spreading Grounds*	28b	No
City of Ontario	Chris Basin*	28c	No
City of Ontario	Cucamonga Channel*	28d	No
City of Ontario	Lower Deer Creek Channel	28e	No
City of Ontario	Ely Percolation and Retention Basins	29a	No
City of Ontario	Ely Percolation and Retention Basins	29b	No
City of Ontario	Ely Percolation and Retention Basins	29c	No
City of Ontario	Cucamonga Channel*	30	No
City of Rancho Cucamonga	Etiwanda and San Sevaine Channels	32	No
City of Rancho Cucamonga	Cucamonga Creek*	33a	No
City of Rancho Cucamonga	Cucamonga Creek*	33b	No

* Levee determined to no longer be in a levee condition. See section 10.10 for more information.

TABLE 13 – LIST OF LEVEES (continued)

Community	Flood Source	Levee Inventory ID	USACE Levee
City of Rancho Cucamonga	San Sevaine Detention Basin	34	No
City of Rancho Cucamonga	Cucamonga Creek Channel*	35	No
City of Rancho Cucamonga	Cucamonga Creek Channel*	36	No
City of Rancho Cucamonga	Demens Debris Basin	37	Yes
City of Rancho Cucamonga	Unknown Creek between Deer Creek Wash and Day Creek Channel	38	No
City of Rancho Cucamonga	Unknown	39	No
City of Rancho Cucamonga	Cucamonga Creek Channel*	40a	No
City of Rancho Cucamonga	Cucamonga Creek Channel*	40b	No
City of Rancho Cucamonga	Cucamonga Creek Channel*	41a	No
City of Rancho Cucamonga	Cucamonga Creek Channel*	41b	No
City of Rancho Cucamonga	Cucamonga Creek Channel*	42	No
City of Rancho Cucamonga	Etiwanda Creek Spreading Grounds	43	No
City of Redlands	Mill Creek	44a	Yes
City of Redlands	Mill Creek	44b	Yes
City of Redlands	Santa Ana River and Mill Creek	46	No
City of Rialto	Lytle Creek Wash	48	Yes
City of Rialto	Lytle Creek Wash	49a	Yes
City of Rialto	Lytle Creek Wash	49b	Yes
City of Rialto	Lytle Creek Wash*	50	Yes
City of San Bernardino	Lytle Creek Wash*	51	Yes
City of San Bernardino	East Twin Creek	52	Yes
City of San Bernardino	Lytle Creek Wash*	53a	Yes
City of San Bernardino	Lytle Creek Wash*	53b	Yes
City of San Bernardino	East Twin Creek	55	No
City of San Bernardino	East Twin Creek*	56	No
City of San Bernardino	East Badger Basin	57a	No
City of San Bernardino	MacQuiddy-Severance Diversion Channel*	57b	No
City of San Bernardino	Daley Basin	58	No
City of San Bernardino	Unknown	59	No
City of San Bernardino	Warm Creek	60	No
City of San Bernardino	Cable Creek Channel	61	No
City of San Bernardino	West Badger Debris Basin	62	No
City of San Bernardino	Western Avenue Storm Drain	63	No

* Levee determined to no longer be in a levee condition. See section 10.10 for more information.

TABLE 13 – LIST OF LEVEES (continued)

Community	Flood Source	Levee Inventory ID	USACE Levee
City of San Bernardino	East Twin Creek	65	Yes
City of San Bernardino	Cable Creek	67	No
City of San Bernardino	Cable Creek	68	No
City of San Bernardino	Cable Creek Channel	69	No
City of San Bernardino	Cable Creek Channel*	70	Yes
City of San Bernardino	Twin Creek Channel (formerly Lower Warm Creek)	71	Yes
City of San Bernardino	Sandy Creek Channel	72	No
City of San Bernardino	West Twin Creek	73	Yes
City of San Bernardino	West Badger Debris Basin	74	Yes
City of San Bernardino	Warm Creek	75	No
City of San Bernardino	Unknown	77	No
City of San Bernardino	Unknown	78	No
City of San Bernardino	Unknown	79	No
City of San Bernardino	Waterman Levee	80a	Yes
City of San Bernardino	Twin Creek	80b	Yes
City of San Bernardino	29th Street Basins	81a	No
City of San Bernardino	Lynwood Basins*	81b	No
City of Twentynine Palms	Twentynine Palms Creek	82	No
City of Twentynine Palms	Twentynine Palms Creek	83	No
City of Twentynine Palms	Twentynine Palms Creek	84	No
City of Twentynine Palms	Twentynine Palms Creek	85	No
City of Twentynine Palms	Twentynine Palms Channel*	86a	No
City of Twentynine Palms	Donnell Basin	86b	No
City of Twentynine Palms	Twentynine Palms Channel*	86c	No
City of Twentynine Palms	Twentynine Palms Channel*	87	No
City of Victorville	Mojave River*	88	No
City of Yucaipa	Wilson Creek	89	No
City of Yucaipa	Unknown	90	No
Town of Yucca Valley	Yucca Creek	91	No
Unincorporated Areas	Cajon Wash	92	Yes
Unincorporated Areas	Rich Basin*	93	No
Unincorporated Areas	Rich Basin*	94	No
Unincorporated Areas	Cajon Wash	95	Yes
Unincorporated Areas	Cajon Wash*	96	No
Unincorporated Areas	Cajon Wash*	97	Yes
Unincorporated Areas	Mojave River	98	No

* Levee determined to no longer be in a levee condition. See section 10.10 for more information.

TABLE 13 – LIST OF LEVEES (continued)

Community	Flood Source	Levee Inventory ID	USACE Levee
Unincorporated Areas	Mojave River	99	No
Unincorporated Areas	Mojave River*	100	No
Unincorporated Areas	Cemetery Wash	101	No
Unincorporated Areas	Quail Wash	102	Yes
Unincorporated Areas	San Sevaine Detention Basin*	103	No
Unincorporated Areas	Mojave River*	104	No
Unincorporated Areas	Lytle Creek Wash*	105	Yes
Unincorporated Areas	Unknown Creek between Deer Creek Wash and Day Creek Channel	107a	No
Unincorporated Areas	Unknown Creek between Deer Creek Wash and Day Creek Channel	107b	No
Unincorporated Areas	Lenwood Creek	108	No
Unincorporated Areas	Sheep Creek	109	No
Unincorporated Areas	Unknown	110	No
Unincorporated Areas	Santa Ana River	111	No
Unincorporated Areas	Lytle Creek Wash	113	Yes
Unincorporated Areas	Lytle Creek Wash	114	Yes
Unincorporated Areas	Lytle Creek Wash	115	Yes
Unincorporated Areas	Lytle Creek Wash*	116	Yes
Unincorporated Areas	Lytle Creek Wash*	117	Yes
Unincorporated Areas	Mojave River*	118	No

* Levee determined to no longer be in a levee condition. See section 10.10 for more information.

