

SAN JUAN CREEK WATERSHED MANAGEMENT STUDY ORANGE COUNTY, CALIFORNIA

FEASIBILITY PHASE

HYDRAULIC APPENDIX

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San Juan Creek Watershed Management Study F3 Feasibility Phase Appendix

Hydraulic and Sedimentation Documentation

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WITHOUT-PROJECT CONDITIONS

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Public Facilities and Resources Department

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1.0 Introduction

1.1 Purpose and Scope

This report represents hydraulic, geomorphic and erosion analyses in support of the San Juan Creek Watershed Study, a cost shared effort between the U.S. Army Corps of Engineers and a number of local sponsors, including the Orange County Public Facilities and Resources Department. The study proposes to develop a watershed management plan that will enhance positive trends in maintaining a healthy San Juan Creek watershed system. The streams included in this study are San Juan Creek, Trabuco Creek, Oso Creek and Canada Gobernadora. The study includes the analyses necessary to determine the potential for initiating "spin-off" feasibility studies which would lead to environmental restoration or other multi-purpose projects (USACE, 1998). This report describes the hydraulic and sedimentation analyses performed in support of the larger study. It includes the following for San Juan Creek, Trabuco Creek, Oso Creek, and Canada Gobernadora:

- Hydraulic and sediment data collection.
- Without-project hydraulic analyses, including HEC-RAS / HEC-2 water surface profiles and floodplain delineations. The hydraulics will serve as input to the sediment analyses and are also used to quantify potential flood damages at bridge and culvert crossing and bank protection.
- Geomorphic analyses that describe the past and current behavior of the study reaches in terms of profile.
- Without-project erosion analyses based on the U.S. Army Corps of Engineers Sediment Analysis Module (SAM).
- Estimate of sand delivery to the ocean and evaluation of changes over time.
- Estimates of non-damaging frequencies for failure by scour at bridge and culvert crossings and bank protection.

1.2 Previous Reports

The U.S. Army Corps of Engineers has conducted the following studies in the San Juan Creek watershed and vicinity:

San Juan & Aliso Creeks Watershed Management Study, Reconnaissance Report. USACE, February 1997.

Coast of California Storm & Tidal Waves Study, River Sediment Discharge Study, Summary Report and Technical Appendix II, prepared for the USACE, Los Angeles District by Simons, Li and Associates, June 1988.

Coast of California Storm & Tidal Waves Study, South Coast Region, Orange County, Sediment Budget Analysis, Dana Point to Newport Bay, Report 97-3, USACE, Los Angeles District, June 1997.

Other Federal Agencies have conducted the following studies in the San Juan Creek watershed and vicinity:

Orange County Flood Insurance Study, Volume 1-4, & Flood Insurance Rate Maps. FEMA, November 1993.

Orange County Soil Survey. U.S. Department of Agriculture, Soil Conservation Service, September 1978.

Private Consultants and local government agencies have conducted the following studies in the San Juan watershed:

Master Drainage Plan for Development near the Confluence of OSO Creek and Trabuco Creek, Phase I, Hydraulic, Erosion and Sedimentation Analysis of Existing Channels. Simons, Li & Associates, Inc., October 1987.

San Juan Creek and Trabuco Creek Facility Nos. L01 and L02 Aggradation/Degradation Study. Simons, Li & Associates, Inc., August 1984.

O'Neil Regional Park, Phase I, Hydraulic, Erosion and Sedimentation Study of Trabuco Creek. Simons, Li & Associates, Inc., September 1984.

Hydrologic and Hydraulic Analysis of January 9, 1980 Flood from OSO Creek. Simons, Li & Associates, Inc., December 1983.

2.0 General Description of the Watershed Area and Watercourses

The San Juan Creek watershed is located primarily in Orange County on the coast of southern California (Figures 2.1 and 2.2). The eastern and southern tips extend into Riverside and San Diego Counties, respectively. The drainage area of the watershed is approximately 456 sq km (176 sq mi). The terrain of the upper watershed is generally hilly, and in some areas very steep. The lower portions of the watershed are generally flat as the streams approach the coastline.

The major watercourse within the San Juan Creek watershed is San Juan Creek. The creek originates in the Santa Ana Mountains of the Cleveland National Forest at an elevation of approximately 1,280 meters (4,200 feet) above mean sea level (msl) and flows approximately 43.5 km (27 miles) from its headwaters to Doheny State Beach (Dana Point) at the Pacific Ocean. The upstream limit of the study is south of Caspers Regional Park at an elevation of approximately 105 meters (350 feet) msl. The study reach includes approximately 17,100 meters (10 ½ miles). The total drainage area that contributes to San Juan Creek (excluding the Trabuco and Oso Creek watersheds) is approximately 315 sq km (122 sq mi). The upper part of the watershed is largely undeveloped. Significant development does not begin until the area of the La Novia bridge crossing, located approximately 6,000 meters (3¾ miles) upstream of Doheny State Beach. San Juan Creek is a natural channel upstream of Interstate-5 (I-5). Downstream of I-5 the San Juan Creek is a trapezoidal channel with concrete sides and a natural bottom. The improved reach is approximately 4,000 meters (2½ miles) long.

The main tributary to San Juan Creek is Trabuco Creek. Trabuco Creek originates in the Santa Ana Mountains of the Cleveland National Forest at an elevation of approximately 1,728 meters (5,670 feet) msl. The creek flows approximately 60 km (25 miles) to the confluence with San Juan Creek. The upstream limit of the study is near Plano Trabuco at an elevation of approximately 180 meters (590 feet) msl. The total length of the study reach is approximately 15,000 meters (9½ miles). The total drainage area that contributes to Trabuco Creek (excluding the Oso Creek watershed) is approximately 100 sq km (38 sq mi). The upper part of the watershed is largely undeveloped as part of it is in the O'Neill Regional Park. Development begins in the area just downstream of the Livingston Graham gravel mine, located approximately 1,300 meters (0.8 miles) upstream of I-5. Trabuco Creek is a natural channel from the

headwaters to approximately 600 meters (1970 feet) upstream of Del Obispo Street. From 600 meters upstream of Del Obispo Street to the confluence with San Juan Creek, Trabuco Creek is a trapezoidal channel with concrete sides and a natural bottom. The improved reach is approximately 1,600 meters (1 mile) long

The main tributary to Trabuco Creek is Oso Creek. Oso Creek originates in the foothills of the Santa Ana Mountains at an elevation of 500m (1,640 feet) msl. The creek flows a distance of 21.7 km (13.5 miles) to the confluence with Trabuco Creek. The total drainage area that contributes to Oso Creek is approximately 41 sq km (16 sq mi). The upstream limit of the study is near the I-5 crossing at an elevation of approximately 86 meters (280 feet) msl. The total length of the study area is approximately 6,600 meters (4 miles). The entire Oso Creek watershed is developed. Oso Creek is a natural channel from the upstream study limit to Camino Capistrano. From Camino Capistrano to approximately 2,140 meters (1.3 miles) upstream of the Trabuco Creek confluence, Oso Creek is an improved channel with reaches that are lined with either concrete or riprap. Oso Creek, from approximately 2,140 meters upstream of the Trabuco confluence to the confluence is a natural channel.

In addition to Trabuco Creek, the main tributaries to San Juan Creek are Horno Creek, Canada Chiquita, Canada Gobernadora, Bell Canyon, Verdugo Wash, Lucas Canyon, Cold Spring Canyon and Hot Spring Canyon. Of these tributaries, Canada Gobernadora was included as part of this watershed study. Canada Gobernadora originates in the Santa Ana Mountains at an elevation of 365 meters (1,200 feet) msl. The total drainage area that contributes to Canada Gobernadora is 28 sq km(11 sq mi). The upstream limit of this study is south of the Coto de Caza golf course. The total length of the study reach is approximately 5,000 meters (3 miles). There is a residential development along the golf course. The remainder of the watershed is mostly undeveloped.

3.0 Data Collection

3.1 Mapping

Project mapping consists of 1inch = 100 meters, 1-meter contour interval topographic mapping. The project area required 5 sheets (24"x36") along San Juan Creek, 5 sheets along Trabuco Creek, 3 sheets along Oso Creek and 2 sheets along Canada Gobernadora.

3.2 As Built Plans

Geometric data for bridges and culverts were taken from as built plans, where available. A list of plans retrieved is included in Appendix A.

3.3 Sediment Samples

During the winter of 1998 / 1999, samples were collected at 13 points along the 4 studied reaches. All of the samples were taken from the streambed; no streambank samples were taken. Samples were taken from approximately the top one foot of the bed layer. The results of the laboratory sieve analysis of these samples are shown on Figure 3.1 through Figure 3.3.

San Juan Creek and Trabuco Creek include a significant amount of gravel and cobbles. Because of the large size of these pieces, they could not be included in the sample that was sent to the laboratory for analysis. An estimate was made in the field of the largest size rock (D100) and the size that represents the rock that is coarser than 85% of the available sediment and rock (D85). The finest 50% of the sample that was taken for laboratory analysis was assumed to accurately represent the finest 50% of the available supply. The coarsest 50% of the sediment gradation curves resulting from the sieve analysis were adjusted based on the field observed D100 and D85. It should be noted that the D100 and D85 estimates are approximate; however, they are sufficiently accurate for the sediment analysis that was performed. If during a future "spin-off" study a significantly more detailed sediment analysis is performed, at that time a more detailed determination of the coarse material may be warranted. Standard procedures, such as the Wolman pebble count, are available for measuring the coarser fraction of the bed material. However, even these procedures may not improve the accuracy of the measurement of the coarse fraction.

The laboratory curves and the adjusted curves used for the sediment transport analysis for San Juan Creek and Trabuco Creek are shown on Figures 3.4 through 3.13. The D70 shown on these curves was added for presentation purposes and is the value obtained along the straight line between the D50 and D85. Figures 3.14 and 3.15 show the mean (D50) and standard deviation ((D84/D16)^{1/2}) of the sediment samples along San Juan and Trabuco Creek.

There are no significant amounts of gravel and cobbles in Oso Creek or Canada Gobernadora. The sediment gradation curve determined from the laboratory sieve analysis was not adjusted for the sediment transport analysis.

The samples and the soil characteristics are listed in Table 3.1, located from upstream to downstream samples along each creek.

Table 3.1 Sediment Samples and Characteristics

Sample #	Location	Soil Classification		D60	D30	D10	Gravel	Sand	Silt/Clay
			(mm)	(mm)	(mm)	(mm)	(%)	(%)	(%)
	San Juan Creek								
SJC1	Bed sample 200 ft u/s of Conrock access road	Brown poorly graded SAND with gravel (SP)	400	5.0	0.80	0.38	40	49	11
SJC2	Bed sample 300 ft u/s of Ortega Highway	Light brown poorly graded SAND (SP)	610	5.5	0.57	0.38	41	46	13
SJC3	Bed sample d/s of La Novia Avenue	Light brown poorly graded SAND with gravel (SP)	483	6.5	0.75	0.39	42	46	12
SJC4	Bed sample between Camino Capistrano and R.R.	Light brown poorly graded SAND (SP)	457	5.6	0.71	0.41	41	47	12
SJC5	Bed sample u/s of Stonehill Drive	Brown poorly graded SAND with gravel (SP)	254	4.7	0.70	0.38	39	49	12
	Trabuco Creek								
RB1	Bed sample near Tijeras golf course	Brownish gray poorly graded SAND (SP)	762	3.5	0.31	0.22	38	12	50
TRB2	Bed sample at proposed Crown Valley crossing	Light brown poorly graded SAND with gravel (SP)	762	12.0	0.75	0.34	46	40	14
TRB3	Bed sample just u/s of Metro- Link R.R	Grayish brown poorly graded SAND (SP)	279	4.6	0.55	0.13	40	38	22

Table 3.1 Sediment Samples and Characteristics

Sample #	Location	Soil Classification	D100	D60	D30	D10	Gravel	Sand	Silt/Clay
			(mm)	(mm)	(mm)	(mm)	(%)	(%)	(%)
TRB4	Bed sample at Oso Road crossing	Light brown poorly graded SAND with gravel (SP)	610	3.0	0.33	0.19	37	25	38
TRB5	Bed sample at Del Obispo crossing	Grayish brown well-graded SAND with silt (SW-SM)	610	4.5	0.58	0.33	40	44	16
	Oso Creek								
OSO1	Bed sample above Camino Capistrano	Light brown poorly graded SAND (SP)	4.6	-	-	-	0	28	72
OSO2	Bed sample at confluence with Trabuco Creek	Light brown poorly graded SAND (SP)	14	0.6	0.26	0.06	4	83	13
	Canada Gobernadora								
CG1	Bed sample at confluence with San Juan Creek	Light brown poorly graded SAND (SP)	5.0	0.61	0.35	0.20	14	84	2

4.0 Without Project Hydraulic and Floodplain Analyses

This chapter describes the without-project hydraulic analyses for existing and ultimate conditions. Water surface profiles were developed for the 2-, 25-, 50-, 100-, 200- and 500-year return intervals. The following sections describe the methodologies and assumptions used in the analyses and the results of those analyses.

4.1 Hydrology

The hydrologic inputs used to compute water surface profiles for existing and ultimate conditions are listed in Table 4.1 and Table 4.2. They are based on the rainfall-runoff modeling described in the "San Juan Creek Watershed Management Study, F3 Feasibility Phase Appendices, Hydrology Documentation", May 1999. Ultimate conditions reflect the future land use based on the build out conditions expected by the year 2050.