On August 22, 2005, FEMA issued Procedure Memorandum No. 34 - Interim Guidance for Studies Including Levees. The purpose of the memorandum was to help clarify the responsibility of community officials or other parties seeking recognition of a levee by providing information identified during a study/mapping project. Often, documentation regarding levee design, accreditation, and the impacts on flood hazard mapping is outdated or missing altogether. To remedy this, Procedure Memorandum No. 34 provides interim guidance on procedures to minimize delays in near-term studies/mapping projects, to help our mapping partners properly assess how to handle levee mapping issues.

While 44 CFR Section 65.10 documentation is being compiled, the release of more up to date DFIRM panels for other parts of a community or county may be delayed. To minimize the impact of the levee recognition and certification process, FEMA issued Procedure Memorandum No. 43 - Guidelines for Identifying Provisionally Accredited Levees on March 16, 2007. These guidelines will allow issuance of preliminary and effective versions of DFIRMs while the levee owners or communities are compiling the full documentation required to show compliance with 44 CFR Section 65.10. The guidelines also explain that preliminary DFIRMs can be issued while providing the communities and levee owners with a specified timeframe to correct any maintenance deficiencies associated with a levee and to show compliance with 44 CFR Section 65.10.

FEMA contacted the communities within San Bernardino County to obtain data required under 44 CFR 65.10 to continue to show the levees as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year.

FEMA understood that it may take time to acquire and/or assemble the documentation necessary to fully comply with 44 CFR 65.10. Therefore, FEMA put forth a process to provide the communities with additional time to submit all the necessary documentation. For a community to avail itself of the additional time it had to sign an agreement with FEMA. Levees for which such agreements were signed are shown on the effective DFIRM as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year and labeled as a Provisionally Accredited Levee (PAL).

Approximate levee failure analyses were carried out for all the levees in Table 13 to indicate the extent of the levee failure floodplains. The methodology used in these analyses is discussed below.

Levees 1a, 1b, and 1c are located on the Mojave River. The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using 10-meter USGS Digital Elevation Models (DEM) topographic information. The floodplain was further smoothed to follow contours.

Levee 2 is located on Lenwood Creek. No failure analysis was performed because the levee was not providing any protection.

Levees 3 and 4 are located on Chino Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 37,196 cfs was computed for a drainage area of 93 sq. mi. The floodplain was mapped using detailed topographic data provided by the City of Chino Hills. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levees 5 and 6 are located on the Santa Ana River. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 180,000 cfs was computed for a drainage area of 700 sq. mi. using FIS. The floodplain was mapped using detailed topographic data provided by the City of Colton. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. The floodplain is stopped at the San Bernardino County boundary.

Levee 7 is located on Reche Canyon Channel. Based on engineering judgment the levee failure floodplain was delineated using detailed topographic data provided by the City of Colton. See section 10.10 of this FIS for an update on this levee.

Levee 8 is located on Etiwanda and San Sevaine Channels. For the left levee, based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain. For the right levee the levee failure floodplain was developed using an approximate analysis which included computation of discharges using the discharges from the Summary of Discharges Table in the FIS and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 1,700 cfs was obtained using the discharges from the Summary of Discharges Table in the FIS. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levees 9 and 10 are located between San Sevaine Channel and Old Sevaine Channel. No failure analysis was performed because the levee was not providing any protection.

Levee 11 is located on City Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 23,558 cfs was computed for a drainage area of 53 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMss. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 12 is located on Patton Basin. The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using USGS 10-meter DEMs. The floodplain was further smoothed to follow contours.

Levees 13a and 13b are located on the Plunge Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 10,265 cfs was computed for a drainage area of 17 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 13c is located on Plunge Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 10,838 cfs was computed for a drainage area of 20 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 14 is located on Plunge Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 12,624 cfs was computed for a drainage area of 29 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 16 is located on Bledsoe Gulch. No failure analysis was performed because the levee was not providing any protection.

Levee 17 is located on Sand Creek Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 2,496 cfs was computed for a drainage area of 3.2 sq. mi. using FIS. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 18 is located on Plunge Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 10,176 cfs was computed for a drainage area of 18 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 19 is located on Plunge Creek. Based on engineering judgment and the levee failure floodplain developed for Levee 18 immediately upstream, the shaded Zone X behind Levee 19 was recommended as the levee failure floodplain for Levee 19.

Levee 20 is located on City Creek Spreading Grounds. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 13,804 cfs was computed for a drainage area of 24 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 22 is located on Buzzard Wash and protects sections of Interstate 40 from flooding. Based on engineering judgment the unshaded Zone X areas along Levee 22 were recommended as the levee failure floodplain.

Levees 23 and 27 are located on Coyote Wash. The levee failure floodplain was developed using engineering judgment based on alluvial fan analysis concepts.

Levee 24 is located on Leming Wash. Using engineering judgment the levee failure floodplain was delineated based on the topographic information (USGS 10-meter DEMs).

Levee 25 is located on an unnamed stream. Using engineering judgment the levee failure floodplain was delineated based on the topographic information (USGS 10-meter DEMs).

Levee 26 is located on the Colorado River. The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using 10-meter USGS Digital Elevation Models (DEM) topographic information. The floodplain was further smoothed to follow contours.

Levee 27 is located on Fox Wash. The levee failure floodplain was developed using engineering judgment based on alluvial fan analysis concepts.

Levees 28a, 28b, 28c, 28d, and 28e are located on Cucamonga Channel, Lower Cucamonga Spreading Grounds, Chris Basin, Cucamonga Channel, and Lower Deer Creek Channel, respectively. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain. Furthermore, the floodplain was refined to follow contours.

Levees 29a, 29 b, and 29c are located on Ely Percolation and Retention Basins. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain. Furthermore, the floodplain was refined to follow contours.

Levee 30 is located on Cucamonga Channel. Based on engineering judgment the levee failure floodplain was delineated using detailed topographic data provided by City of Ontario.

Levee 32 is located on Etiwanda and San Sevaine Channels. No failure analysis was performed because the levee was not providing any protection from the base flood.

Levee 33a is located on Cucamonga Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 8,565 cfs was computed for a drainage area of 11 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 33b is located on Cucamonga Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 10,255 cfs was computed for a drainage area of 16 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 34 is located on San Sevaine Detention Basin. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 5,680 cfs was computed for a drainage area of 8 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 35 is located on Cucamonga Creek Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 12,600 cfs was computed for a drainage area of 20 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 36 is located on Cucamonga Creek Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 12,900 cfs was computed for a drainage area of 21 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using detailed topographic data provided by the City of Ontario and USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 37 is located on Demens Debris Basin. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 1,110 cfs was computed for a drainage area of 1.4 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 38 is located on an unnamed creek between Deer Creek Wash and Day Creek Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 9,830 cfs was computed for a drainage area of 14 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 39 is located on an unnamed stream. No failure analysis was performed because the levee was not providing any protection from the base flood.