Table 4.1 Hydrologic Inputs – Peak Discharges for Existing Conditions

Conc. Points	HEC-2	Q2	Q25	Q50	Q100	Q200	Q500
From/To	Cross Sections	(cms)	(cms)	(cms)	(cms)	(cms)	(cms)
San Juan Creek							
Pacific Ocean to confluence with Trabuco Creek	100+00 to 137+50	74	640	1006	1510	2185	3202
Confluence with Trabuco Creek to La Novia Bridge	139+00 to 161+50	15	451	725	1074	1519	2222
La Novia Bridge to Ortega Highway Bridge	163+00 to 190+00	14	428	691	1023	1454	2148
Ortega Highway Bridge to confl. with Canada Gobernadora	191+50 to 220+00	14	422	683	1006	1425	2120
Confluence with Canada Gobernadora to upstream limit	221+50 to 271+00	13	374	589	884	1253	1873
Trabuco Creek							
Confluence with San Juan Creek	100+00 to 101+50	74	623	989	1479	2140	3117
Confluence with San Juan Creek to Confluence with Oso Creek	103+00 to 134+50	74	244	354	536	782	1162
Confluence with Oso Creek to Confluence with Tijeras Cyn. Creek	136+00 to 230+50	16	164	283	428	674	1017
Confluence with Tijeras Cyn. Creek to upstream limit	232+00 to 250+00	12	147	241	360	544	833

Table 4.1 Hydrologic Inputs – Peak Discharges for Existing Conditions

Conc. Points From/To	HEC-2 Cross Sections	Q2 (cms)	Q25 (cms)	Q50 (cms)	Q100 (cms)	Q200 (cms)	Q500 (cms)
Oso Creek							
Confluence with Trabuco Creek to Crown Valley Parkway	100+00 to 145+00	74	130	139	153	221	337
Crown Valley Parkway to just d/s of Galivan Retarding Basin	146+25 to 149+50	74	125	133	139	221	337
Just d/s of Galivan Retarding Basin to Galivan Basin weir structure	150+08 to 152+64	74	113	116	122	224	337
Galivan Basin weir structure to confluence with La Paz Creek	152+94 to 166+00	74	193	227	258	357	470
Confluence with La Paz Creek to upstream limit of La Paz Creek	167+50 to 170+50	17	51	60	65	88	119
Canada Gobernadora							
Confluence with San Juan Creek to upstream limit	100+00 to 151+00	9	94	147	196	278	385

Table 4.2 Hydrologic Inputs – Peak Discharges for Ultimate Conditions

Conc. Points From/To	HEC-2 Cross Sections	Q2 (cms)	Q25 (cms)	Q50 (cms)	Q100 (cms)	Q200 (cms)	Q500 (cms)
San Juan Creek							
Pacific Ocean to confluence with Trabuco Creek	100+00 to 137+50	74	666	1029	1533	2227	3231
Confluence with Trabuco Creek to La Novia Bridge	139+00 to 161+50	18	459	734	1080	1536	2227
La Novia Bridge to Ortega Highway Bridge	163+00 to 190+00	16	434	694	1029	1459	2148
Ortega Highway Bridge to confl. with Canada Gobernadora	191+50 to 220+00	15	425	686	1006	1431	2120
Confluence with Canada Gobernadora to upstream limit	221+50 to 271+00	13	374	589	884	1253	1873
Trabuco Creek							
Confluence with San Juan Creek	100+00 to 101+50	74	649	1015	1502	2176	3146
Confluence with San Juan Creek to Confluence with Oso Creek	103+00 to 134+50	74	261	374	547	810	1182

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Table 4.2 Hydrologic Inputs – Peak Discharges for Ultimate Conditions

Conc. Points From/To	HEC-2 Cross Sections	Q2 (cms)	Q25 (cms)	Q50 (cms)	Q100 (cms)	Q200 (cms)	Q500 (cms)
Confluence with Oso Creek to Confluence with Tijeras Cyn. Creek	136+00 to 230+50	26	187	303	456	691	1034
Confluence with Tijeras Cyn. Creek to upstream limit	232+00 to 250+00	20	153	272	380	575	867
Oso Creek							
Confluence with Trabuco Creek to Crown Valley Parkway	100+00 to 145+00	74	130	139	153	221	337
Crown Valley Parkway to just d/s of Galivan Retarding Basin	146+25 to 149+50	74	125	133	139	221	337
Just d/s of Galivan Retarding Basin to Galivan Basin weir structure	150+00 to 152+64	74	113	116	122	224	337
Galivan Basin weir structure to confluence with La Paz Creek	152+94 to 166+00	74	193	227	258	357	470
Confluence with La Paz Creek to upstream limit of La Paz Creek	167+50 to 170+50	17	51	60	65	88	119
Canada Gobernadora							
Confluence with San Juan Creek to upstream limit	100+00 to 151+00	16	113	159	204	292	391

4.2 Hydraulic Modeling

4.2.1 Computer Model

Water surface profiles were computed using the HEC-2 Water Surface Profiles computer program and the HEC-River Analysis System (HEC-RAS) program, both developed by the U.S. Army Corps of Engineers. The sediment transport model used in this study (the USACE's Sediment Analysis Module (SAM)) is written to work directly with the HEC-2 Tape95 output files. The results of the HEC-2 and HEC-RAS output files are similar, with the exception being at some bridge crossings. HEC-RAS results were used to define the floodplain limits and the profiles. HEC-2 results were used in the sediment transport computations. The HEC-RAS and HEC-2 file names are summarized in Table 4.3.

The Trabuco Creek HEC model, upstream of I-5 on the right bank, predicts that flows above the 50-year return period break out of the main channel and follow a path separate from the main channel. Therefore a separate model was used for floodplain mapping in this reach.

There were minor differences between the length of the floodplain for high and low flows near two bends on San Juan Creek. A preliminary hydraulic analysis showed that the difference in reach lengths had a negligible effect on the water surface elevations. Therefore, only one model was created to analyze high flows and low flows.

Table 4.3 HEC-2 / HEC-RAS Files

	Table 4.5 HEC-	-2 / HEC-KAS FILES	
HEC Models	Return Interval (year)	Condition	Description
SANJUAN.*	2, 25, 50, 100, 200, 500	Existing	San Juan Creek
TRABUCO.*	2, 25, 50, 100, 200, 500	Existing	Trabuco Creek
OSO.*	2, 25, 50, 100, 200, 500	Existing/Ultimate	Oso Creek
CANGOB.*	2, 25, 50, 100, 200, 500	Existing	Canada Gobernadora
TRABRK.*	2, 25, 50, 100, 200, 500	Existing	Trabuco Creek Overflow on Right Bank U/S of I-5
ULT-SANJUAN.*	2, 25, 50, 100, 200, 500	Ultimate	San Juan Creek
ULT-TRABUCO.*	2, 25, 50, 100, 200, 500	Ultimate	Trabuco Creek
ULT-CANGOB.*	2, 25, 50, 100, 200, 500	Ultimate	Canada Gobernadora
ULT-TRABRK.*	2, 25, 50, 100, 200, 500	Ultimate	Trabuco Creek Overflow on Right Bank U/S of I-5

4.2.2 Cross Sections

An approximate centerline was laid out along all 4 creeks. This centerline does not follow all the meanders of the low flow channel. However, it should be noted that the invert shown on the flood profiles in the HEC-RAS model does represent the thalweg of the channel. Cross sections were taken at 150-meter intervals along the centerline, oriented left to right looking downstream. At each section the location of the centerline was set at 5,000. Additional sections were taken

where needed to adequately model bridges, culverts and drop structures. The stationing of the sections corresponds to the cumulative stream length. The most downstream station was set at 100+00. For example Station 150+00 is 5,000 meters above the downstream limit, Station 100+00.

4.2.3 Manning's n-values

Manning's n-values for main channel, left overbank, and right overbank were estimated reach-by-reach based on the topographic mapping, aerial photos and field reconnaissance. The main channel n-values were determined using procedures by Chow (1959) and Arcement and Schneider (1989). A base n-value for a straight, uniform smooth channel of a given material was selected and then adjusted according to the surface irregularity, variations in shape and size, obstructions, vegetation and meandering. The channels in this study were earthen, sand bed, rock lined or concrete. The degree of surface irregularity, vegetation and meandering varied among the reaches.

The overbank n-values were determined using the "Modified Channel Method" (Arcement and Schneider, 1989) in which a base n-value for a smooth, bare floodplain surface was selected and adjusted for surface irregularities, obstructions (such as boulders and structures) and vegetation.

The selected n-value was kept constant between different discharges. It should be noted that the channel roughness can vary between flow regimes and discharges. For example the impact of an obstruction on the roughness experienced by the channel, such as large boulders, varies depending on the depth of flow relative to the height of the obstruction.

Tables summarizing the Manning's n-values for each reach are included in Appendix B. Photographs of the study reaches are also included in Appendix B

4.2.4 Bridges

The following bridges and culverts cross San Juan Creek between Caspers Regional Park and the Pacific Ocean.

Table 4.4 San Juan Creek Bridge/Culvert Crossings

Crossing Name	Station
Conrock Access Road	242+00
Antonio Parkway	197+00
Lower Ortega Highway	189+00
La Novia Avenue	160+00
Interstate 5	144+00
Camino Capistrano	142+50
Metrolink Railroad	141+00
Stonehill Drive	115+50
Camino Las Ramblas	103+50
Pacific Coast Highway	103+00

The following bridges and culverts cross Trabuco Creek between Plano Trabuco and the San Juan Creek confluence.

Table 4.5 Trabuco Creek Bridge/Culvert Crossings

Crossing Name	Station
Oso Parkway	221+00
Trabuco Cyn Road	170+50
Ranch Viejo	146+50
Interstate 5	146+00
Camino Capistrano	145+00
Metrolink Railroad	137+00
Del Obispo St	110+00

The following bridges and culverts cross Oso Creek between I-5 and the Trabuco Creek confluence. The San Joaquin Corridor – 73 (Station 132+50) and Paseo De Colinas (Station 135+50) bridges were not modeled in the hydraulic model because the bridge decks are very high and they have no obstructions (i.e. piers) within the channel.

Table 4.6 Oso Creek Bridge/Culvert Crossings

Crossing Name	Station
Interstate 5	166+50
Camino Capistrano	155+00
Metrolink Railroad	154+50
Galivan Orifice Bridge	153+00
Crown Valley Pkwy	146+50
Paseo De Colinas	135+50
San Joaquin 73	132+50
High School	128+00
Double Box Culvert	122+50

There are no bridge or culvert crossings on Canada Gobernadora between the Coto de Caza golf course and the confluence with San Juan Creek.

The special bridge method was used within the HEC-2 model to analyze all bridge crossings. The special culvert method was used within the HEC-2 model to analyze all culvert crossings. All input parameters were based on design plans, topography and/or field reconnaissance. The width of each pier or culvert wall was increased by 0.6 meters on each side of each pier to account for debris accumulation.

4.2.5 Levees, Block Walls and Berms

The lower 4,000 meters (2 ½ miles) of San Juan Creek are improved as a trapezoidal channel with concrete sides. Levees / berms have been built up above the channel banks. Once the levee is overtopped, it was assumed for the floodplain mapping that the levee along that bank fails along the entire reach. Freeboard was not considered for determining if the levees were overtopped. The levees were divided into two reaches – upstream and downstream of Stonehill Drive. See Section 4.3 for further discussion regarding the impact of the levees on the floodplain boundary.

Numerous block walls and berms exist throughout the watershed. Based on discussion between the County and the USACE, an assumption was made that if greater than 1 foot of water is expected against the wall or berm it will fail. The impact of the berms and walls are discussed further in Section 4.3.

4.2.6 Starting Water Surface Elevations

The initial estimate of the starting water surface elevation for all profiles on San Juan Creek was the "mean higher high water" (mhhw) level. This elevation is approximately the same along the southern California coast from Huntington Beach to Oceanside Harbor. The mhhw elevation is equivalent to a starting water surface elevation of 1.65 meters. Preliminary HEC-2 runs showed that this elevation is below critical depth; therefore, all profiles were started at critical depth. The normal depth elevation was used as the starting water surface elevation on Trabuco Creek, Oso Creek and Canada Gobernadora.

4.2.7 Split Flows on Trabuco Creek

In large flood events (greater than the 50-year flood event) flows are forced into a pond used by the Livingston Graham gravel mine (Station 169+00). When the flow exits the pond it follows a path through the gravel mine independent from the main channel flowpath. As the flow moves through the gravel mine staging area it is directed towards the downstream residential area. A separate HEC-RAS hydraulic model was used to determine the water surfaces through this overflow reach. The amount of flow that would be expected in this overflow reach was determined through the flow distribution in the main channel model (see section 4.3.5 for further discussion).

4.2.8 Flow Regime

With the exception of some isolated sections, near bridges and drop structures, and through lined channels, the profiles on all 4 creeks are subcritical. A significant portion of Canada Gobernadora flows near critical depth. The HEC-RAS output, which was used to define the flood profiles and the overflow boundaries, reflects both regimes. The HEC-2 output, which was used in the sediment transport analysis, reflects only the subcritical regime. Because bridge effects are not included in sediment transport capacity calculations and supercritical flow occurs

infrequently (except in lined channels where capacity is addressed separately), the exclusion of the supercritical regime in the HEC-2 results is not anticipated to have any significant effect on the results of the transport analyses.

4.2.9 Results: HEC-RAS output, Profiles and Floodplains

The HEC-RAS summary output files for the 2-, 25-, 50-, 100-, 200-, and 500-year events for both existing and ultimate condition discharges are included as Appendix C. Electronic input files on are included on the CD-Rom submitted separately. These files can be used to generate cross sections, rating curves and flood profiles Plotted floodplains for each return interval for existing conditions are plotted on overflow maps included as Appendix D. Differences in water surface elevations for the ultimate conditions are not significantly different (typically less than 0.1 meters on San Juan Creek and Canada Gobernadora and typically less than 0.3 meters on Trabuco Creek. There are no changes between existing and ultimate conditions on Oso Creek). The only exception is on Canada Gobernadora during the 2-year flow event where water surface elevations can be up to 0.5 meters different. The flow in this event is very low, 9-16 cms. The additional flow amount is not significant enough to warrant further investigation. Because of the negligible differences, plotted profiles and overflow boundaries for the ultimate conditions are not included. Existing conditions profiles are shown in Appendix E.

4.2.10 Physical Model

Between August 1992 and September 1994 a physical model study was performed by the U.S. Army Engineer Waterways Experiment Station for the Orange County Environmental Agency Public Works. The study limits extended along San Juan Creek from 50 meters upstream of I-5 to 884 meters downstream of the confluence with Trabuco Creek. The limits along Trabuco Creek extended 1,550 meters upstream of the confluence with San Juan Creek. The focus of the model study was to investigate hydraulic conditions and flow patterns along both streams, potential scour patterns, the need for bottom stabilization and the optimal length and location for training walls. This study showed that there are instabilities in the confluence area, as demonstrated by the formation of standing waves. Channel instability can lead to an increased risk of failure along the bank protection or at bridges. This instability is, to some degree, reflected in the hydraulic model for the F3 study by the occurrence of critical flow just upstream

and downstream of the confluence. As a result of the physical model study several recommendations were made to improve the stability of the channel. One such recommendation was to concrete line the invert of the channel.

4.3 Overbank Floodplain Boundary Discussion

In areas throughout the lower part of the watershed manmade features, such as levees and block walls, have been constructed. These features have the potential to impact the limit of flooding for certain frequency events. The impacts determined based on the hydraulic analyses at each of these locations is discussed below.

4.3.1 San Juan Creek near La Novia Bridge

Downstream of La Novia bridge north of San Juan Creek a block wall has been constructed along school grounds. This wall can control water that overflows from the stream adjacent to the wall. However, upstream of La Novia Avenue flow from the 100-year event has inundated the north bank past the block wall. Therefore upstream overbank flow will inundate both sides of the block wall.

4.3.2 San Juan Creek upstream of Stonehill Drive

Levees have been constructed along the east and west bank of San Juan Creek up to Interstate-5. According to the plans the height of the levees from the invert to the constructed top of the levee is 4.3 to 4.6 meters (14 to 15 feet). The levee along the west side was raised in 1989. A comparison of the top of levee elevation shown on the design plans with the field survey information at the confluence shows negligible differences. Based on the current field survey, the height from the invert to the top of bank is approximately 6 meters along the west bank upstream of Station 125+50. This leaves 0.4 to 0.9 meters of freeboard between the 100-year water surface and the top of the levee. Between Station 124+00 and Stonehill Drive the height from the invert to the top of levee decreases to 5.2 to 5.9 meters. This reduces the freeboard to between 0.3 and -0.1 meters. At Station 121+00 flow can overtop the west levee. High ground 75 meters west of the levee prevents flow from inundating any structures. However, because the levee is overtopped it is assumed to fail along the west bank upstream of Stonehill Drive. Flow overtops the levee further upstream on the east side (Station 136+00) so the levee along the east

bank upstream of Stonehill Drive is also assumed to fail. In addition to levee overtopping flows, the east and west overbanks are also inundated by the backwater caused by Stonehill Drive. The 100-year backwater elevation of 14 meters extends upstream to approximately Station 123+00. It should be noted that the design flow shown on the latest channel plans (dated 1996) of 1,671 cms (59,000 cfs) is greater than the 100-year discharge of 1,510 cms (53,000 cfs) used for this study.