Levees 40a and 41a are located on Cucamonga Creek Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 12,100 cfs was computed for a drainage area of 19 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levees 40b and 41b are located on Cucamonga Creek Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 12,580 cfs was computed for a drainage area of 20 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 42 is located on Cucamonga Creek Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 13,280 cfs was computed for a drainage area of 23 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using detailed topographic data provided by City of Ontario and USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 43 is located on Etiwanda Creek Spreading Grounds. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 7480 cfs was computed for a drainage area of 14 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levees 44a and 44b are located on Mill Creek. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain. See section 10.10 of this FIS for an update on levee 44b.

Levee 46 is located on Santa Ana River and Mill Creek. The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using detailed topographic data provided by City of Redlands. The floodplain was further smoothed to follow contours.

Levee 48 is located on Lytle Creek Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 3,0010 cfs was computed for a drainage area of 51 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 49a is located on Lytle Creek Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 3,0030 cfs was computed for a drainage area of 51 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 49b is located on Lytle Creek Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 30,040 cfs was computed for a drainage area of 51 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 50 is located on Lytle Creek Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 48,990 cfs was computed for a drainage area of 137 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 51 is located on Lytle Creek Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 48,990 cfs was computed for a drainage area of 137 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levees 52, 55, 56, 65, 81a, and 81b are located on East Twin Creek. Based on engineering judgment the levee failure floodplain was delineated using contours derived from USGS 10-meter DEMs. See section 10.10 of this FIS for an update on these levees.

Levees 53a and 53b are located on Lytle Creek Wash. Based on engineering judgment the levee failure floodplain was delineated using contours derived from USGS 10-meter DEMs.

Levee 57a is located on East Badger Basin. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 1,754 cfs was computed for a drainage area of 2.7 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 57b is located on MacQuiddy-Severance Diversion Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. Discharge of 196 cfs and 228 cfs were computed for the two reaches behind this levee using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 58 is located on Daley Basin. The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using USGS 10-meter DEMs. The floodplain was further smoothed to follow contours.

Levee 59 is located on an unnamed basin. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 890 cfs was computed for a drainage area of 2.5 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 60 is located on Warm Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 91,720 cfs was computed for a drainage area of 260 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using detailed topographic data provided by City of Colton and USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 61 is located on Cable Creek Channel. The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using USGS 10-meter DEMs. The floodplain was further smoothed to follow contours. This levee is analyzed as part of analysis for Levee 69.

Levee 62 is located on West Badger Debris Basin. This levee is actually slope protection and so no failure analysis was performed because the levee was not providing any protection from base flood. Furthermore, the attributes of this structure in the DFIRM database were changed to not indicate this structure as a levee.

Levee 63 is located on Western Avenue Storm Drain. The levee failure floodplain was developed using an approximate analysis which included using discharges from the FIS and water-surface elevations computed by a HEC-RAS hydraulic analysis. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levees 67 and 68 are located on Cable Creek. No failure analysis was performed because the levee was not providing any protection.

Levee 69 is located on Cable Creek Channel. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levee 70 is located on Cable Creek Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 6,540 cfs was computed for a drainage area of 8 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 71 is located on Twin Creek Channel (formerly Lower Warm Creek). The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using USGS 10-meter DEMs. The floodplain was further smoothed to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 72 is located on Sandy Creek Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 2,500 cfs was computed for a drainage area of 3.2 sq. mi. using the Summary of Discharges Table (Table 7) in the FIS. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 73 is located on West Twin Creek. No failure analysis was performed because the levee was not providing any protection.

Levee 74 is located on West Badger Debris Basin. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 7,150 cfs was computed for a drainage area of 11 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 75 is located on Warm Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 670 cfs was computed for a drainage area of 0.8 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 77 is located on East Badger Basin. This levee is actually slope protection and so no failure analysis was performed because the levee was not providing any protection from base flood. Furthermore, the attributes of this structure in the DFIRM database were changed to not indicate this structure as a levee.

Levee 78 is located on an unnamed stream. This levee was analyzed as part of Levee 70.

Levee 79 is located on an unnamed stream. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 5,340 cfs was computed for a drainage area of 6 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 80a is located on Waterman Levee. Based on engineering judgment the levee failure floodplain was delineated using contours derived from USGS 10-meter DEMs. See section 10.10 of this FIS for an update on this levee.

Levee 80b is located on Twin Creek. Based on engineering judgment the levee failure floodplain was delineated using contours derived from USGS 10-meter DEMs. See section 10.10 of this FIS for an update on this levee.

Levee 82, 83, and 84 are located on the Twentynine Palms Creek. No failure analysis was performed because these levees do not provide any protection from the base flood. See section 10.10 of this FIS for an update on levee 82.

Levee 85 is located on Twentynine Palms Creek. The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using USGS 10-meter DEMs. The floodplain was further smoothed to follow contours.

Levees 86a, 86c, and 87 are located on Twentynine Palms Channel. The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using USGS 10-meter DEMs. The floodplain was further smoothed to follow contours.

Levee 86b is located on the Donnel Basin. The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using USGS 10-meter DEMs. The floodplain was further smoothed to follow contours. See section 10.10 of this FIS for an update on this levee.

Levees 88, 100, and 118 are located on the Mojave River. The levee failure floodplain was developed using an approximate analysis which included discharges for the Mojave River studied in detail downstream and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 26,500 cfs was computed for a drainage area of 510 sq. mi. from the Summary of Discharges Table in the FIS. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 89 is located on Wilson Creek. No failure analysis was performed because the levee was not providing any protection from the base flood.

Levee 90 is located between Wilson Creek and Oak Glen Creek. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 2,390 cfs was computed for a drainage area of 4.4 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 91 is located on Yucca Creek. No failure analysis was performed because the levee was not providing any protection.

Levee 92 is located on Cajon Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 22,160 cfs was computed for a drainage area of 72 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levees 93 and 94 are located on Rich Basin. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 1,360 cfs was computed for a drainage area of 1.9 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 95 is located on Cajon Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 22,350 cfs was computed for a drainage area of 72 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 96 is located on Cajon Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 22,310 cfs was computed for a drainage area of 72 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 97 is located on Cajon Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 31,680 cfs was computed for a drainage area of 91 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levees 98, 99, and 104 are located on the Mojave River. The levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using USGS 10-meter DEMs. The floodplain was further smoothed to follow contours. See section 10.10 of this FIS for an update on levee 98.

Levee 101 is located on Cemetery Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 2,240 cfs was computed for a drainage area of 2.8 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 102 is located on Quail Wash. No failure analysis was performed because the levee was not providing any protection. See section 10.10 of this FIS for an update on this levee.