4.3.3 San Juan Creek downstream of Stonehill Drive

Levees have been constructed along the east and west bank of San Juan Creek from Stonehill Drive downstream to Pacific Coast Highway (PCH). The plans show that the height of the levee from the invert to the constructed top of the levee is 4.3 meters (14 feet) with a small reach raised to 5.8 meters (19 feet). The levees were raised in 1982 and 1986. The levees are sufficient to contain the 100-year flow. However, backwater from the PCH bridge causes inundation of both overbank. The 100-year backwater elevation of approximately 8 meters extends up to between Station 108+00 and 110+00. The east overbank is also inundated by flows from upstream of Stonehill Drive. The overtopping flows can continue under Stonehill Drive along San Juan Creek Road and inundate the east overbank. It should be noted that adequate freeboard was not considered in the levee failure analysis. In some locations the water surface elevation is very close to the top of the levee. For example at Station 110+50 the 100-year water surface elevation is within 0.25 meters of the top of the levee on the west bank.

4.3.4 San Juan Creek at PCH Bridge

The hydraulic analysis shows that during the 100-year flood, flow overtops PCH bridge. Once flow overtops the bridge it will run east and west along PCH. An existing K-Rail barrier that runs along the middle the roadway at the bridge will prevent flow from continuing directly downstream along San Juan Creek. At the point where the K-Rails end flow can cross to the south side of the bridge and continue south to the downstream side of the bridge. Extensive flooding during the 100-year event in the overbank east and west of San Juan Creek upstream of PCH will flow south and inundate the east and west overbank downstream of PCH.

4.3.5 Trabuco Creek upstream of I-5

The 100-year event overbank flooding westerly of Trabuco Creek upstream of Interstate-5 is caused by upstream breakout flows through the Livingston Graham gravel mine. In events greater than a 50-year flood event, there is breakout through the gravel mine that is directed towards the downstream residential area. There are earthen dikes (near Station 159+00) that direct the flow back into the main channel just above the residential area, but they are not engineered dikes. The water depth at the dikes is approximately 0.46 meters (1.51 feet) therefore, they were assumed to fail for the floodplain mapping (see failure discussion is Section 4.2.5). Flow does not breakout of the main channel downstream of the gravel mine to Interstate-5 for the 100-year flood event, therefore the discontinuous block wall that separates most of the residential area from the channel does not influence the mapping of the floodplain.

4.3.6 Trabuco Creek near Del Obispo Bridge

The 100-year event overbank flooding along Trabuco Creek near Del Obispo Bridge (Station 110+00) is caused by backwater from the bridge. The backwater is pushed laterally though the residential areas along Trabuco Creek until it reenters downstream near the San Juan Creek confluence. Since flow does not breakout of the main channel downstream of Del Obispo Bridge for the 100-year flood event the block wall along the trailer park does not influence the mapping of the floodplain.

4.3.7 Oso Creek upstream of Camino Capistrano

The hydraulic model for Oso Creek includes the proposed concrete channel from downstream of the Galivan Retarding Basin culvert to upstream of the Metrolink and Camino Capistrano bridges. For the 100-year event the model predicts subcritical flow from the culvert through the Camino Capistrano bridge, which causes pressure and weir flow. The hydraulic model was run again assuming that a hydraulic jump occurs downstream of the Metrolink and Camino Capistrano bridges. To do this the flow was forced to a supercritical depth downstream of the bridges. The model again predicted subcritical flow with negligible change in the water surface through the bridges causing pressure and weir flow. Therefore, the overbank flooding on the

south side of the channel upstream of the bridges in these hydraulic models is caused by bridge losses and not downstream effects.

5.0 Geomorphic Analysis

A geomorphic analysis was conducted to assess the characteristics and general stability of San Juan Creek, Trabuco Creek, and Oso Creek. Changes in the profile of these creeks over time were investigated in light of changes in development and flood history. This analysis was not performed for Oso Creek and Canada Gobernadora since no historical data is available. The analysis relied primarily on field reconnaissance, historical maps and previous reports listed in Table 5.1.

Table 5.1 Geomorphic Analysis – Historical Information Used

Historical Information	Date	Source/Author
Mapping		
Topographic map*	1960	
Topographic map (1967 topography)*	1970	USACE, LA District
Topographic map*	1984	OCEMA
* Note that this information was obtained from		
the SLA(1984) report listed below		
Reports		
Orange County Annual Scour Study	1991	
Orange County Annual Scour Study	1993	
San Juan Creek and Trabuco Creek Facility Nos. L01 and L02 Aggradation/Degradation Study	1984	Simons, Li and Associates Inc.
Orange County Annual Scour Study	1995	
Orange County Annual Scour Study	1995	

5.1 Major Events

The largest recorded events occurred on San Juan Creek in 1995 and 1969. Based on the statistical analysis of the gage data (see Hydrology appendix) these flows correlate to approximately 50-year events. In the past 25 years large events have also occurred during 1998, 1978, 1980, 1993 and 1983. The largest flows recorded on Trabuco Creek occurred in 1937 and 1970. The flows correlated to approximately 50-year events. Gage data on this creek was only recorded up to 1971. Events of large magnitudes are often responsible for large changes in the stream profile.

5.2 Stream Bed Profiles

5.2.1 San Juan Creek

Figure 5.1 compares the stream bed profile based on the current project mapping (1998) to that from 1960, 1970, and 1984 topographic mapping. Physical landmarks (such as bridge crossings) were used to plot the 1998 data with the historical data. The following is a description of the significant changes in the profiles, proceeding from upstream to downstream. The reaches were divided based on hydraulic parameters and are described in Section 6.2.

In Reach 1 there is a large amount of degradation between the 1970 and 1984 profile. Large flow events occurring during 1983 may account for this large jump. From 1984 to 1998 there is some aggradation occurring in this reach.

In Reaches 2 through 4 there is a constant degradation trend from the 1970 profile to the 1984 profile to the 1998 profile. The largest difference occurs between the 1970 and 1984 profiles. Large flow events occurring in 1983 may be responsible for the large differences.

In Reaches 5 and 6 the degradation trend continues but the largest differences are between the 1984 and 1998 profiles. The lowered profile reflects the gravel pit in the Conrock Mining Lease area. The mining had started before 1984 and the jump in profile may reflect the detail level of the topography as much as the actual extraction processes.

In Reach 7 there is a constant degradation rate from 1970 to 1998.

In Reaches 8 through 14 there is significant degradation from the 1970 profile to the 1984 profiles. From 1984 to 1998 there are minor differences in the stream profile. These minor changes are degradational in Reaches 7, 8, 11 and 12 and aggradational in Reaches 9, 10, 13 and 14. Historical data from 1960 begins in Reach 11. The 1960 streambed profile shows minor degradation from the 1970 profile.

Reaches 15 through 17 show minor and constant degradation from 1960 to 1970. More significant degradation occurred from 1970 to 1984. Aggradation from 1984 to 1998 brought the profile back up to a point midway between the 1984 and 1970 profile.

Reaches 18 and 19 show large degradation from 1960 to 1970. The 1984 and 1998 profiles are fairly similar to the 1970 profiles.

Reaches 20 and 21 show degradation from 1960 to 1984 and then aggradation from 1984 to 1998.

In summary, the upper reaches show significant degradation from 1970 to 1984 and continuing degradation through 1998. The middle and lower reaches show large degradation from 1970 to 1984 and then a slightly aggradational trend from 1984 to 1998. The large change in the 1984 bed profile is most likely a result of the large flows experienced in this watershed in the 1978, 1980, and 1983 floods. The middle and lower reaches are readjusting to a profile closer to the 1970 profile. This process of natural readjustment may be slowed due to activity in the watershed. The upper reaches do not appear to be making this adjustment, most likely as a result of the mining extraction in these reaches.

Records of San Juan Creek's profile are not available from the time before development began. Before the time of the oldest historical data agricultural development may have already had a significant impact on the creek. It is possible that San Juan Creek has been adjusting to those changes since agricultural development began.

5.2.2 Trabuco Creek

Figure 5.2 compares the stream bed profile based on the current project mapping (1998) and historical information from 1984, 1970, and 1960, where available. The profiles were registered to each other based on physical landmarks, such as bridge crossings and confluence points.

In Reach 10 there was significant degradation from the 1960 profile to the 1970 profiles From 1970 to 1984 there was degradation in the upper section, while the I-5 structure caused

aggradation in the lower section. From 1984 to 1998 there was aggradation in the upper section and degradation in the middle of the reach.

In Reach 11 there is significant degradation from the 1960 profile to the 1970 profile in the upper and middle sections of the reach. From 1970 to 1984 there was additional degradation especially in the lower section of the reach. From 1984 to 1998 there was aggradation in the lower section of the reach due to the controlled crest elevation of the grouted stone drop structure placed under the Metro-Link Railroad Bridge.

In Reach 12 there is minimal change from the 1960 profile to the 1970 profile. From 1970 to 1984 there was significant degradation. The large change in the 1984 bed profile is most likely a result of the large flows experienced in this watershed in the 1983 flood. From 1984 to 1998 there is slight degradation in the reach due. This degradation is a result of the deficit of sediment in the flow caused by the aggradation upstream of the Metro-Link Railroad Bridge.

In Reach 13 there is minimal change from the 1960 profile to the 1970 profile. From 1970 to 1984 there was significant degradation. The large change in the 1984 bed profile is most likely a result of the large flows experienced in this watershed in the 1978, 1980, and 1983 floods. From 1984 to 1998 there is minimal change in the stream profiles with slight degradation in the upper section and slight aggradation in the lower section.

In Reach 14 there is significant degradation from the 1960 profile to the 1970 profile. This is due to the construction of the improved channel in 1962. From 1970 to 1984 there was degradation in the upper section. The change in the 1984 bed profile is most likely a result of the large flows experienced in this watershed in the 1983 floods. From 1984 to 1998 there was slight aggradation in the reach due to the channel recovering from the large events before 1984.

In Reach 15 there is significant degradation from the 1960 profile to the 1970 profile. This is due to the construction of the improved channel in 1962. From 1970 to 1998 there has been minimal change in the stream profile.

6.0 Erosion / Sedimentation Analyses

6.1 SAM Hydraulic Design Package

The SAM Sediment Hydraulic Package is an integrated system of programs developed through the Flood Damage Reduction and Stream Restoration Research Program to aid engineers in analyses associated with designing, operating and maintaining flood control channels and stream restoration projects (Copeland, 1997). SAM combines the hydraulic information and the bed material gradation information to compute the sediment transport capacity for a given cross section at a given discharge at a single point in time. A number of sediment transport functions are available for this calculation. The calculated sediment transport rates can then be combined with an event hydrograph to compute the total sediment carrying capacity (volume) of that cross section for a single event or over a period of time represented by the hydrograph. This total volume is referred to in the SAM User's Manual as the "yield". This yield should be considered to be a "potential yield" since changes in the cross section along the time represented by the hydrograph are not considered. For example a section with a high transport rate may begin to erode over time. The eroded section will have a decreased transport capacity as a result of the changed hydraulic characteristics. These changes are not considered in SAM. This is a limitation in a steady-state sediment transport analysis procedure.

The hydraulics module (SAM.HYD) calculates hydraulic parameters based on a single cross section. An alternative hydraulics module, SAM.M95, can be used when the output from a HEC-2 analysis is available. This latter module was used in the analysis of transport capacities within the San Juan watershed. Average hydraulic parameters across a user defined reach are calculated and formatted for input into the SAM.SED module. Cross sections in a reach can be omitted from the averaging calculation. In this way local effects, such as bridges, can be excluded from the averaging calculations. These average parameters can be computed for multiple profiles.

The SAM.SED module combines the hydraulic parameters with the bed material gradation curve to compute bed material sediment discharge rating curves by size classification. A wide range of sediment transport procedures is available for this calculation. The SAMAID program provides the user with recommended procedures based on the best matches between the hydraulic parameters and D50 of the study reach with the same parameters of selected rivers. Calibrations based on measured data have been performed between the available procedures and the selected rivers. This calibration has shown which procedures best predict the actual sediment transport capacity of a particular river. By determining which procedures provide the best prediction on rivers with characteristics similar to the study reach, a procedure to determine the transport on the study reach can be selected. SAM.SED provides a transport capacity (metric tons/day) for each given discharge. If these computations are made over a series of reaches within a river, the relative sediment yield for adjacent reaches can be compared. If the potential sediment yield within a particular reach is less than that provided by the reach immediately upstream then there will be more sediment coming into the reach than can be transported by that reach. In this situation it is expected that the reach will experience aggradation. Likewise if the sediment transport capacity of a given reach is higher than that of the reach immediately upstream it is expected that the reach will experience degradation. By carrying out this comparison along each reach of the river (with the upstream reach being defined as the supply reach) the potential sediment yield excess or deficit can be defined along the river. If a representative length and cross section are provided for each reach, the excess or deficit sediment yield can be converted into average aggradation or degradation depths along the reach.

6.2 Application to the San Juan Creek Watershed

This section describes the application of the SAM methodology to San Juan Creek, Trabuco Creek, Oso Creek and Canada Gobernadora.

6.2.1 San Juan Reaches

The overall study reach extends from the Pacific Ocean to Caspers Regional Park. Within this reach, 21 individual reaches were defined for the sedimentation analyses (Figure 6.1). The goal of the reach breakdown was to define individual reaches having reasonably similar hydraulic characteristics throughout the defined reach. The reaches were broken down based on a comparison of hydraulic parameters (primarily top width and velocity), existing hydraulic controls (such as bridges and drop structures), and cross sectional geometry. Table 6.1 summarizes the reach limits, lengths, channel information, the sediment samples used to develop the bed material gradation curve to represent that reach, and other pertinent features within the reach.

Table 6.1 Erosion/Sedimentation Reaches

		Reach	Sediment	Channel		Other
Reach	Station Location	Length (m)	Sample	Dimensions	Slope	features
	San Juan					
	Creek					
1	271+00 to 265+00	600	SJC1	1 m deep low flow	0.8%	Wide channel bed within Conrock Mining Lease
2	265+00 to 259+50	550	SJC1	5-6 m deep	1.2%	Incised channel within Conrock Mining Lease
3	259+50 to 251+00	850	SJC1	200 m wide	0.7%	No clear low flow Within Conrock Mining Lease
4	251+00 to 242+00	900	SJC1	30 m wide (min)	0.4%	Within Conrock Mining Lease
5	242+00 to 233+50	850	SJC1	30-40 m wide	0.9%	Within Conrock Mining Lease
6	233+50 to 222+00	1150	SJC1	200 m wide	0.4%	Large lake/gravel pit; Within Conrock Mining Lease
7	222+00 to 212+00	1000	SJC2	1 - 2 m deep 20 – 40 m wide	0.5%	Canada Gobernadora confluence
8	212+00 to 204+00	800	SJC2	1 m deep low flow 200 m wide	0.6%	Canada Chiquita confluence
9	204+00 to 197+00	700	SJC2	1 - 2 m deep 150 - 200 m wide	0.6%	Upstream of Antonio Parkway
10	197+00 to 189+00	800	SJC2	1 m deep low flow 50 – 100 m wide	0.7%	Between Antonio Parkway and Lower Ortega Highway
11	189+00 to 182+00	700	SJC2	<100 m wide	0.7%	
12	182+00 to 174+00	800	SJC3	<100 m wide	0.7%	Decrease in height of right bank at upper end of reach
13	174+00 to 167+00	700	SJC3	<100 m wide	0.6%	No significant incisement on left bank

Table 6.1 Erosion/Sedimentation Reaches

		Reach	Sediment	Channel		Other
Reach	Station Location	Length (m)	Sample	Dimensions	Slope	features
14	167+00 to 160+00	700	SJC3	40 – 50 m wide	0.5%	La Novia Ave road embankment, Riprap protection along right overbank
15	160+00 to 152+00	800	SJC3	1 m deep <100 m wide	0.6%	Height of banks decrease; golf course on left bank; channel realigned about 1960; Horno Creek confluence
16	152+00 to 145+00	700	SJC4	100 m wide	0.5%	No well defined low flow channel
17	145+00 to 138+50	650	SJC4	50 m wide	0.8%	Between I-5 and Trabuco Creek Confluence Concrete or Riprap Side Slopes and Natural Sand Bed Bottom
18	138+50 to 130+00	850	SJC4	50 m wide	0.4%	concrete side slopes and natural bottom channel; levees
19	130+00 to 122+00	800	SJC5	50 m wide	0.4%	concrete side slopes and natural bottom channel; levees; upstream of Stonehill Dr.
20	122+00 to 115+00	700	SJC5	50 m wide	0.5%	concrete side slopes and natural bottom channel; levees; downstream of Stonehill D.
21	115+00 to 104+00	1100	SJC5	50 – 60 m wide	0.4%	concrete side slopes and natural bottom channel; levees; upstream of PCH

6.2.2 Trabuco Creek Reaches

The overall study reach extends from the confluence with San Juan Creek to O'Neill Regional Park. Within this reach, 15 individual reaches were defined for the sedimentation analyses (Figure 6.1). Table 6.2 summarizes the reach limits, lengths, channel information, the sediment samples used to develop the bed material gradation curve to represent that reach, and other pertinent features within the reach.

Table 6.2 Erosion/Sedimentation Reaches

Reach	Station Location	Reach Length (m)	Sediment Sample	Channel Dimensions	Slope	Other features
	Trabuco Creek					
1	250+00 to 240+00	1000	TRB1	1 m deep low flow 100 – 250 m wide	1.6%	Unimproved reach within O'Neill Regional Park
2	240+00 to 230+00	1000	TRB1	1 m deep low flow 50 – 200 m wide	1.5%	Unimproved reach within O'Neill Regional Park
3	230+00 to 221+00	900	TRB1	1 m deep low flow 50 – 130 m wide	1.6%	Tijeras Creek Confluence to Oso Parkway
4	221+00 to 210+00	1100	TRB1	1 m deep low flow	1.6%	End of O'Neill Regional Park

Table 6.2 Erosion/Sedimentation Reaches

Reach	Station Location	Reach Length (m)	Sediment Sample	Channel Dimensions	Slope	Other features
Keacii	Station Location	Length (III)	1		1	
				50 – 160 m wide		
5	210+00 to 200+00	1000	TRB2	1 m deep low flow 90 – 150 m wide	1.3%	
6	200+00 to 190+00	1000	TRB2	1 m deep low flow 90 – 170 m wide	1.5%	
7	190+00 to 180+00	1000	TRB2	1 m deep low flow 110 – 200 m wide	1.3%	Downstream of proposed Crown Valley Parkway
8	180+00 to 169+00	1100	TRB2	1 m deep low flow 200 – 300 m wide	0.7%	Livingston Graham mining operation
9	169+00 to 158+00	1100	TRB3	10 – 20 m wide	0.7%	Incised main channel with wide flat right overbank
10	158+00 to 146+00	1200	TRB3	10 – 20 m wide	0.9%	Incised main channel with wide flat right overbank
11	146+00 to 136+00	1000	TRB3	10 – 50 m wide	0.8%	Grouted stone drop structure at Metro-Link Railroad, Cahnnel invert 15 ft lower at D/S of drop structure
12	136+00 to 126+00	1000	TRB4	50 – 140 m wide	0.6%	Oso Creek confluence at U/S
13	126+00 to 116+00	1000	TRB4	40 – 80 m wide	0.6%	Narrower bottom width
14	116+00 to 108+00	800	TRB5	22.6 m wide	0.7%	Concrete lined banks and earthen bottom
15	108+00 to 100+00	800	TRB5	22.6 m wide	0.6%	Concrete lined banks and earthen bottom

6.2.3 Oso Creek Reaches

The overall study reach extends from the confluence with Trabuco Creek to the Interstate-5 crossing. Within this reach, 6 individual reaches were defined for the sedimentation analyses (Figure 6.1). Table 6.3 summarizes the reach limits, lengths, channel information, the sediment samples used to develop the bed material gradation curve to represent that reach, and other pertinent features within the reach.

Table 6.3 Erosion/Sedimentation Reaches

		Reach	Sediment	Channel		Other
Reach	Station Location	Length (m)	Sample	Dimensions	Slope	Features
	Oso Creek					
1	166+00 to 156+00	1000	OSO1	20 – 40 m wide	0.6%	Natural channel with concrete drop structure; La Paz confluence

Table 6.3 Erosion/Sedimentation Reaches

Reach	Station Location	Reach Length (m)	Sediment Sample	Channel Dimensions	Slope	Other Features
2	156+00 to 146+50	950	OSO1	21.3–14.6 m wide	0.5%	Rect. Concrete channel, Trap channel with concrete side and riprap bottom; Galivan Retarding Basin; u/s of Crown Valley
3	146+50 to 136+00	1050	OSO1	20 – 40 m wide	0.8%	Trapezoidal channel, MSE walls on the overbank, Channel lined with riprap
4	136+00 to 121+00	1500	OSO1	9.1 m wide	0.7%	Rectangular concrete channel and Reinforced box culvert
5	121+00 to 110+00	1100	OSO2	20 m wide	1.0%	Incised natural channel
6	110+00 to 100+00	1000	OSO2	20 - 50 m wide	0.8%	Incised natural channel

6.2.4 Canada Gobernadora

The overall study reach extends from the confluence with San Juan Creek to the Coto de Caza golf course. Within this reach, 6 individual reaches were defined for the sedimentation analyses (Figure 6.1). Table 6.4 summarizes the reach limits, lengths, channel information, the sediment samples used to develop the bed material gradation curve to represent that reach, and other pertinent features within the reach.

		Table 6	5.4 I	Erosion/Sedimentation Reaches					
		Reach	Sediment	Channel		Other			
Reach	Station Location	Length (m)	Sample	Dimensions	Slope	features			
	Canada								
	Gobernadora								
1	151+00 to 142+00	900	CG1	1 m deep	1.0%	Low flow channel transitions abruptly into			
1	151+00 to 142+00	900	CGI	250 - 350 m wide	1.0%	right bank			
2	142+00 to 134+00	800	CG1	1-2 m deep	0.9%	Low flow channel aligned along right bank			
2	142100 to 134100	800	CGI	200 m wide	0.770	Low now channel angled along fight balls			
3	134+00 to 126+00	800	CG1	1-2 m wide	0.8%	Low flow channel aligned along right bank			
				200 - 300 m wide					
4	126+00 to 118+00	800	CG1	1 m wide	2.1%	Small Canyons enter Canada Gobernadora			
				300 m wide					
5	118+00 to 109+00	900	CG1	8 m deep	1.0%	Small Canyons enter Canada Gobernadora			
J	110.00 to 107.00	, , ,	001	≤10 m wide	11070	Zinan canyons enter canada cootinadora			
6	109+00 to 100+00	900	CG1	$1 \text{ m} \rightarrow 3\text{-}4 \text{ m deep}$	1.7%	Wide flat floodplain			
O	107100 to 100100	700	COI	200 m wide	1.7/0	Wide Hat Hoodplain			

6.3 Average Hydraulic Parameters

The average hydraulic parameters for each of the reaches on San Juan Creek, Trabuco Creek, Oso Creek and Canada Gobernadora were computed using the SAM.M95 module and are listed in Table 6.5 through Table 6.8. The average hydraulic parameters for the 100-year event for each of the reaches on San Juan Creek, Trabuco Creek, Oso Creek and Canada Gobernadora are shown on Figure 6.2 through Figure 6.17. The average of a given parameter is computed as a length-weighted average of the values at each section within a contiguous reach.

Table 6.5 San Juan Creek Average Hydraulic Parameters - Existing Conditions

Reach	Features	HEC-2 Cross					_		
	- Toutures	Sections Limits		2-year	25-year	50-year	100-year	200-year	500-year
1	Conrock Mining	271+00	E. Slope (m/m)	6.59E-03	8.78E-04	5.72E-04	4.55E-04	3.90E-04	4.20E-04
		265+00	Velocity (m/s)	1.38	1.34	1.34	1.41	1.48	1.73
			Eff. Width (m)	17.3	120.3	135.6	151.3	166.4	176.7
			Eff. Depth (m)	0.54	2.33	3.24	4.13	5.01	5.99
2	Conrock Mining	265+00	E. Slope (m/m)	8.59E-03	6.71E-03	5.95E-03	5.30E-03	3.46E-03	2.52E-03
		259+50	Velocity (m/s)	1.93	4.16	4.17	4.46	4.05	4.14
			Eff. Width (m)	9.2	32.3	46.1	53.5	60.7	61.1
			Eff. Depth (m)	0.73	2.79	3.06	3.69	4.41	5.76
3	Conrock mining	259+50	E. Slope (m/m)	3.90E-03	4.47E-03	4.07E-03	3.62E-03	3.07E-03	2.18E-03
		251+00	Velocity (m/s)	0.63	2.04	2.34	2.62	2.81	2.91
			Eff. Width (m)	82.8	141.8	147.1	152.4	159.9	170.2
			Eff. Depth (m)	0.25	1.30	1.71	2.21	2.78	3.78
4	Conrock mining	251+00	E. Slope (m/m)	2.78E-03	1.30E-03	1.19E-03	9.29E-04	7.02E-04	4.45E-04
	Access road	242+00	Velocity (m/s)	0.89	1.74	1.98	2.10	2.12	2.03
			Eff. Width (m)	27.0	81.4	84.6	87.1	91.6	99.8
			Eff. Depth (m)	0.54	2.59	3.35	4.39	5.52	7.27
5	Conrock mining	242+00	E. Slope (m/m)	8.86E-03	6.03E-03	5.42E-03	4.73E-03	4.40E-03	4.23E-03
	Access road	233+50	Velocity (m/s)	1.35	2.96	3.26	3.56	3.86	4.18
			Eff. Width (m)	23.1	69.3	78.9	83.7	89.4	103.6
			Eff. Depth (m)	0.42	1.82	2.27	2.87	3.41	3.96
6	Conrock mining	233+50	E. Slope (m/m)	5.18E-04	5.34E-04	5.92E-04	6.33E-04	6.66E-04	7.90E-04
	Gravel pit	222+00	Velocity (m/s)	0.30	1.02	1.24	1.47	1.69	2.05
			Eff. Width (m)	122.0	163.1	167.2	171.0	175.5	178.6
			Eff. Depth (m)	0.36	2.25	2.80	3.43	4.06	4.81
7	Canada Gob.	222+00	E. Slope (m/m)	4.18E-03	4.47E-03	4.66E-03	4.91E-03	5.02E-03	4.94E-03
	Confluence	212+00	Velocity (m/s)	1.05	2.22	2.67	3.14	3.58	4.08
			Eff. Width (m)	26.3	124.8	129.3	131.6	133.7	134.4
			Eff. Depth (m)	0.50	1.47	1.89	2.31	2.76	3.41
8		212+00	E. Slope (m/m)	5.72E-03	8.17E-03	8.18E-03	8.65E-03	7.61E-03	7.89E-03
		204+00	Velocity (m/s)	0.96	2.55	2.85	3.07	3.36	3.76
			Eff. Width (m)	42.2	143.6	175.9	224.2	229.6	265.6
			Eff. Depth (m)	0.35	1.15	1.36	1.46	1.84	2.12

Table 6.5 San Juan Creek Average Hydraulic Parameters - Existing Conditions

		an Juan Cro	ok Miverage i	Tydiadi	ic i aran	ictcis	LAISHII	Condi	10113
Reach	Features	HEC-2 Cross		2	25	50	100	200	500
		Sections Limits		2-year	25-year	50-year	100-year	200-year	500-year
9	Antonio Parkway	204+00	E. Slope (m/m)	3.08E-03	4.63E-03	4.70E-03	4.44E-03	4.26E-03	4.01E-03
		197+00	Velocity (m/s)	0.76	2.09	2.40	2.71	3.05	3.47
			Eff. Width (m)	48.0	154.0	178.5	186.1	190.3	195.1
			Eff. Depth (m)	0.39	1.31	1.59	2.00	2.46	3.13
			_						
10	Antonio Parkway	197+00	E. Slope (m/m)	1.07E-02	4.83E-03	3.94E-03	3.17E-03	2.49E-03	1.32E-03
	Lower Ortega Hwy	189+00	Velocity (m/s)	1.03	2.50	2.75	2.91	3.02	2.74
			Eff. Width (m)	64.2	114.8	125.2	135.1	139.9	146.0
			Eff. Depth (m)	0.21	1.48	1.98	2.53	3.22	4.48
11	Lower Ortega Hwy	189+00	E. Slope (m/m)	7.92E-03	6.88E-03	6.49E-03	6.11E-03	4.95E-03	4.23E-03
		182+00	Velocity (m/s)	1.13	3.18	3.67	4.10	4.18	4.47
			Eff. Width (m)	39.7	82.9	89.5	96.3	108.9	113.5
			Eff. Depth (m)	0.31	1.62	2.10	2.59	3.13	3.89
12		182+00	E. Slope (m/m)	4.57E-03	4.79E-03	4.77E-03	4.72E-03	5.23E-03	4.53E-03
		174+00	Velocity (m/s)	1.03	2.86	3.32	3.74	4.33	4.66
			Eff. Width (m)	33.7	82.7	91.4	99.9	104.5	107.4
			Eff. Depth (m)	0.40	1.81	2.28	2.74	3.17	3.94
13		174+00	E. Slope (m/m)	6.33E-03	5.61E-03	5.28E-03	4.85E-03	3.67E-03	3.43E-03
		167+00	Velocity (m/s)	0.92	2.83	3.27	3.64	3.72	4.13
			Eff. Width (m)	56.1	95.0	102.6	107.6	112.0	112.0
			Eff. Depth (m)	0.27	1.59	2.06	2.58	3.28	4.05
14	La Novia Avenue	167+00	E. Slope (m/m)		4.08E-03				3.77E-04
		160+00	Velocity (m/s)	0.97	2.80	3.07	2.89	2.52	1.84
			Eff. Width (m)	47.8	77.5	83.7	89.4	100.4	100.7
			Eff. Depth (m)	0.31	1.98	2.61	3.53	4.36	6.28
15	La Novia Avenue	160+00	E. Slope (m/m)	6.08E-03	5.37E-03			3.49E-03	8.68E-04
		152+00	Velocity (m/s)	0.96	3.08	3.61	3.87	3.79	2.45
			Eff. Width (m)	52.8	78.5	84.6	89.7	92.6	94.4
			Eff. Depth (m)	0.30	1.86	2.36	2.91	3.51	5.18
1.6	T. 7	152 00	E 61 (/)	2.255.04	2.075.02	2.205.02	0.425.04	2.175.04	4.2.CE 05
16	I-5	152+00	E. Slope (m/m)					2.17E-04	
		145+00	Velocity (m/s)	0.35		2.58	2.04		
			Eff. Width (m)	74.4	94.6	100.6	108.9	112.9	115.4
			Eff. Depth (m)	0.58	1.84	2.71	4.04	5.86	8.59
17	I-5	145 : 00	E. Slope (m/m)	1.70E.02	4.02E.02	2.79E.02	2 20E 02	2.64E.02	1 26E 02
1 /		145+00						2.64E-03	
	Camino Capistrano	138+50	Velocity (m/s)	0.86	3.71	4.25	4.59	4.82	4.23
	Metrolink RR		Eff. Width (m)	37.2	52.4	57.0	62.8	66.5	66.5
			Eff. Depth (m)	0.47	2.32	2.99	3.72	4.73	6.78
18	Trabuco Creek	138+50	E. Slope (m/m)	3 68E 02	3.13E-03	2 08E 02	2 85E 02	2.62E-03	2 32E U2
10	Confluence	130+00	Velocity (m/s)	1.76	3.65	4.19	4.71	5.26	5.91
	Confluence	130⊤00	Eff. Width (m)	52.0	64.2	68.8	74.4	76.8	76.8
			Eff. Depth (m)	0.81	2.73	3.49	4.31	5.41	7.06
			ъп. Depui (III)	0.61	2.13	3.49	4.31	3.41	7.00
19		130+00	E. Slope (m/m)	4 51F-03	4.05F-03	3 95F-03	2 89F_03	2.31E-03	2.01F-03
1)		122+00	Velocity (m/s)	1.94	4.03L-03	4.73	4.89	5.29	5.90
		122100	Eff. Width (m)	47.1	58.0	62.7	68.5	69.0	69.0
			211. (Tidui (III)	77.1	30.0	02.7	00.5	07.0	07.0