Levee 103 is located on San Sevaine Detention Basin. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 9,050 cfs obtained from FIS was used. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 105 is located on Lytle Creek Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 32,850 cfs was computed for a drainage area of 61 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 107a is located on Unknown Creek between Deer Creek Wash and Day Creek Channel. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 9,210 cfs was computed for a drainage area of 12 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Levee 107b is located on Unknown Creek between Deer Creek Wash and Day Creek Channel. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain. See section 10.10 of this FIS for an update on this levee.

Levee 108 is located on Lenwood Creek. No failure analysis was performed because the levee was not providing any protection.

Levee 109 is located on Sheep Creek. The levee failure floodplain was developed using Alluvial Fan analysis. A discharge of 6,470 cfs was computed for a drainage area of 15 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using contours derived from USGS 10-meter DEMs.

Levee 110 is located on Santa Ana River. No failure analysis was performed because the levee was not providing any protection.

Levee 111 is located on Santa Ana River. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain. See section 10.10 of this FIS for an update on this levee.

Levee 113 is located on Lytle Creek Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 29,270 cfs was computed for a drainage area of 49 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 114 is located on Lytle Creek Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 29,460 cfs was computed for a drainage area of 50 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levee 115 is located on Lytle Creek Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 30,810 cfs was computed for a drainage area of 54 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours. See section 10.10 of this FIS for an update on this levee.

Levees 116 and 117 are located on Lytle Creek Wash. The levee failure floodplain was developed using an approximate analysis which included computation of discharges using the USGS NFF equations for California and water-surface elevations computed by a HEC-RAS hydraulic analysis. A discharge of 57,590 cfs was computed for a drainage area of 155 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using USGS 10-meter DEMs. The floodplain obtained using the approximate hydrology and hydraulic analyses was refined using engineering judgment to follow contours.

Table 14, "Letters of Map Correction, Revision 7" includes the LOMRs issued which were included in this update.

TABLE 14 - LETTERS OF MAP CORRECTION, REVISION 7

COMMUNITY	FLOOD SOURCE	CASE #	EFFECTIVE
City of Barstow	Lenwood Creek	06-09-B313P	November 30, 2006
City of Chino Hills	Little Chino Creek	97-09-959P	August 8, 1997
City of Chino Hills	Carbon Canyon Creek	97-09-301P	January 17, 1997
City of Chino	Carbon Canyon Creek	97-09-301P	January 17, 1997
City of Chino	Cypress Channel	96-09-1056P	September 17, 1996
City of Colton	San Timoteo Channel	07-09-1957P	November 9, 2007
City of Colton	Santa Ana River	05-09-0670X	April 6, 2005
City of Colton	Santa Ana River	05-09-0636X	March 17, 2005
City of Colton	San Timoteo Creek, San Timoteo Wash A, San Timoteo Wash B	00-09-871P	June 27, 2001
City of Colton	Reche Canyon Channel	97-09-363P	January 21, 1998
City of Fontana	24th Street Diagonal Channel, Etiwanda Channel, San Sevaine Channel	03-09-0351P	April 29, 2003
City of Fontana	24th Street Diagonal Channel	02-09-505P	August 22, 2002
City of Grand Terrace	Santa Ana River	05-09-0636X	March 17, 2005
City of Highland	Oak Creek Channel & Plunge Creek	04-09-1439P	September 23, 2005
City of Highland	Santa Ana River	05-09-0636X	March 17, 2005
City of Highland	City Creek	99-09-158P	January 22, 1999
City of Loma Linda	San Timoteo Creek, San Timoteo Wash A, San Timoteo Wash B	00-09-871P	June 27, 2001
City of Ontario	East Etiwanda Creek	04-09-1115P	April 28, 2005
City of Ontario	Cypress Channel Aqueduct	04-09-1384P	November 29, 2004
City of Ontario	Tributary Watershed	02-09-044P	March 13, 2002
City of Ontario	Sultana Storm Drain	98-09-609P	June 22, 1998

TABLE 14 - LETTERS OF MAP CORRECTION, REVISION 7 (continued)

COMMUNITY	FLOOD SOURCE	CASE #	EFFECTIVE
City of Ontario	San Antonio Drain	97-09-731P	November 20, 1997
City of Ontario	East Etiwanda Creek	97-09-263P	December 30, 1996
City of Ontario	Cypress Channel	96-09-1056P	September 17, 1996
City of Ontario		96-09-768P	June 21, 1996
City of Rancho Cucamonga	Day Canyon Creek	06-09-BC88P	September 29, 2006
City of Rancho Cucamonga	Hellman Avenue	06-09-BA67P	July 27, 2006
City of Rancho Cucamonga	Church Street Storm Drain	06-09-B039P	March 31, 2006
City of Rancho Cucamonga	Haven Avenue Tributary Watershed	05-09-A065P	February 24, 2006
City of Rancho Cucamonga	East Tributary To Alta Loma Channel, West Tributary To Alta Loma	03-09-0356P	January 14, 2004
City of Rancho Cucamonga		03-09-1073P	July 21, 2003
City of Rancho Cucamonga	24th Street Diagonal Channel, Etiwanda Channel, San Sevaine Channel	03-09-0351P	April 29, 2003
City of Rancho Cucamonga	24th Street Diagonal Channel	02-09-505P	August 22, 2002
City of Rancho Cucamonga	Tributary Watershed	02-09-044P	March 13, 2002
City of Rancho Cucamonga	Demens Creek Channel	01-09-681P	August 7, 2001
City of Rancho Cucamonga	Demens Basin & Unnamed Flooding Source	01-09-645P	June 29, 2001
City of Rancho Cucamonga	Etiwanda Creek	01-09-421P	March 30, 2001
City of Rancho Cucamonga	Unnamed Overland Flooding	01-09-187P	March 14, 2001
City of Rancho Cucamonga	East Etiwanda Storm Drain	00-09-429P	April 4, 2000
City of Rancho Cucamonga	Etiwanda Spreading Grounds & San Sevaine Spreading Grounds	98-09-381P	May 13, 1998
City of Rancho Cucamonga	Day Creek Canyon Washes & Un Wash between East Etiwanda & Dry Creek	96-09-753P	March 6, 1997
City of Rancho Cucamonga	Alta Loma Channel	97-09-245P	December 18, 1996

TABLE 14 - LETTERS OF MAP CORRECTION, REVISION 7 (continued)