Table 6.5 San Juan Creek Average Hydraulic Parameters - Existing Conditions

Reach	Features	HEC-2 Cross							
		Sections Limits		2-year	25-year	50-year	100-year	200-year	500-year
			Eff. Depth (m)	0.81	2.69	3.39	4.51	5.99	7.86
20	Stonehill Avenue	122+00	E. Slope (m/m)	3.51E-03	3.65E-03	3.49E-03	7.85E-04	7.08E-04	7.20E-04
		115+00	Velocity (m/s)	1.76	3.92	4.46	3.17	3.55	4.15
			Eff. Width (m)	50.1	60.1	66.3	76.4	77.1	77.1
			Eff. Depth (m)	0.84	2.72	3.41	6.24	7.99	10.00
21	Stonehill Avenue	115+00	E. Slope (m/m)	3.74E-03	3.64E-03	3.68E-03	3.64E-03	3.44E-03	3.13E-03
	Camino L Ramblas	104+00	Velocity (m/s)	1.71	3.76	4.42	5.01	5.54	6.21
	PCH		Eff. Width (m)	56.5	66.5	70.5	76.8	82.6	84.8
			Eff. Depth (m)	0.77	2.56	3.23	3.93	4.77	6.08

Table 6.6 Trabuco Creek Average Hydraulic Parameters - Existing Conditions

Part France Conditions									10115
Reach	Features If Any	HEC-2 Cross Sections Limits		2-year	25-year	50-year	100-year	200-year	500-year
	<u> </u>			2 year	20 year	20 300	100 year	200 year	- soo year
1	Within O'Neill	250+00	E. Slope (m/m)		7.31E-03	1.31E-02		1.13E-02	
	Regional Park	240+00	Velocity (m/s)	1.23	1.89	2.47	2.83	3.00	3.40
			Eff. Width (m)	34.7	109.3	143.1	159.3	178.0	209.7
			Eff. Depth (m)	0.28	0.71	0.68	0.80	1.02	1.17
2	Within O'Neill	240+00	E. Slope (m/m)	1.75E-02	1.38E-02	1.31E-02	1.23E-02	1.05E-02	1.09E-02
	Regional Park	230+00	Velocity (m/s)	0.95	2.06	2.43	2.75	3.05	3.57
			Eff. Width (m)	102.2	144.8	153.0	160.6	166.1	177.1
			Eff. Depth (m)	0.13	0.50	0.67	0.84	1.11	1.37
3	O'Neill Regional	230+00	E. Slope (m/m)	8.73E-03	9.30E-03	8.71E-03	7.86E-03	5.63E-03	4.54E-03
	Park to Oso Pkwy	221+00	Velocity (m/s)	1.19	2.76	3.25	3.44	3.29	3.38
	Tank to obo Thiny	221.00	Eff. Width (m)	43.1	56.8	62.1	75.0	101.6	120.2
			Eff. Depth (m)	0.31	1.05	1.40	1.65	1.98	2.42
4	Oso Pkwy to	221.00	E Clana (m/m)	4 52E 02	0.62E.02	9.72E.02	7.96E.02	7.69E.02	7.43E-03
4	Limit of O'Neill	221+00 210+00	E. Slope (m/m)	4.53E-03 0.87	9.62E-03 2.06	8.73E-03 2.44	7.86E-03 2.74	7.68E-03 3.24	7.43E-03 3.74
		Z10+00	Velocity (m/s) Eff. Width (m)	58.2	121.6	126.8	132.8	135.8	139.3
	Regional Park		` '	0.32		0.91			
			Eff. Depth (m)	0.52	0.66	0.91	1.18	1.53	1.95
5	Limit of O'Neill	210+00	E. Slope (m/m)	1.56E-02	1.37E-02	1.27E-02	1.13E-02	1.00E-02	9.17E-03
	Regional Park	200+00	Velocity (m/s)	1.20	2.49	2.98	3.34	3.78	4.15
			Eff. Width (m)	65.7	97.5	101.5	105.9	111.6	123.0
			Eff. Depth (m)	0.20	0.67	0.93	1.20	1.58	1.95
6	1000 m U/S	200+00	E. Slope (m/m)	7.44E-03	1.11E-02	1.22E-02	1.16E-02	1.05E-02	9.87E-03
	To Proposed	190+00	Velocity (m/s)	0.91	2.31	2.84	3.26	3.76	4.29
	Crown Valley		Eff. Width (m)	75.0	101.9	112.3	116.1	118.1	122.6
	Parkway		Eff. Depth (m)	0.23	0.70	0.89	1.13	1.52	1.94
7	Proposed Crown	190+00	E. Slope (m/m)	4.95E-03	1.45F-02	1.26F-02	1 23F-02	1.10E-02	1.04F-02
,	Valley Pkwy	180+00	Velocity (m/s)	0.75	2.12	2.48	2.88	3.29	3.75
	vancy rawy	100 / 00	Eff. Width (m)	91.1	152.8	160.9	164.9	171.3	178.2
			Eff. Depth (m)	0.24	0.51	0.71	0.90	1.20	1.52
8		180+00	E. Slope (m/m)	6.53E-05	3.37E-04	3.60E-04	2.89E-04	1.85E-04	1.21E-04
0	Livingston Graham		Velocity (m/s)	0.55E-05	0.61	0.76	0.83	0.85	0.86
	Mining area	109+00	• • •	123.2	178.4	186.9	192.0	196.1	198.0
	Willing area		Eff. Width (m) Eff. Depth (m)	0.75	1.49	1.96	2.62	3.78	5.33
0	T	160.00	E GI (/)	2.000 02	2.105.02	2.055.02	2.745.02	2.505.02	2.245.02
9	Livingston Graham		E. Slope (m/m)	2.86E-03	3.10E-03		2.74E-03		3.24E-03
	Mining area to Residential area	158+00	Velocity (m/s)	1.31	2.48	2.87	3.14	3.92	4.16 42.2
	Residential area		Eff. Width (m) Eff. Depth (m)	12.3 1.00	26.7 2.47	30.9 3.19	35.5 3.85	38.9 4.41	5.19
4.0	D 11 11	450.00	-						4
10	Residential area to		E. Slope (m/m)		5.46E-03	4.65E-03		2.48E-03	
	Rancho Viejo, I-5	146+00	Velocity (m/s)	1.72	3.25	3.58	3.89	3.47	3.20
			Eff. Width (m)	12.6	22.8	27.5	30.9	35.6	36.7
			Eff. Depth (m)	0.74	2.20	2.86	3.53	4.37	5.30
11	Rancho Viejo, I-5	146+00	E. Slope (m/m)	4.63E-03				2.77E-03	1.80E-03
	To MetroLink RR	136+00	Velocity (m/s)	1.32	2.77	3.09	3.31	3.60	3.41

Table 6.6 Trabuco Creek Average Hydraulic Parameters - Existing Conditions

.			C	•		G			
Reach	Features	HEC-2 Cross							
	If Any	Sections Limits		2-year	25-year	50-year	100-year	200-year	500-year
			Eff. Width (m)	23.1	35.1	39.9	45.5	53.5	65.0
			Eff. Depth (m)	0.53	1.69	2.29	2.84	3.49	4.44
12	MetroLink RR	136+00	E. Slope (m/m)	3.44E-03	3.13E-03	3.20E-03	2.73E-03	2.48E-03	2.09E-03
		126+00	Velocity (m/s)	1.45	1.98	2.25	2.43	2.65	2.86
			Eff. Width (m)	54.0	81.3	88.8	98.4	108.0	116.0
			Eff. Depth (m)	0.84	1.44	1.72	2.17	2.65	3.38
13		126+00	E. Slope (m/m)	4.64E-03	4.30E-03	3.68E-03	3.17E-03	3.28E-03	3.87E-03
	Improved channel	116+00	Velocity (m/s)	1.88	2.66	2.76	3.00	3.28	3.91
			Eff. Width (m)	40.0	51.8	60.9	66.8	77.6	82.5
			Eff. Depth (m)	0.99	1.77	2.10	2.66	2.96	3.40
14	Improved channel	116+00	E. Slope (m/m)	6.40E-03	6.17E-03	5.84E-03	5.45E-03	2.84E-03	1.16E-03
	To D/S of Del	108+00	Velocity (m/s)	3.00	4.39	4.84	5.35	4.20	2.88
	Obispo St		Eff. Width (m)	23.0	28.4	31.0	34.7	46.2	59.6
			Eff. Depth (m)	1.07	1.96	2.36	2.89	3.28	3.63
15	D/S of Del Obispo	108+00	E. Slope (m/m)	3.30E-03	4.50E-03	4.65E-03	2.08E-03	1.21E-03	2.44E-03
	To San Juan Crk	100+00	Velocity (m/s)	1.98	3.69	4.28	3.50	2.86	4.05
	Confluence		Eff. Width (m)	39.5	45.5	48.3	53.6	58.2	59.0
			Eff. Depth (m)	0.95	1.91	2.33	3.14	3.50	3.48

Table 6.7 Oso Creek Average Hydraulic Parameters - Existing Conditions

Reach	Features	HEC-2 Cross	0 1				υ		
	If Any	Sections Limits		2-year	25-year	50-year	100-year	200-year	500-year
1	D/S of I-5 to	166+00	E. Slope (m/m)	5.53E-04	1.16E-03	1.01E-03	8.67E-04	4.11E-04	1.90E-04
	Camino Capistrano	156+00	Velocity (m/s)	1.01	1.76	1.76	1.73	1.44	1.16
			Eff. Width (m)	33.8	36.7	37.1	37.3	37.8	38.0
			Eff. Depth (m)	2.10	2.75	3.05	3.33	4.44	5.69
		455.00	- al ()	2005.05	0.505.05	0.407-05	0.555.05	5.0 (F.0.5	1 225 01
2	Camino Capistrano		E. Slope (m/m)		8.52E-05			7.36E-05	1.23E-04
	To Crown Valley	146+50	Velocity (m/s)	0.83	1.35	1.42	1.48	1.48	1.99
	Parkway		Eff. Width (m)	19.9	19.9	19.9	19.9	19.9	19.9
			Eff. Depth (m)	3.86	4.45	4.58	4.71	5.69	6.06
3	Crown Valley	146+50	E. Slope (m/m)	3.45E-03	2.85E-03	2.77E-03	2.64E-03	2.77E-03	2.74E-03
	Parkway to	136+00	Velocity (m/s)	2.33	2.55	2.57	2.59	2.95	3.28
	Paseo De Colinas		Eff. Width (m)	22.4	27.1	27.7	28.6	31.5	35.7
			Eff. Depth (m)	1.42	1.87	1.94	2.04	2.38	2.82
4	Paseo De Colinas	136+00	E. Slope (m/m)	5.32E-04	7.33E-04	7.53E-04	7.73E-04	5.56E-04	2.31E-04
	Natural Channel	121+00	Velocity (m/s)	2.71	3.69	3.81	3.99	4.11	3.20
			Eff. Width (m)	10.8	11.1	11.2	11.2	11.5	11.9
			Eff. Depth (m)	2.34	2.92	3.01	3.15	4.23	5.62
_		121 00	T 61	00	- 00F 02	- 0 1 F 00	4.055.00	4 (55 00	4 225 02
5	Natural Channel	121+00	E. Slope (m/m)		5.09E-03			4.67E-03	4.33E-03
	Natural Channel	110+00	Velocity (m/s)	2.50	2.84	2.88	2.93	3.15	3.44
			Eff. Width (m)	18.2	22.0	22.6	23.5	27.0	31.3
			Eff. Depth (m)	1.62	2.08	2.14	2.23	2.60	3.13
6	Natural Channel	110+00	E. Slope (m/m)	5.40E-03	5.04E-03	5.01E-03	4.98E-03	4.77E-03	4.42E-03
	Trabuco Creek	100+00	Velocity (m/s)	2.41	2.78	2.84	2.92	3.22	3.56
	Confluence		Eff. Width (m)	19.7	22.9	23.3	23.8	26.0	29.2
			Eff. Depth (m)	1.56	2.04	2.11	2.21	2.64	3.25

Table 6	5.8 Car	nada Goberna	dora Averag	ge Hydra	aulic Pa	rameter	s - Exist	ing Con	ditions
Reach	Features If Any	HEC-2 Cross Sections Limits		2-year	25-year	50-year	100-year	200-year	500-year
1		151+00	E. Slope (m/m)	6.07E-03	5.79E-03	5.59E-03	9.44E-03	8.93E-03	8.64E-03
		142+00	Velocity (m/s)	1.34	1.99	2.27	2.53	2.73	2.89
		112100	Eff. Width (m)	20.2	75.5	82.5	124.0	139.5	163.5
			Eff. Depth (m)	0.33	0.63	0.78	0.62	0.73	0.81
2		142+00	E. Slope (m/m)	1.24E-03	2.73E-03	7.18E-03	7.06E-03	6.85E-03	6.71E-03
		134+00	Velocity (m/s)	0.48	1.19	1.80	1.98	2.22	2.47
			Eff. Width (m)	79.4	154.4	179.1	183.8	193.2	200.5
			Eff. Depth (m)	0.24	0.51	0.46	0.54	0.65	0.78
3		134+00	E. Slope (m/m)	3.00E-04	6.67E-03	6.77E-03	6.72E-03	6.40E-03	6.42E-03
		126+00	Velocity (m/s)	0.28	1.39	1.65	1.83	2.06	2.31
			Eff. Width (m)	105.1	204.8	213.1	217.2	221.4	229.5
			Eff. Depth (m)	0.31	0.33	0.42	0.49	0.61	0.73
4		126+00	E. Slope (m/m)	6.61E-04	1.41E-03	1.57E-03	1.67E-03	4.42E-03	4.50E-03
		118+00	Velocity (m/s)	0.37	0.89	1.08	1.22	1.83	2.05
			Eff. Width (m)	94.7	194.6	203.3	209.8	225.8	237.9
			Eff. Depth (m)	0.26	0.54	0.67	0.77	0.67	0.79
5		118+00	E. Slope (m/m)	7.42E-03	6.41E-03	4.17E-03	4.01E-03	3.55E-03	3.27E-03
		109+00	Velocity (m/s)	2.06	3.73	3.00	2.98	3.18	3.33
			Eff. Width (m)	8.0	16.9	33.0	43.5	48.0	55.6
			Eff. Depth (m)	0.55	1.49	1.49	1.51	1.82	2.08
6	San Juan Creek	109+00	E. Slope (m/m)	1.85E-03	2.06E-03	3.72E-03	3.64E-03	4.70E-03	4.68E-03
	Confluence	100+00	Velocity (m/s)	0.70	1.17	1.60	1.77	2.15	2.42
			Eff. Width (m)	42.5	130.0	145.2	149.7	156.5	161.5
			Eff. Depth (m)	0.30	0.62	0.63	0.74	0.82	0.98

6.4 **Bed Material Gradation Curves**

The bed material gradation curves described in Section 3.3 were used within SAM.SED.