COMMUNITY	FLOOD SOURCE	CASE #	EFFECTIVE
City of Rancho Cucamonga	Beryl Avenue Watershed, Carnelian Avenue Watershed, Hellman Avenue Watershed, Hermosa Avenue Watershed, Jasper Street/19th Street, Romana Avenue/Baseline Watershed, Vista Grove Storm Drain	96-09-733P	June 21, 1996
City of Rancho Cucamonga	Area Vii & Archibald Avenue Watershed	96-09-768P	June 21, 1996
City of Redlands	Santa Ana River	05-09-0636X	March 17, 2005
City of Redlands	San Timoteo Creek, San Timoteo Wash A, San Timoteo Wash B	00-09-871P	June 27, 2001
City of Rialto	Santa Ana River	05-09-0636X	March 17, 2005
San Bernardino County Unincorporated Areas	Lenwood Creek	07-09-0591X	January 23, 2007
San Bernardino County Unincorporated Areas	Lenwood Creek	06-09-B313P	November 30, 2006
San Bernardino County Unincorporated Areas	Santa Ana River	05-09-0636X	March 17, 2005
San Bernardino County Unincorporated Areas	East Tributary to Alta Loma Channel, West Tributary to Alta Loma	03-09-0356P	January 14, 2004
San Bernardino County Unincorporated Areas	Mojave River	02-09-555P	September 19, 2002
San Bernardino County Unincorporated Areas	Mill Creek & Mill Creek Tributaries	02-09-197P	July 2, 2002
San Bernardino County Unincorporated Areas	Demens Creek Canyon	01-09-681P	August 7, 2001
San Bernardino County Unincorporated Areas	San Timoteo Creek, San Timoteo Wash A, San Timoteo Wash B	00-09-871P	June 27, 2001
San Bernardino County Unincorporated Areas	Zone AO	96-09-918P	July 30, 1996
City of San Bernardino	Unnamed Drain From Mescham Canyon Basin to Cable Creek Channel	06-09-BB30P	December 29, 2006

TABLE 14 - LETTERS OF MAP CORRECTION, REVISION 7 (continued)

COMMUNITY	FLOOD SOURCE	CASE #	EFFECTIVE
City of San Bernardino	Wiggins Hill Basin, Devils Canyon Channel & Wiggins No. 2 Dam	05-09-A082P	January 30, 2006
City of San Bernardino	Bailey Canyon Channel (A.K.A., "Bailey Canyon" or "Bailey Creek Channel")	05-09-2100121P	October 7, 2005
City of San Bernardino	Santa Ana River	05-09-0636X	March 17, 2005
City of San Bernardino	San Timoteo Creek, San Timoteo Wash A, San Timoteo Wash B	00-09-871P	June 27, 2001
City of San Bernardino	Western Avenue Storm Drain	97-09-1017P	November 20, 1997
City of San Bernardino		96-09-1144P	October 4, 1996
City of Yucaipa	Gateway Wash, Oak Glen Creek, Wilson Creek	03-09-0821P	September 2, 2003
City of Yucaipa	Wilson Creek	01-09-280P	March 5, 2002
Town of Yucca Valley	Miller Creek	99-09-873P	August 18, 1999

10.8 Eighth Revision

The study for San Bernardino County and incorporated areas was revised on September 26, 2014, to modify the floodway, BFEs, and floodplain delineations of East Etiwanda Creek and Etiwanda and San Sevaine Channel because of the Etiwanda/San Sevaine System improvement project. The area of revision is geographically located in San Bernardino County Unincorporated Areas and in the Cities of Fontana and Rancho Cucamonga. The incorporated LOMR case number is 11-09-1164P. The LOMR was based on CLOMR case number 10-09-0163R and converted to a Physical Map Revision (PMR) on March 29th, 2011.

The improvement project includes channelization along the San Sevaine Channel from just upstream of Riverside Drive to the confluence with East Etiwanda Creek, along the Etiwanda/San Sevaine System from just upstream of Foothill Boulevard to just downstream of I-15, and along the Etiwanda Channel from just upstream of I-15 to approximately 1,350 feet upstream of Summit Avenue. The channelization project caused East Etiwanda Creek flows from the Etiwanda/San Sevaine System to be diverted completely into the Etiwanda/San Sevaine System at the confluence.

As a result of LOMR 11-09-1164, the flood hazard information was revised for areas along the Etiwanda/San Sevaine System from just upstream of Riverside Drive to approximately 300 feet upstream of 14th Street and along East Etiwanda Creek from just upstream of San Bernardino Avenue to the confluence with the Etiwanda/San Sevaine System. The hydrologic and hydraulic analysis for the channelization project of Etiwanda/ San Sevaine System was prepared by Birge Engineering, Inc. under contract with the San Bernardino County Flood Control District.

Table 15, "Letters of Map Correction, Revision 8," includes the issued LOMRs that were included in this update.

TABLE 15 - LETTERS OF MAP CORRECTION, REVISION 8

COMMUNITY	FLOOD SOURCE	CASE #	EFFECTIVE
Fontana, City of *	San Sevaine Wash	08-09-0931P	October 14, 2008
Rancho Cucamonga, City of	Etiwanda Channel	11-09-1337P	May 24, 2011
Ontario, City of	East Etiwanda Creek, Tributary to East Etiwanda Creek	11-09-3314P	November 3, 2011
Ontario, City of **	East Etiwanda Creek	12-09-2406P	January 4, 2013
Ontario, City of ***	East Etiwanda Creek, Tributary to East Etiwanda Creek	13-09-0673P	September 20, 2013

* LOMR superseded by new study which only includes the channel.
** LOMR incorporated on panels included in PMR and in FIS report. Note that LOMR extends on to panel 06071C8641H which was not revised at this time. This portion of the LOMR will be revalidated when the PMR is effective.
*** LOMR incorporated on panels included in PMR and in FIS report. Note that LOMR extends on to panel 06071C8633H which was not revised at this time. This portion of the LOMR will be revalidated when the PMR is effective.

Hydrologic analyses were performed for the 1-percent and 0.2-percent annual chance flood using the San Bernardino County Flood Control District unit hydrograph method and the Advanced Engineering Software FLoodSCX computer program. This computer program provides the ability to develop a link-node watershed model utilizing a user-input mainline channel by-pass and basin inflow hydrograph and to then prepare a routing analysis for a flow-through retarding basin. The estimated discharge from the 72", 84" and 96" diameter outlet pipes was prepared using Haestad's Flow Master Program. The storage volume capacity of Jurupa Basin was based on the design plans for the Jurupa Basin Outlet Works at the San Sevaine Channel. Based on the basin routing analysis, the maximum discharge at the basin outlet is 10,626 cfs. A more conservative discharge of 11,200 cfs was used for hydraulics analysis.

Peak discharge-drainage area relationships for Etiwanda/San Sevaine System are shown in Table 7. The discharge-drainage relationships for East Etiwanda Creek upstream of San Bernardino Avenue that were previously shown in this table have been eliminated due to the restudy, since the flows for East Etiwanda Creek are diverted completely into the Etiwanda/San Sevaine System.

Water-surface elevations for floods of the selected recurrence intervals were computed through the use of the HEC-RAS 3.3 step backwater computer program (USACE, 2008). The flow in the channelized Etiwanda/San Sevaine System was modeled as supercritical condition. The boundary condition used is critical depth.