6.5 **Sediment Transport Function**

The SAM model includes a number of sediment transport capacity functions for bed loads and total load (bed load and suspended load). Wash load, which is assumed to be limited only by the production of the watershed, is not included in any of the functions and is assumed to be carried through the system. The choice of the transport function to apply to each flooding source began with the results of the previously described SAMAID program. Table 6.9 shows the results of this program for each study watercourse. Only the results using the 100-year average hydraulic parameters are included in the table. It should be noted that the SAMAID results for each frequency event were similar. The next step is selecting a function from those recommended by SAMAID. This was done by comparing the sediment transport capacity results from procedures recommended by SAMAID with the results from a combination of the Meyer-Peter Muller (MPM) bed load equation and Einstein suspended load equation. The combined MPM-Einstein function is coded within a sediment transport model developed by Tetra Tech / Infrastructure Southwest Group, (Tt/ISG, formerly Simons, Li and Associates). This model has been shown to provide good results when applied to coastal streams, like those in the San Juan Creek watershed, in southern California.

	Table 6.9 SAMAID Results											
Q	Reach	Yang	A-W	MPM	Brownlie	L-M	L-C	Yang, D50	MPM-E			
1	1	57,698	31,506	32,686	35,959	42,398	315,708		9,150			
1	2	559,146	300,841	02,000	639,962	565,392	5,861,790		191,309			
1	3	457,135	234,313	180,175	405,572	428,872	4,414,396		206,542			
1	4	107,350	56,323	44,381	77,192	91,065	638,698		200,042			
1	5	1,074,231	592,696	339,114	1,236,459	1,147,456	14,852,613		382,977			
1	6	107,013	56,031	52,942	70,209	88,561	675,172		165,821			
1	7	1,494,055	818,257	503,728	2,355,509		28,402,614		566,225			
1	8	2,473,234	1,351,533	1,050,125	3,620,275	2,346,125	55,235,744		1,140,088			
1	9	1,218,048	644,942	462,495	1,713,211	1,060,845	20,198,784		537,443			
1	10	275,925	158,184	122,420	365,140	212,133	2,643,340		122,482			
1	11	1,494,095	876,178	490,218		1,377,480	24,573,348		566,495			
1	12	1,992,564	34,023,276	468,557	1,856,557	2,104,397	49,375,776		576,745			
1	13	1,289,347	16,718,044	327,225	1,127,127	1,389,231	28,055,808		371,887			
1	14	31,375	84,129	16,618	19,436	51,593	343,124		16,934			
1	15	115,008		44,276	73,842	155,550	1,538,815		47,612			
1	16	379	456	774	178	1,369	4,140		441			
1	17	503,601	4,547,363	131,219		562,800	6,238,720		227,620			
1	18	2,171,753		431,914	2,717,395		34,946,000		855,300			
1	19	1,796,254		286,323	2,202,744	1,844,837	26,501,192		786,723			
1	20	451,285		90,273	487,868	512,045	4,443,519		239,087			
1	21		63,383,560	471,927	3,589,926		51,390,280		1,183,979			
Q		Yang	A-W	MPM		L-M	L-C	Yang, D50	MPM-E			
	Reach				Brownlie	<u> </u>						
2	1	33,721	18,507	22,983	19,247	24,866	195,440		4,730			
2	3	549,021	297,408	400.740	616,587	570,669	6,754,338		188,791			
2		412,665	210,535	182,743	351,808	393,750	4,759,345		189,197			
2	4	142,434	73,068	59,350	102,696	124,392	1,061,749		075.040			
2	5	717,826	389,928	248,251	775,661	756,927	10,082,994		275,948			
2	6	48,473	26,073	30,336	28,688	35,795	303,963		85,088			
2	7	967,529	517,350	379,017	1,380,683	868,577	17,635,398		388,252			
2	8	1,473,308	783,446	702,276	1,972,642	1,346,317	31,035,242		713,576			
2	9	781,049	406,317	350,044	997,949	656,742	12,742,547		362,002			
2	10	439,585	245,217	196,108		359,202	5,298,829		188,497			
2	11	1,188,105	689,708	436,560		1,092,638	20,360,900		478,050			
2	12		24,306,464	411,681	1,374,309	1,667,125	40,169,664		437,391			
	13		10,025,983	265,341					264,492			
2	14	149,669		57,203	93,680	194,752	2,172,279		57,385			
2	15	801,461	8,939,036	223,698		870,565	17,119,130		231,874			
2	16	8,046	14,651	6,471	5,066	16,580	79,869		5,352			
2	17			243,645	1,054,693	1,016,281	15,659,020		375,484			
2	18	1,508,163	22,560,364	343,831	1,730,772	1,556,896	24,620,898		582,459			
2	19	1,293,804	19,524,974	229,678	1,444,945	1,332,568	19,437,674		541,458			
2	20	255,822	1,608,833	60,377	221,989	303,372	2,486,801	335,451	136,258			
2	21	2,009,254		359,062	2,237,877	2,045,135	35,236,296		776,612			
Q	Reach	Yang	A-W	MPM	Brownlie	L-M	L-C	Yang, D50	MPM-E			
3	1	32,399	17,352	23,643	17,696	23,828	214,294		3,764			
3	2	712,734	405,019		866,109	799,047	11,263,242		259,801			
3	3	321,469	162,808	161,060	258,288	306,711	4,086,988		152,428			
3	4	138,835	70,742	62,417	97,446	123,484	1,199,906					
3	5	523,130	279,703	199,862	529,470	545,371	7,597,075		214,918			
3	6	27,517	14,951	20,725	14,946	20,335	177,981	47,936	53,903			

			ı	Table 6.9	SAMA	AID Results	,		
Q	Reach	Yang	A-W	MPM	Brownlie	L-M	L-C	Yang, D50	MPM-E
3	7	614,873	321,121	277,197	796,312	526,494	10,673,745	_	267,558
3	8	1,100,489	575,759	609,109	1,365,708	984,971	23,597,466	1,083,154	557,812
3	9	518,272	265,652	270,855	607,680	430,910	8,335,302	572,133	254,604
3	10	395,812	219,253	196,604	503,627	324,802	5,135,703	454,357	182,717
3	11	1,026,249	597,385	410,180	1,619,032	956,060	18,984,226	1,038,291	449,720
3	12	902,253	10,370,509	269,574	707,786	967,236	21,080,522	661,000	252,351
3	13	895,546	9,856,158		686,046	960,320	20,949,158	652,667	237,671
3	14	259,310	1,657,332	90,141	163,546	310,138	4,448,398	262,421	84,685
3	15	907,724	11,101,398	260,375	731,243	970,620	21,415,848	663,349	247,189
3	16	68,466	226,450	31,882	43,295	94,480	870,685	90,409	34,479
3	17	834,865	10,208,654	226,129	847,208	861,385	14,102,024	641,967	305,360
3	18	1,034,994	12,922,107	267,019	1,087,900	1,072,972	16,845,756	830,357	389,066
3	19	1,053,031	14,424,831	204,562	1,085,380	1,080,593	16,743,934	849,052	406,947
3	20	174,723	936,371	46,669	140,435	214,365	1,739,903	225,661	91,848
3	21	1,363,020	20,397,518	266,787	1,396,832	1,388,816	23,734,730	1,012,707	504,589
Q	Reach	Yang	A-W	MPM	Brownlie	L-M	L-C	Yang, D50	MPM-E
4	1	31,328	16,364	24,981	16,293	22,947	245,648	49,161	3,281
4	2	503,751	282,966		579,350	561,059	8,436,284	470,329	200,065
4	3	217,142	108,411	128,369		203,586	2,996,142	238,174	113,345
4	4	115,491	58,304	57,996	77,115	103,219	1,136,575	148,068	
4	5	378,812	199,728	164,910	356,215	389,607	5,941,698	373,794	170,397
4	6	13,703	7,533	13,073	6,661	10,323	93,843	24,180	31,888
4	7	347,070	177,306	186,969	401,375	288,576	5,669,630	380,642	168,421
4	8	667,213	344,152	397,563	783,516	577,426	13,627,994	665,850	353,727
4	9	332,563	168,581	207,769	356,822	270,546	5,277,618	366,042	174,109
4	10	320,297	175,408		385,845	262,707	4,442,029	356,870	162,378
4	11	673,088	383,270			611,418	12,271,503		314,934
4	12	557,391	5,190,696			602,000	12,653,181	414,284	152,150
4	13	612,269	5,633,424	216,418	427,637	657,892	14,231,395	439,777	158,914
4	14	352,170	2,700,151	123,395	248,480	397,444	7,086,088		101,062
4	15	707,024	7,814,754	224,506	531,617	754,372	17,051,184	497,248	183,136
4	16	207,196	1,099,180		128,795	240,707	3,596,930		96,460
4	17	610,326	6,675,819	183,231	576,563	628,479	10,546,792		208,609
4	18	652,144		192,234	628,720	683,462	10,423,745		234,109
4	19		12,872,852	195,545		957,183	16,671,898		338,806
4	20	790,585	9,507,022	170,188		806,470	13,204,136	,	292,383
4	21	827,692	9,881,820	180,909	771,697	842,774	14,086,558	625,187	301,048
Q	Reach	Yang	A-W	MPM	Brownlie	L-M	L-C	Yang, D50	MPM-E
5	1	28,796	14,695	26,045	14,099	21,014	275,662	41,366	3,666
5	2	357,793	202,245		410,995	404,277	6,419,449	323,817	144,868
5	3	133,910	65,784	96,451	76,831	120,728	1,956,727		77,501
5	4	74,347	37,087	44,094	45,385	65,767	793,385		
5	5	247,855	128,335	123,235	214,996	249,843	4,140,188		120,525
5	6	5,941	3,305		2,513	4,458	44,416	1	15,185
5	7	175,875	88,673	120,221	179,596	139,305	2,699,916		95,874
5	8	376,066	190,592	258,807	405,833	317,915	7,397,338	1	213,194
5	9	178,247	89,307	133,635	174,177	138,185	2,740,863	197,938	102,139
5	10	224,646	121,077	151,002	249,324	181,835	3,285,149	243,790	127,346
5	11	394,269	218,697	218,908	508,810	341,177	6,985,543	398,314	206,087
5	12	304,146	2,172,047	123,457	194,671	338,397	6,629,548	230,459	81,800
5	13	356,125	2,567,596	150,325	221,232	391,041	8,132,688		91,307
5	14	251,969	1,694,489	101,844	162,375	286,134	5,230,435	202,529	68,663

	Table 6.9 SAMAID Results											
Q	Reach	Yang	A-W	MPM	Brownlie	L-M	L-C	Yang, D50	MPM-E			
5	15	385,284	3,195,689	146,258	256,596	417,374	8,855,465	277,492	99,817			
5	16	236,553	1,362,729	98,147	156,466	262,434	4,757,982	194,607	95,082			
5	17	360,649	3,140,631	127,669	307,499	379,930	6,131,919	269,015	120,520			
5	18	385,046	3,128,950	133,729	336,324	416,776	6,050,794	312,542	136,545			
5	19	544,786	5,796,201	128,885	475,840	555,252	9,373,693	403,674	193,768			
5	20	470,051	4,542,123	114,523	403,075	485,966	7,753,650	363,970	171,609			
5	21	450,802	4,050,553	114,345	375,823	470,769	7,359,733	352,122	159,953			
Q	Reac	Yang	A-W	MPM	Brownlie	L-M	L-C	Yang, D50	MPM-E			
6	1	3,531	1,646	6,416	1,298	2,585	53,454	3,599	1,660			
6	2	8,462	4,112		5,112	7,856	153,081	7,759	5,861			
6	3	971	433	5,227	214	674	15,006	953	1,444			
6	4	2,320	1,097	4,283	832	1,680	32,126	2,548				
6	5	6,273	2,916	10,480	2,824	5,218	108,025	5,775	5,384			
6	6	12	3	311	0	10	410	0	237			
6	7	2,508	1,247	5,777	1,410	1,486	35,433	2,857	2,315			
6	8	3,273	1,570	10,162	1,659	1,907	50,752	3,544	3,361			
6	9	1,198	601	4,817	586	694	16,718	1,407	1,474			
6	10	7,058	3,536	33,361	3,930	4,006	112,752	6,855	9,053			
6	11	5,613	2,838	17,296	3,463	3,245	85,060	5,746	6,104			
6	12	3,219	4,678	6,231	862	4,672	62,600	2,604	973			
6	13	4,145	5,303	10,953	1,060	5,908	87,345	2,961	1,251			
6	14	4,205	5,776	9,587	1,014	5,926	87,910	3,103	1,249			
6	15	4,534	6,157	10,620	1,211	6,380	95,502	3,311	1,273			
6	16	15	6	196	0	76	565	5	7			
6	17	902	994	2,627	301	1,680	12,746	920	397			
6	18	25,943	66,834	24,164	11,882	31,902	381,543	21,631	8,346			
6	19	35,047	108,188	18,938	15,599	40,816	537,949	27,688	11,041			
6	20	23,798	61,984	14,220	10,420	29,188	341,661	20,593	7,974			
6	21	24,905	62,618	15,501	10,560	30,509	363,007	21,147	7,889			

One nearby example of a calibrated use of the MPM /Einstein function is in the sediment transport analysis in San Diego Creek to Newport Bay (Boyle Engineering Corporation, 1982). Similar hydraulic and sediment characteristics are present on San Juan and San Diego Creek. The San Diego Creek watershed has a basin slope that varies from steep hillsides to flatter terrains. Based on analysis of gage data, the 100-year discharge for San Diego Creek upstream of the Peters Canyon Wash confluence is 14,000 cfs (396 cms). The total drainage area at this point is 42.9 sq.mi (111 km²). This is equivalent to 3.6 cms/km². San Juan Creek has a 100-year discharge of 1,510 cms for a drainage area 450.2 km², or 3.4 cms/km². Channel velocities for San Diego Creek range from 5.7 fps (1.7 mps) to 14.6 fps (4.5 mps). The San Juan Creek velocities generally range from 2 to 4 mps. The D50 in San Diego Creek ranges from 0.33 mm to 0.72 mm. On San Juan Creek the D50 ranges from 0.8 mm to 1.5 mm. The sediment transport results using the MPM-Einstein function compared well with the measured gage data. The MPM-Einstein function was also used in the Coast of California Storm and Tidal Wave Study (SLA, 1988) which evaluated sedimentation along coastal canyons between Dana Point (the mouth of San Juan Creek) and the Mexican Border.

Figures 6.18 through 6.25 show the comparison of the sediment transport rates between the SAMAID recommended functions and the combined MPM-Einstein procedure for the 25-year and 100-year flood events. The comparison is similar for the remaining events. For both San Juan Creek and Trabuco Creek two functions recommended by SAMAID were calculating capacities over an order of magnitude different than the remaining functions. These functions, Laursen-Copeland and Ackers-White on San Juan Creek and Laursen-Copeland and Yang D50 on Trabuco Creek, were discarded as outliers. The trends of increasing and decreasing transport capacity are similar among all the procedures. The procedure selected for final use in determining the sediment transport capacity was that which gave results closest to the MPM-Einstein procedure. The following list indicates the final selected procedure for each watercourse.