Cross sections and hydraulic structures for the hydraulic analyses were taken from as-built plans of the Etiwanda/San Sevaine System improvement project. The as-built plans were provided by the San Bernardino Flood Control District.

The channel and overbank roughness factors (Manning's "n") used in the hydraulics computations ranged from 0.014 to 0.03 for Etiwanda/San Sevaine System. The Manning's n values were taken as-built plans and field observation.

As a result of the project of channelization of Etiwanda/San Sevaine System, the Special Flood Hazard Areas along the Etiwanda/San Sevaine System are revised. Due to the diversion of flow from Etiwanda Creek, the Special Flood Hazard Area and regulatory floodway along the East Etiwanda Creek are removed from just upstream of San Bernardino Avenue to the confluence in this restudy.

In addition, the regulatory floodway along the Etiwanda/San Sevaine System is removed since the 1-percent annual chance flood is contained in the channel based on this restudy.

Due to the incorporation of the Etiwanda/San Sevaine System study, several flood profiles were added and several profiles were deleted from the 2008 FIS. In FIS Volume 2, East Etiwanda Creek profile numbers 55P-59P are no longer applicable and were deleted. In order to maintain effective profile numbering and the alphabetical order of the streams, the new profiles for the Etiwanda/San Sevaine System were added as 61aP-61gP. In FIS Volume 3, San Sevaine Channel profile numbers 159P-162P are no longer applicable and were deleted.

On May 13, 2013, the SBCFCD submitted the required information for the Day Creek Basins levee, levee inventory ID 107b, to allow FEMA to accredit the levee. The levee appears on FIRM panel 06071C7895J and, with this revision, the levee notes on the FIRM panel have been modified to reflect the accreditation of the levee.

10.9 Ninth Revision

The study for San Bernardino County and incorporated areas was revised on February 18, 2015, to modify the approximate floodplain delineations of West Cucamonga Channel from 8th Street Basin to Ely Percolation and Retention Basins in the City of Ontario. The area of revision is geographically located in San Bernardino County and in the City of Ontario. The incorporated LOMR case number is 11-09-3686P and it was converted to a Physical Map Revision (PMR) on February 28, 2012.

The improvement project includes the channelization of West Cucamonga Creek from just upstream of 6th Street to the Ely Percolation and Retention Basins.

The hydrologic and hydraulic analysis for the channelization project of West Cucamonga Creek was prepared by HDR Engineering, Inc. under contract with the San Bernardino County Flood Control District.

Also included in this revision was the incorporation of LOMR Case Number 13-09-0388P. This modification became effective on July 15, 2013, and impacts FIRM 06071C8628 and 06071C8630. The flooding source within the City of Rancho Cucamonga affected as part of this study is the Hellman Avenue Storm Drain Line IV-2.

Detailed information regarding the hydrologic and hydraulic analyses for the channelization project of West Cucamonga Creek can be found in the "West Cucamonga Creek Channel Including Princeton Basin Hydrology and Hydraulic Report for LOMR" document dated July 2011.

As a result of the project of channelization of West Cucamonga Creek, the Special Flood Hazard Areas (Zone A and Zone AO) along this creek are revised.

On May 13, 2013, the SBCFCD submitted the required information for the Ely Percolation and Retention Basins levees, levee inventory IDs 29a, 29b and 29c, to allow FEMA to accredit the levee. The levee appears on FIRM panel 06071C8636J and, with this revision, the levee notes on the FIRM panel have been modified to reflect the accreditation of the levee.

Modifications were also made to reflect FEMA's determination of previously identified PALs along Cucamonga Creek Channel within the footprint of the PMR. These changes were based on FEMA's letter to SBCFCD dated July 25, 2013.

10.10 Tenth Revision

The study for San Bernardino County and incorporated areas was revised on September 2, 2016, to modify PAL notes on panels due to changes to the levee statuses for several levees throughout San Bernardino County, and to perform and incorporate a new approximate study on Sheep Creek in Wrightwood.

For applicable PALs in the County, the SBCFCD submitted analyses to prove that conditions have changed along some leveed flooding sources so that the predicted BFEs for the levee areas are below the landward toe of the levee. Therefore, the levee systems are no longer necessary to protect landward areas during a 1%-annual-chance flood event. Where appropriate, Zone X (shaded) protected by levee zones were removed and replaced with the historic flood hazard zones from the pre-PAL countywide study. Table 16, "List of PAL Levees Determined to No Longer Be in a Levee Condition" lists the levees meeting these criteria. Note that Table 13 of this FIS has also been revised to identify the levees that meet these criteria. Because this revision was not county-wide, there are unrevised FIRM panels where these levees are present. The levee notes on the FIRMs will be updated for these levees the next time the FIRM panel is revised.

TABLE 16 - LIST OF PAL LEVEES DETERMINED TO NO LONGER BE IN A LEVEE CONDITION

Community	Levee Name	Levee Inventory ID
City of Barstow	Mojave River	1a
City of Highland	City Creek	11
City of Highland	Plunge Creek	13a
City of Highland	Plunge Creek	13c
City of Highland	Plunge Creek	14
City of Ontario	Cucamonga Channel	28a
City of Ontario	Lower Cucamonga Spreading Grounds	28b
City of Ontario	Chris Basin	28c
City of Ontario and Unincorporated Areas	Cucamonga Channel	28d
City of Ontario	Cucamonga Channel	30
City of Rancho Cucamonga	Cucamonga Creek	33a
City of Rancho Cucamonga	Cucamonga Creek	33b
City of Rancho Cucamonga	Cucamonga Creek Channel	35
City of Rancho Cucamonga	Cucamonga Creek Channel	36
City of Rancho Cucamonga	Cucamonga Creek Channel	40a
City of Rancho Cucamonga	Cucamonga Creek Channel	40b
City of Rancho Cucamonga	Cucamonga Creek Channel	41a
City of Rancho Cucamonga	Cucamonga Creek Channel	41b
City of Rancho Cucamonga	Cucamonga Creek Channel	42
City of San Bernardino	Lytle Creek Wash Island Levee	50
City of San Bernardino	Lytle Creek Wash – Cajon Creek	51
City of San Bernardino	Muscoy Levee	53a
City of San Bernardino	Muscoy Levee	53b
City of San Bernardino	Lynwood Basin #2	56
City of San Bernardino	MacQuiddy-Severance Diversion Channel	57b
City of San Bernardino	Devil Creek Diversion Channel	70
City of San Bernardino	East Twin Creek (Lynwood Basins #3 and #4)	81b
City of Twentynine Palms	Twentynine Palms Channel	86a
City of Twentynine Palms	Twentynine Palms Channel	86c
City of Twentynine Palms	Twentynine Palms Channel	87
City of Victorville	Mojave River	88
Unincorporated Areas	Rich Basin	93
Unincorporated Areas	Rich Basin	94
Unincorporated Areas	Muscoy Groin #1	96
Unincorporated Areas	Muscoy Groin #4	97
Unincorporated Areas	Spring Valley	100
Unincorporated Areas	Banana Basin	103
Unincorporated Areas	Lenwood	104
Unincorporated Areas	Lytle Creek Levee	105
City of Rialto and Unincorporated Areas	Island Levee	116
Unincorporated Areas	Muscoy Levee	117
Unincorporated Areas	Mojave River	118

The SBCFCD also submitted levee accreditation reports for some levees that are predicted to provide protection during a 1-percent-annual-chance flood event. Specifics on levees that have been accredited as of the time of this FIS publication are below. This revision section provides updates to the levee information presented in the FIS starting on page 137.