Stream	Function
San Juan Creek	Yang D50
Trabuco Creek	Ackers-White
Oso Creek	Ackers-White
Canada Gobernadora	Laursen-Copeland

6.6 Potential Sediment Yield Results

The peak sediment transport rates using the selected function are listed in Table 6.10 through Table 6.13 and are shown graphically in Figure 6.26 through Figure 6.29

Table 6.10 San Juan Creek Peak Sediment Transport Rates(Yang-D50 Method)

Reach	2-Year	25-Year	50-Year	100-Year	200-Year	500-Year
		Metr	ric Tons per Da	ay		
1	3,599	41,366	49,161	55,196	61,451	105,472
2	7,759	323,817	470,329	679,527	591,937	650,451
3	953	144,934	238,174	359,748	477,965	573,912
4	2,548	93,368	148,068	188,329	207,430	177,772
5	5,775	240,498	373,794	529,531	732,513	1,095,141
6	0	10,588	24,180	47,936	83,244	175,407
7	2,857	195,825	380,642	661,944	1,029,368	1,578,759
8	3,544	377,828	665,850	1,083,154	1,472,198	2,438,765
9	1,407	197,938	366,042	572,133	861,363	1,345,447
10	6,855	243,790	356,870	454,357	522,439	362,287
11	5,746	398,314	680,348	1,038,291	1,241,662	1,592,612
12	2,604	230,459	414,284	661,000	1,091,359	1,426,794
13	2,961	255,706	439,777	652,667	738,321	1,038,441
14	3,103	202,529	297,564	262,421	182,882	53,872
15	3,311	277,492	497,248	663,349	651,034	153,464
16	5	194,607	201,155	90,409	15,136	962
17	920	269,015	454,236	641,967	801,769	527,920
18	21,631	312,542	525,454	830,357	1,221,494	1,778,462
19	27,688	403,674	686,171	849,052	1,109,810	1,588,786
20	20,593	363,970	607,190	225,661	335,451	573,967
21	21,147	352,122	625,187	1,012,707	1,499,353	2,214,626

Table 6.11 Trabuco Creek Peak Sediment Transport Rates(Acker-White Method)

Reach	2-Year	25-Year	50-Year	100-Year	200-Year	500-Year
		Metr	ic Tons per Da	ay		
1	7,447	109,822	460,372	872,605	1,142,071	2,189,684
2	11,153	239,525	465,483	760,884	1,114,823	2,167,057
3	7,764	254,286	502,364	731,625	768,204	950,612
4	2,509	182,837	350,193	553,655	1,050,080	1,831,282
5	6,378	128,669	250,271	381,026	606,635	917,549
6	2,064	97,203	230,444	384,811	639,177	1,049,899
7	1,035	115,393	204,901	355,995	580,498	951,681
8	0	326	983	1,384	1,355	1,260
9	1,230	29,420	57,523	90,190	238,580	314,028
10	4,150	74,408	122,640	181,932	121,380	83,969
11	2,398	54,732	88,667	125,177	194,906	174,848
12	16,037	78,423	140,811	200,379	298,013	409,349
13	35,211	168,131	218,046	315,501	518,338	1,117,958
14	47,324	222,767	338,796	532,141	257,657	70,780
15	15,819	178,843	323,257	145,657	68,225	279,266

Table 6.12 Oso Creek Peak Sediment Transport Rates(Acker-White Method)

_	Reach	2-Year	25-Year	50-Year	100-Year	200-Year	500-Year
			Met	tric Tons per D) ay		
	1	863	12,033	11,670	10,444	3,959	1,233
	2	13	308	436	561	494	3,623
	3	25,853	42,279	44,331	46,641	86,990	149,715
	4	5,802	22,823	26,428	31,928	33,669	9,850
	5	53,468	101,875	110,014	121,925	180,686	285,316
	6	50,097	97,917	107,603	121,806	189,775	304,574

Table 6.13 Canada Gobernadora Peak Sediment Transport Rates(L-C Method)

Reach	2-Year	25-Year	50-Year	100-Year	200-Year	500-Year
		Metr	ric Tons per Da	ay		
1	28,317	441,837	774,889	2,339,849	3,384,122	4,824,209
2	980	87,443	818,117	1,181,577	1,869,696	2,852,562
3	60	346,555	683,064	1,016,727	1,561,734	2,480,378
4	289	25,702	58,640	98,639	832,531	1,352,394
5	61,316	1,111,884	756,469	953,314	1,265,335	1,675,417
6	2,718	58,797	293,823	436,838	1,089,551	1,749,681

For each event the steady state transport capacities for the discharges were integrated with a time varying hydrograph to give a total sediment yield. The SED.YLD module in SAM can perform this integration. However the hydrograph at each concentration point along the studied reach for each frequency event must be entered as input data. Given the extensive stream length in this watershed study, developing this input data would have been a cumbersome procedure. Instead a procedure developed by Tt/ISG was used to determine the volumes. This procedure uses a pattern hydrograph to perform the integration. Storm hydrographs at various frequencies and concentration points were grouped along each stream based on a similar pattern. The hydrographs were scaled based on a ratio of the peak discharges. The sediment discharges were then integrated over the appropriated hydrograph. This allows the volume calculation to be performed in a batch format. As an independent check on the Tt/ISG procedure, the results using the SAM.YLD module and the Tt/ISG program at a single concentration point were compared. The resulting weights varied by less than 5%. This was determined to be an acceptable variation.

The event yields by weight and volume assuming a bulk density of 1.5 g/cm³ (93 lb/ft³) are listed in Table 6.14 through Table 6.17.

Table 6.14 San Juan Creek Total Sediment Yield (Yang-D50 Method)

Reach	2-	Year	25-	Year	50-	Year	100-	-Year	200-	Year	500-	Year
#	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons
1	962	1,436	12,860	12,860 19,198		27,668	24,427 36,466		29,747 44,407		38,978	58,188
2	2,061	3,077	100,729	150,374	154,352	230,424	225,266	336,288	277,606 414,423		342,944	511,964
3	258	385	45,090	67,313	72,079	107,603	109,338	163,225	153,228	228,746	213,628	318,914
4	6,501	9,705	29,048	43,364	45,853	68,452	65,445	97,699	84,452	126,074	102,927	153,654
5	1,529	2,282	74,801	111,666	117,265	175,058	172,324	257,254	239,416	357,412	351,432	524,634
6	17	25	3,285	4,905	5,987	8,938	10,883	16,247	18,665	27,865	37,421	55,865
7	756	1,128	60,913	90,934	105,454	157,427	171,335	255,776	266,586	397,972	434,063	647,989
8	945	1,410	117,533	175,458	196,224	292,933	303,969	453,780	439,153	655,588	693,641	1,035,500
9	378	565	61,578	91,926	104,710	156,316	161,497	241,091	241,263	360,169	382,504	571,020
10	1,821	2,718	75,829	113,201	118,536	176,956	164,374	245,385	211,390	315,574	245,084	365,873
11	1,529	2,282	123,902	184,966	204,142	304,753	308,649	460,766	423,181	631,745	587,983	877,768
12	687	1,025	71,676	107,002	120,378	179,706	186,751	278,791	288,543	430,750	435,447	650,056
13	790	1,180	79,537	118,737	131,385	196,137	197,060	294,180	265,205	395,910	372,869	556,636
14	825	1,231	62,989	94,033	98,390	146,881	125,190	186,889	141,527	211,278	143,899	214,819
15	876	1,308	86,310	128,848	144,377	215,533	211,070	315,095	270,811	404,280	290,841	434,181
16	17	25	60,530	90,362	85,027	126,933	95,167	142,070	94,681	141,344	84,321	125,879
17	241	359	83,670	124,906	136,903	204,375	201,640	301,018	274,932	410,431	328,857	490,933
18	2,139	3,194	97,214	145,126	156,495	233,624	242,352	361,795	360,385	537,999	539,597	805,535
19	2,735	4,084	125,575	187,465	202,948	302,970	290,950	434,345	399,792	596,829	559,549	835,321
20	2,037	3,041	113,219	169,019	181,743 271,315		205,946 307,445		242,843 362,527		293,713	438,468
21	2,088	3,117	109,530	163,512	179,892	268,551	284,316	424,440	429,831	641,673	655,857	979,094

Table 6.15 Trabuco Creek Total Sediment Yield (Acker-White Method)

Reach	2-	Year	25-	Year	50-	Year	100-	-Year	200-	Year	500-	Year
#	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons
1	884	1,320	20,784	31,027	43,517	64,964	87,877	131,186	158,332	236,365	274,297	409,484
2	1,325	1,977	45,330	67,671	77,333 115,446		121,821 181,860		193,630	289,060	314,255	469,135
3	1,845	2,754	52,259	78,015	102,500	153,017	162,937 243,240		239,024	356,826	326,595	487,556
4	596	890	36,105	53,899	71,725	107,075	116,829	174,408	204,686	305,565	347,780	519,182
5	1,515	2,262	27,616 41,226	52,501	78,376	83,418	124,531	135,923	202,912	211,229	315,333	
6	490	732	19,544	19,544 29,176	41,675	62,214	71,998	107,482	125,875	187,912	210,866	314,791
7	246	367	22,524	33,625	43,871 65,492		72,397	108,077	123,135	183,822	197,554	294,918
8	0	0	63	93	153	228	266	396	396	591	544	812
9	292	436	6,205	9,263	11,940	17,825	19,218	28,690 37,711		56,296	63,806	95,253
10	986	1,472	16,191	24,170	28,905	43,150	43,945	65,603	58,786	87,758	68,361	102,053
11	570	851	11,596	17,311	20,900	31,201	31,471	46,982	48,957	73,086	65,659	98,018
12	1,585	2,367	18,632	27,815	28,929	43,186	45,293	67,616	67,390	100,602	100,456	149,966
13	3,481	5,196	39,946	59,633	56,538	84,403	82,385	122,989	120,621	180,068	200,546	299,385
14	4,678	6,984	52,926	79,011	77,635	115,897	120,114	179,311	149,043	222,498	161,716	241,417
15	1,564	2,334	42,491	63,432	67,062	100,113	85,683	127,912	93,220	139,163	119,133	177,848

Table 6.16 Oso Creek Total Sediment Yield (Yang-D50 Method)

Reach	2-1	Year	25-	Year	50-	Year	100-	-Year	200	-Year	500-Year		
#	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons	
1	76	113	325	486	417	622	502	750	738	1,101	1,004	1,499	
2	76	113	325	486	417	622	502	750	738	1,101	1,004	1,499	
3	76	113	325	486	417	622	502	750	738	1,101	1,004	1,499	
4	76	113	325	486	417	622	502	750	738	1,101	1,004	1,499	
5	4,705	7,023	15,663	23,383	16,751	25,006	18,454	27,550	26,821	40,040	41,459	61,892	
6	4,408	6,580	15,055	22,475	16,104	24,040	17,777	26,538	26,193	39,102	41,408	61,816	

Table 6.17 Canada Gobernadora Total Sediment Yield (L-C Method)

Reach	2-Year		25-	Year	50-	Year	100-	-Year	200-	-Year	500-Year		
#	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons	m^3	met. tons	
1	3,530	5,269	46,602	69,570	80,195	119,718	131,668	196,560	211,995	316,475	355,259	530,347	
2	121	181	6,420	9,584	26,345	39,329	44,850	66,954	97,230	145,149	166,452	248,487	
3	8	12	23,160	34,575	52,430	78,270	80,753	120,552	132,652	198,029	206,709	308,585	
4	32	48	1,873	2,796	4,184	6,246	6,599	9,851	23,172	34,593	44,372	66,241	
5	7,641	11,406	111,257	166,089	173,155	258,495	231,252	345,224	299,137	446,566	392,051	585,273	
6	339	506	5,567	8,311	13,827	20,642	21,773	32,504	48,550	72,477	84,500	126,145	

6.7 Aggradation and Degradation

Comparison of the total event yield indicates the potential of each reach to be aggradational or degradational. As stated previously, if the potential sediment yield within a particular reach is less than that provided by the reach immediately upstream then there will be more sediment coming in than is going out and aggradation is expected. If the potential sediment yield within a reach is greater than what is supplied by the upstream reach, more is going out than is coming in and degradation is expected. If the two are the same, the reaches are in equilibrium with respect to each other. In reaches where tributaries enter the main channel, the volume of supply to that reach was increased to account for the expected inflow of sediment from that tributary. This increase was included in the calculation to determine the expected aggradation / degradation. Tributaries to San Juan Creek include Trabuco Creek, Horno Creek and Canada Chiquita. Oso Creek is a tributary to Trabuco Creek.

Table 6.18 through Table 6.20 lists the volume of transported material for each reach. The difference in the transport volume between the reach in question and the reach immediately upstream is also tabulated. Table 6.18 through Table 6.20 also lists the average top width of flow within the channel and the length of each reach. The volumetric difference in transport capacity was assumed to be evenly distributed over an area defined by the reach length and the channel width, and an average depth of potential aggradation or degradation was calculated for each event, as shown in Table 6.18 through Table 6.20. The aggradational and degradational trends by reach for each studied watercourse are also shown for the 25- and 100-year events in Figure 6.30 through Figure 6.37.