Levee 7, located on Reche Canyon Channel, was determined to be de-accredited from providing protection from the 1%-annual-chance flood event. To revise the Zone X (shaded) protected by levee area to a SFHA, a natural valley analysis was performed by modifying a between-levee HEC-RAS version 4.1 model provided by SBCFCD to include areas on the landward side of the levee. SBCFCD 2013 LiDAR topographic data and the flows used in the provided model created by West Consultants for SBCFCD were utilized to complete the study.

Levee 37, located on Demens Debris Basin, was accredited on May 2, 2012. The effective Zone X (shaded) protected by levee area has been maintained from the effective study.

Levee 44b, located on Mill Creek, was determined to be de-accredited from providing protection from the 1%-annual-chance flood event. To revise the Zone X (shaded) protected by levee area to a SFHA, a natural valley analysis was performed by modifying a between-levee HEC-RAS version 4.1 model provided by SBCFCD to include areas on the landward side of the levee. SBCFCD 2013 LiDAR topographic data and the flows used in the provided model created by West Consultants for SBCFCD were utilized to complete the study. Due to the inability to tie-in the landward water surface elevations, the landward flood hazard areas were not revised as a part of this revision.

Levee 48, located on Lytle Creek Wash, and commonly known as Riverside Groin #3, was accredited on September 8, 2014. Updated FIRM panels for this levee were not able to be included in the scope and will be modified through a future revision.

Levee 49a, located on Lytle Creek Wash, and commonly known as Riverside Groin #4, was accredited on September 8, 2014. Updated FIRM panels for this levee were not able to be included in the scope and will be modified through a future revision.

Levee 49b, located on Lytle Creek Wash, and commonly known as Riverside Groin #5, was accredited on September 8, 2014. Updated FIRM panels for this levee were not able to be included in the scope and will be modified through a future revision.

Levees 52 and 65, located on East Twin Creek, were accredited on January 26, 2015. The effective Zone X (shaded) protected by levee area has been maintained from the effective study.

Levee 55, located on East Twin Creek, was accredited on January 26, 2015. The effective Zone X (shaded) protected by levee area has been maintained from the effective study with this revision.

Levee 59, located on Mill Basin, was accredited on June 11, 2014. The effective Zone X (shaded) protected by levee area has been maintained from the effective study with this revision.

Levee 71, located on Twin Creek Channel (formerly Lower Warm Creek), was determined to be de-accredited from providing protection from the 1%-annual-chance flood event. To revise the Zone X (shaded) protected by levee area to a SFHA, a natural valley analysis was performed by modifying a between-levee HEC-RAS version 4.1 model provided by SBCFCD to include areas on the landward side of the levee. SBCFCD 2013 LiDAR topographic data and the flows used in the provided model created by Tetra Tech and AMEC for SBCFCD were utilized to complete the study.

Levee 74, located on West Badger Debris Basin, and commonly called Devil Creek Levee, was accredited on May 2, 2012. The effective Zone X (shaded) protected by levee area has been maintained from the effective study.

Levee 79, located on an unnamed stream and commonly known as Devil Creek Spreading Grounds Levee, was determined to be de-accredited from providing protection from the 1%-annual-chance flood event. To revise the Zone X (shaded) protected by levee area to a SFHA, a natural valley analysis was performed by modifying a between levee HEC-RAS version 4.1 model provided by SBCFCD to include areas on the landward side of the levee. SBCFCD 2013 LiDAR topographic data and the flows used in the provided model created by West Consultants for SBCFCD were utilized to complete the study. This flooding source has been named Devil Creek for this study.

Levee 80a, located on Waterman Levee, was accredited on January 26, 2015. The effective Zone X (shaded) protected by levee area has been maintained from the effective study.

Levee 80b, located on Twin Creek, was accredited on January 26, 2015. The effective Zone X (shaded) protected by levee area has been maintained from the effective study.

Levee 82, located on Twentynine Palms Channel, was identified in the effective FIS as not providing any protection, but subsequent analysis determined that it did provide protection. The levee was determined to be de-accredited from providing protection from the 1%-annual-chance flood event. To revise the Zone X (shaded) protected by levee area to a SFHA, a natural valley analysis was performed by modifying a between levee HEC-RAS version 4.1 model provided by SBCFCD to include areas on the landward side of the levee. FEMA 2012 LiDAR topographic data and the flows used in the provided model created by West Consultants for SBCFCD were utilized to complete the study.

Levee 85, located on Twentynine Palms Channel, was determined to be de-accredited from providing protection from the 1%-annual-chance flood event. To revise the Zone X (shaded) protected by levee area to a SFHA, a natural valley analysis was performed by modifying a between levee HEC-RAS version 4.1 model provided by SBCFCD to include areas on the landward side of the levee. FEMA 2012 LiDAR topographic data and the flows used in the provided model created by West Consultants for SBCFCD were utilized to complete the study. The model was also extended downstream by incorporating an as-built drawing provided by SBCFCD for Utah Trail.

Levee 86b, located on the Donnell Basin, was accredited on June 11, 2014. The effective Zone X (shaded) protected by levee area has been maintained from the effective study.

Levee 92, located on Cajon Wash, and commonly known as Lower Devore Levee, was accredited on June 3, 2013. Updated FIRM panels for this levee were not able to be included in the scope and will be modified through a future revision.

Levee 95, located on Cajon Wash, and commonly known as Muscoy Groin #2, was determined to be de-accredited from providing protection from the 1%-annual-chance flood event. To revise the Zone X (shaded) protected by levee area to a SFHA, an analysis was performed by SBCFCD using a HEC-RAS version 5.0 2D model to confirm that flows from Cajon Wash in a natural valley scenario would not overtop the quarry located landward of the levee. The quarry is designated as a Zone A area with this FIRM revision. SBCFCD 2013 LiDAR topographic data and the flows used in the provided model created by Tetra Tech for SBCFCD were utilized to complete the study.

Levee 98, located on Mojave River, was determined to be de-accredited from providing protection from the 1%-annual-chance flood event. To revise the Zone X (shaded) protected by levee area to a SFHA, a natural valley analysis was performed by modifying a between-levee HEC-RAS version 4.1 model provided by SBCFCD to include areas on the landward side of the levee. SBCFCD 2013 LiDAR topographic data and the flows used in the provided model created by West Consultants for SBCFCD were utilized to complete the study.

Levee 102, located on Quail Wash, was identified in the effective FIS as not providing any protection. Upon further analysis, it was determined that it was providing protection. The levee was accredited on January 30, 2014. To determine the Zone X (shaded) protected by levee area, a natural valley analysis was performed by modifying the HEC-RAS version 4.1 model developed for accreditation to include areas on the landward side of the levee. USGS NED topographic data and the flows used in the accreditation report developed by Tetra Tech and AMEC were utilized to complete the study. Note that BFEs on the landward side of the levee were not changed as a part of this update.

Levee 107b, located on Unknown Creek between Deer Creek Wash and Day Creek Channel, and commonly known as the Day Creek Basins Levee, was accredited on February 14, 2014. The effective Zone X (shaded) protected by levee area has been maintained from the effective study and the PAL note was removed with the September 26, 2014 revision.

Levee 111, located on Santa Ana River, was determined to be de-accredited from providing protection from the 1%-annual-chance flood event. To revise the Zone X (shaded) protected by levee area to a SFHA, a natural valley analysis was performed by modifying a between-levee HEC-RAS version 4.1 model provided by SBCFCD to include areas on the landward side of the levee. SBCFCD 2013 LiDAR topographic data and the flows used in the provided model created by West Consultants for SBCFCD were utilized to complete the study. Due to the inability to tie-in the landward water surface elevations, the landward flood hazard areas were not revised as a part of this revision.

Levee 113, located on Lytle Creek Wash, and commonly known as Riverside Groin #2, was accredited on September 8, 2014. Updated FIRM panels for this levee were not able to be included in the scope and will be modified through a future revision.

Levee 114, located on Lytle Creek Wash, and commonly known as Riverside Groin #4, was accredited on September 8, 2014. Updated FIRM panels for this levee were not able to be included in the scope and will be modified through a future revision.

Levee 115, located on Lytle Creek Wash, and commonly known as Riverside Groin #5, was accredited on September 8, 2014. Updated FIRM panels for this levee were not able to be included in the scope and will be modified through a future revision.

The revision also includes an update to the approximate study on Sheep Creek. The previous floodplain delineation was based on a debris map according to SBCFCD, and Sheep Creek was determined by the revised analysis to generally flow within its banks. The approximate study utilized the USGS regional regression equations updated in 2012 to determine flow rates for the system. Cross section information was based on LiDAR topographic data obtained by FEMA in 2012. HEC-RAS version 4.1 was used to determine water surface elevations for the reach.

The revision also revises the area in the vicinity of the San Bernardino International Airport which had previously been Zone D. The airport historically was the Norton Air Force Base which closed in 1994. The Zone D area has been converted to Zone X unshaded, except for the reach of City Creek that passes through the legacy Zone D area. An approximate study was completed on City Creek to analyze the flood risk of the reach. The approximate study utilized the effective flows for City Creek to determine flow rates for the system. Cross section information was based on LiDAR topographic data obtained by SBCFCD in 2013. HEC-RAS version 4.1 was used to determine water surface elevations for the reach.

Within this jurisdiction there are one or more levees that have not been demonstrated by the community or levee owner(s) to meet the requirements of 44CFR Part 65.10 of the NFIP regulations as it relates to the levee's capacity to provide 1 percent annual chance flood protection. As such, the floodplain boundaries in this area were taken directly from the previously effective FIRM and are subject to change. Please refer to the Notice to Flood Insurance Study Users page at the front of this FIS report for more information on how this may affect the floodplain boundaries shown on the FIRM.

A final CCO meeting for the tenth revision was held on December 11, 2014, to review the results. The meeting was attended by communities, FEMA and the study contractor.

Table 17, "Letters of Map Correction, Revision 10," includes the issued LOMRs that were included in this update.

TABLE 17 - LETTERS OF MAP CORRECTION, REVISION 10

COMMUNITY	FLOOD SOURCE	CASE #	EFFECTIVE
San Bernardino, City of [1]	Western Avenue Storm Drain	08-09-1884P	12/12/2008
Highland, City of	Oak Creek Channel	08-09-1617P	2/27/2009
Apple Valley, City of; Hesperia, City of; and San Bernardino County Unincorporated Areas	Mojave River	08-09-1552P	6/19/2009
San Bernardino, City of	Unnamed Pond	09-09-1602P	10/15/2009
Rancho Cucamonga, City of	Demens Basin Turnout	09-09-3162P	12/23/2009
Highland, City of	Plunge Creek	09-09-2760P	1/22/2010
Rancho Cucamonga, City of	Alta Loma Channel	10-09-1134P	2/26/2010
Colton, City of and San Bernardino, City of	Lytle Creek (East Branch) (previously called Lytle Creek)	09-09-2788P	11/15/2010
Rancho Cucamonga, City of and San Bernardino County Unincorporated Areas	Cucamonga Creek	11-09-3693P	11/1/2011
Rancho Cucamonga, City of	Demens Creek	11-09-1023P	4/28/2011
Apple Valley, Town of	Mojave River	12-09-1775P	10/15/2012
Ontario, City of [2]	East Etiwanda Creek	12-09-2406P	1/4/2013
Apple Valley, Town of	Desert Knolls Wash	12-09-1907P	3/11/2013
Redlands, City of and San Bernardino, City of	Santa Ana River	12-09-0729P	8/2/2013
Ontario, City of [2]	East Etiwanda Creek	13-09-0673P	9/20/2013

[1] LOMR incorporated only on panels included in PMR and in FIS report. Note that LOMR extends on to panel 06071C7945H which was not revised at this time. This portion of the LOMR will be revalidated when the PMR is effective.

[2] LOMR incorporation completes initial incorporation with September 26, 2014 revision. See Table 15.

TABLE 17 - LETTERS OF MAP CORRECTION, REVISION 10 (continued)

COMMUNITY	FLOOD SOURCE	CASE #	EFFECTIVE
San Bernardino, City of and San Bernardino County Unincorporated Areas [1]	Cajon Creek	13-09-1112P	11/29/2013
Apple Valley, City of; Hesperia, City of; San Bernardino County Unincorporated Areas; and Victorville, City of	Mojave River	13-09-2728P	8/15/2014
San Bernardino, City of	Santa Ana River	14-09-2935P	8/24/2015

[1] LOMR incorporated only on panels included in PMR and in FIS report. Note that LOMR extends on to panel 06071C7910H which was not revised at this time. This portion of the LOMR will be revalidated when the PMR is effective.