Reach #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Reach Length (m)	600	550	850	900	850	1150	1000	800	700	800	700	800	700	700	800	700	650	850	800	700	1100
2-Year Event																					
_	0.62	2061	250	6501	1520	17	756	0.45	270	1001	1.520	607	700	025	076	17	241	2120	2725	2027	2000
Capacity (m ³)	962	2061	258	6501	1529	17	756	945	378	1821	1529	687	790	825	876	17	241	2139	2735	2037	2088
Difference (m³)	0	-1099	1804	-6244	4973	1511	-399	-86	566	-1443	292	842	-104	-34	56	859	-223	-335	-596	698	-51
Channel Width (m)	24.5	9.2	82.8	27.0	23.1	122.0	26.3	42.2	48.0	64.2	39.7	33.7	56.1	47.8	52.8	74.4	37.2	52.0	47.1	50.1	56.5
Agg/Deg (m)	0.00	-0.22	0.03	-0.26	0.25	0.01	-0.02	0.00	0.02	-0.03	0.01	0.03	0.00	0.00	0.00	0.02	-0.01	-0.01	-0.02	0.02	0.00
25-Year Event																					
Capacity (m ³)	12860	100729	45090	29048	74801	3285	60913	117533	61578	75829	123902	71676	79537	62989	86310	60530	83670	97214	125575	113219	109530
Difference (m ³)	0	-87869	55639	16043	-45753	71516	-52060	-54521	55955	-14251	-48073	52225	-7861	16549	-22155	25781	-23140	28946	-28361	12356	3689
Channel Width (m)	150.5	32.3	141.8	81.4	69.3	163.1	124.8	143.6	154.0	114.8	82.9	82.7	95.0	77.5	78.5	94.6	52.4	64.2	58.0	60.1	66.5
Agg/Deg (m)	0.00	-4.94	0.46	0.22	-0.78	0.38	-0.42	-0.47	0.52	-0.16	-0.83	0.79	-0.12	0.31	-0.35	0.39	-0.68	0.53	-0.61	0.29	0.05
1.56,2.66 ()	0.00		00	0.22	0.70	0.50	02	0	0.02	0.10	0.00	0.77	0.12	0.01	0.00	0.07	0.00	0.00	0.01	0.2	0.00
50-Year Event																					
Capacity (m ³)	18534	154352	72079	45853	117265	5987	105454	196224	104710	118536	204142	120378	131385	98390	144377	85027	136903	156495	202948	181743	179892
Difference (m ³)	0	-135818	82273	26226	-71411	111277	-85640	-87076	91514	-13826	-85606	83764	-11006	32995	-44143	59350	-51875	47469	-46452	21205	1851
Channel Width (m)	162.2	46.1	147.1	84.6	78.9	167.2	129.3	175.9	178.5	125.2	89.5	91.4	102.6	83.7	84.6	100.6	57.0	68.8	62.7	66.3	70.5
Agg/Deg (m)	0.00	-5.36	0.66	0.34	-1.06	0.58	-0.66	-0.62	0.73	-0.14	-1.37	1.15	-0.15	0.56	-0.65	0.84	-1.40	0.81	-0.93	0.46	0.02
100-Year Event																					
Capacity (m ³)	24427	225266	109338	65445	172324	10883	171335	303969	161497	164374	308649	186751	197060	125190	211070	95167	201640	242352	290950	205946	284316
Difference (m ³)	0	-200839	115929	43893	-106879	161441	-138678	-127394	142472	-2877	-144275	121898	-10309	71870	-83431	115903	-106473	44971	-48598	85005	-78370
Channel Width (m)	174.6	53.5	152.4	87.1	83.7	171.0	131.6	224.2	186.1	135.1	96.3	99.9	107.6	89.4	89.7	108.9	62.8	74.4	68.5	76.4	76.8
Agg/Deg (m)	0.00	-6.83	0.89	0.56	-1.50	0.82	-1.05	-0.71	1.09	-0.03	-2.14	1.53	-0.14	1.15	-1.16	1.52	-2.61	0.71	-0.89	1.59	-0.93
200-Year Event																					
Capacity (m ³)	29747	277606	153228	84452	239416	18665	266586	439153	241263	211390	423181	288543	265205	141527	270811	94681	274932	360385	399792	242843	429831
Difference (m ³)	0	-247859	124377	68776	-154964	220751	-199371	-164630	197890	29873	-211791	134638	23338	123678	-125943	176131	-180251	7767	-39408	156950	-186989

San Juan Creek Watershed Management Study

Reach #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Reach Length (m)	600	550	850	900	850	1150	1000	800	700	800	700	800	700	700	800	700	650	850	800	700	1100
Channel Width (m)	186.7	60.7	159.9	91.6	89.4	175.5	133.7	229.6	190.3	139.9	108.9	104.5	112.0	100.4	92.6	112.9	66.5	76.8	69.0	77.1	82.6
Agg/Deg (m)	0.00	-7.43	0.92	0.83	-2.04	1.09	-1.49	-0.90	1.49	0.27	-2.78	1.61	0.30	1.76	-1.70	2.23	-4.17	0.12	-0.71	2.91	-2.06
500-Year Event																					
Capacity (m ³)	38978	342944	213628	102927	351432	37421	434063	693641	382504	245084	587983	435447	372869	143899	290841	84321	328857	539597	559549	293713	655857
Difference (m ³)	0	-303966	129317	110701	-248505	314010	-312141	-247806	311137	137420	-342899	152535	62578	228970	-142451	206519	-244535	-91607	-19952	265836	-362144
Channel Width (m)	195.2	61.1	170.2	99.8	103.6	178.6	134.4	265.6	195.1	146.0	113.5	107.4	112.0	100.7	94.4	115.4	66.5	76.8	69.0	77.1	84.8
Agg/Deg (m)	0.00	-9.04	0.89	1.23	-2.82	1.53	-2.32	-1.17	2.28	1.18	-4.32	1.78	0.80	3.25	-1.89	2.56	-5.66	-1.40	-0.36	4.92	-3.88
Average Event																					
Capacity (m ³)	4,691	34,628	15,628	13,166	26,317	1,291	22,478	41,876	22,051	26,166	43,558	25,758	27,811	20,897	29,683	18,918	28,614	35,039	44,258	37,863	39,749
Agg/Deg (m)	0.00	-3.97	0.29	0.08	-0.51	0.21	-0.40	-0.38	0.43	-0.08	-0.59	0.57	-0.06	0.22	-0.22	0.25	-0.46	0.23	-0.30	0.22	-0.04

	Table 6.19	Trabuco Creek Trans	sport Capacity, Di	ifferences, and Trends
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Reach #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Reach Length (m)	1000	1000	900	1100	1000	1000	1000	1100	1100	1200	1000	1000	1000	800	800
2-Year Event															
Capacity (m ³)	884	1325	1845	596	1515	490	246	0	292	986	570	1585	3481	4678	1564
Difference (m ³)	0	-440	-520	1249	-919	1025	244	246	-292	-694	416	476	-1895	-1197	3114
Channel Width (m)	34.7	102.2	43.1	58.2	65.7	75.0	91.1	123.2	12.3	12.6	23.1	54.0	40.0	23.0	39.5
Agg/Deg (m)	0.00	0.00	-0.01	0.02	-0.01	0.01	0.00	0.00	-0.02	-0.05	0.02	0.01	-0.05	-0.07	0.10
25-Year Event															
Capacity (m ³)	20784	45330	52259	36105	27616	19544	22524	63	6205	16191	11596	18632	39946	52926	42491
Difference (m ³)	0	-24547	-6929	16155	8489	8072	-2981	22462	-6142	-9986	4594	-3009	-21313	-12981	10436
Channel Width (m)	109.3	144.8	56.8	121.6	97.5	101.9	152.8	178.4	26.7	22.8	35.1	81.3	51.8	28.4	45.5
Agg/Deg (m)	0.00	-0.17	-0.14	0.12	0.09	0.08	-0.02	0.11	-0.21	-0.36	0.13	-0.04	-0.41	-0.57	0.29
50-Year Event															
Capacity (m ³)	43517	77333	102500	71725	52501	41675	43871	153	11940	28905	20900	28929	56538	77635	67062
Difference (m ³)	0	-33816	-25167	30775	19224	10826	-2196	43718	-11787	-16965	8004	-3194	-27609	-21097	10573
Channel Width (m)	143.1	153.0	62.1	126.8	101.5	112.3	160.9	186.9	30.9	27.5	39.9	88.8	60.9	31.0	48.3
Agg/Deg (m)	0.00	-0.22	-0.45	0.22	0.19	0.10	-0.01	0.21	-0.35	-0.51	0.20	-0.04	-0.45	-0.85	0.27
100-Year Event															
Capacity (m ³)	87877	121821	162937	116829	83418	71998	72397	266	19218	43945	31471	45293	82385	120114	85683
Difference (m ³)	0	-33944	-41116	46108	33411	11420	-399	72131	-18953	-24727	12474	-8419	-37092	-37728	34431
Channel Width (m)	159.3	160.6	75.0	132.8	105.9	116.1	164.9	192.0	35.5	30.9	45.5	98.4	66.8	34.7	53.6
Agg/Deg (m)	0.00	-0.21	-0.61	0.32	0.32	0.10	0.00	0.34	-0.49	-0.67	0.27	-0.09	-0.56	-1.36	0.80
200-Year Event															
Capacity (m ³)	158332	193630	239024	204686	135923	125875	123135	396	37711	58786	48957	67390	120621	149043	93220

Reach #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Reach Length (m)	1000	1000	900	1100	1000	1000	1000	1100	1100	1200	1000	1000	1000	800	800
Difference (m ³)	0	-35298	-45394	34337	68763	10048	2740	122739	-37314	-21075	9828	-10849	-53231	-28422	55823
Channel Width (m)	178.0	166.1	101.6	135.8	111.6	118.1	171.3	196.1	38.9	35.6	53.5	108.0	77.6	46.2	58.2
Agg/Deg (m)	0.00	-0.21	-0.50	0.23	0.62	0.09	0.02	0.57	-0.87	-0.49	0.18	-0.10	-0.69	-0.77	1.20
500-Year Event															
Capacity (m ³)	274297	314255	326595	347780	211229	210866	197554	544	63806	68361	65659	100456	200546	161716	119133
Difference (m ³)	0	-39957	-12340	-21185	136551	363	13312	197010	-63262	-4555	2702	-24497	-100090	38831	42582
Channel Width (m)	209.7	177.1	120.2	139.3	123.0	122.6	178.2	198.0	42.2	36.7	65.0	116.0	82.5	59.6	59.0
Agg/Deg (m)	0.00	-0.23	-0.11	-0.14	1.11	0.00	0.07	0.90	-1.36	-0.10	0.04	-0.21	-1.21	0.81	0.90
Average Event															
Capacity (m ³)	9,150	17,009	20,115	14,233	11,056	8,066	8,700	25	2,560	6,156	4,435	7,290	15,299	19,993	14,725
Agg/Deg (m)	0.00	-0.09	-0.09	0.09	0.05	0.05	-0.01	0.07	-0.17	-0.24	0.08	-0.02	-0.24	-0.31	0.21

Table 6.20 Oso Creek & Canada G. Transport Capaci Oso Creek							Transport Capacity, I	, Differences, and Trends Canada Gobernadora						
Reach #	1	2	3	4	5	6	Reach #	1	2	3	4	5	6	
Reach Length (m)	1000	950	1050	1500	1100	1000	Reach Length (m)	900	900	800	800	800	900	
2-Year Event							2-Year Event							
Capacity (m ³)	76	76	76	76	4705	4408	Capacity (m ³)	3530	121	8	32	7641	339	
Difference (m ³)	1416	0	0	0	-4629	297	Difference (m ³)	0	3408	113	-24	-7608	7301	
Channel Width (m)	33.8	19.9	22.4	10.8	18.2	19.7	Channel Width (m)	20.2	79.4	105.1	94.7	8.0	42.5	
Agg/Deg (m)	0.04	0.00	0.00	0.00	-0.23	0.02	Agg/Deg (m)	0.00	0.05	0.00	0.00	-1.19	0.19	
25-Year Event							25-Year Event							
Capacity (m ³)	325	325	325	325	15663	15055	Capacity (m ³)	46602	6420	23160	1873	111257	5567	
Difference (m ³)	3701	0	0	0	-15338	609	Difference (m ³)	0	40183	-16740	21287	-109383	105689	
Channel Width (m)	36.7	19.9	27.1	11.1	22.0	22.9	Channel Width (m)	75.5	154.4	204.8	194.6	16.9	130.0	
Agg/Deg (m)	0.10	0.00	0.00	0.00	-0.63	0.03	Agg/Deg (m)	0.00	0.29	-0.10	0.14	-8.10	0.90	
50-Year Event							50-Year Event							
Capacity (m ³)	417	417	417	417	16751	16104	Capacity (m ³)	80195	26345	52430	4184	173155	13827	
Difference (m ³)	4417	0	0	0	-16334	647	Difference (m ³)	0	53850	-26085	48246	-168971	159328	
Channel Width (m)	37.1	19.9	27.7	11.2	22.6	23.3	Channel Width (m)	82.5	179.1	213.1	203.3	33.0	145.2	
Agg/Deg (m)	0.12	0.00	0.00	0.00	-0.66	0.03	Agg/Deg (m)	0.00	0.33	-0.15	0.30	-6.40	1.22	
100-Year Event							100-Year Event							
Capacity (m ³)	502	502	502	502	18454	17777	Capacity (m ³)	131668	44850	80753	6599	231252	21773	
Difference (m ³)	4901	0	0	0	-17952	678	Difference (m ³)	0	86818.23	-35903.3	74154.21	-224653	209478.9	
Channel Width (m)	37.3	19.9	28.6	11.2	23.5	23.8	Channel Width (m)	124.0	183.8	217.2	209.8	43.5	149.7	
Agg/Deg (m)	0.13	0.00	0.00	0.00	-0.69	0.03	Agg/Deg (m)	0.00	0.52	-0.21	0.44	-6.46	1.55	

		C	oso Cree	ek			Canada Gobernadora						
Reach #	1	2	3	4	5	6	Reach #	1	2	3	4	5	6
Reach Length (m)	1000	950	1050	1500	1100	1000	Reach Length (m)	900	900	800	800	800	900
200-Year Event							200-Year Event						
Capacity (m ³)	738	738	738	738	26821	26193	Capacity (m ³)	211995	97230	132652	23172	299137	48550
Difference (m ³)	6846	0	0	0	-26083	628	Difference (m ³)	0	114765	-35422	109480	-275965	250588
Channel Width (m)	37.8	19.9	31.5	11.5	27.0	26.0	Channel Width (m)	139.5	193.2	221.4	225.8	48.0	156.5
Agg/Deg (m)	0.18	0.00	0.00	0.00	-0.88	0.02	Agg/Deg (m)	0.00	0.66	-0.20	0.61	-7.19	1.78
500-Year Event							500-Year Event						
Capacity (m ³)	1004	1004	1004	1004	41459	41408	Capacity (m ³)	355259	166452	206709	44372	392051	84500
Difference (m ³)	9297	0	0	0	-40455	51	Difference (m ³)	0	188807	-40257	162337	-347679	307551
Channel Width (m)	38.0	19.9	35.7	11.9	31.3	29.2	Channel Width (m)	163.5	200.5	229.5	237.9	55.6	161.5
Agg/Deg (m)	0.24	0.00	0.00	0.00	-1.17	0.00	Agg/Deg (m)	0.00	1.05	-0.22	0.85	-7.82	2.12
Average Event							Average Event						
Capacity (m ³)	144	144	144	144	7,325	6,989	Capacity (m ³)	18,877	3,632	9,029	908	40,997	2,596
Agg/Deg (m)	0.07	0.00	0.00	0.00	-0.44	0.02	Agg/Deg (m)	0.00	0.21	-0.06	0.10	-5.51	0.76

The transport capacity of an probability weighted average event is computed by integrating the capacities of each event with the corresponding frequency of occurrence as given by the following equation:

$$C_{avg} = 0.48C_2 + 0.24C_{25} + 0.015C_{50} + 0.0075C_{100} + 0.004C_{200} + 0.0035C_{500}$$

where C_{avg} is the probability weighted event average transport capacity and C_n is the transport capacity for the n-year event. An average trend toward being an aggradational or degradational reach is computed in the same way using depths of each event. Table 6.18 through Table 6.20 gives the probability weighted average event results in terms of capacity and depth for each reach. These average event results represent a low estimate of the average annual sediment transport capacity. This is in part a result of not accounting for base flow. Inaccuracies are also introduced because the relationship between the sediment transport rate and the flow discharge are not linear. In addition, a true average annual value would include an estimate of the sediment transported during floods other than the n-year frequency events over a long period of time.

The computed depth of aggradation or degradation is sensitive to the assumed reach length. For example, if the reach in question is divided into two subreaches, each having similar hydraulics, then the upper subreach will be the one where the difference in transport capacity is distributed. Since it is only half as long it will have twice the aggradation or degradation. At the same time the lower subreach would be in equilibrium with the upper subreach and would thus show no aggradation or degradation. Consequently, the computed depths are useful only in the sense of comparing the trends in one reach against those in another. They are not applicable to the design of structures.

6.8 Discussion of Results

6.8.1 San Juan Creek Aggradation / Degradation Trends

The transport capacity through Reach 1 was considered to be the supply reach to Reach 2. The following table shows the results of the transport capacity of Reach 1 compared to the watershed yield determined using the MUSLE procedure and the LAD Debris Method. Table 6.21 shows that the transport capacity based on the SAM results is close to an equilibrium state with the expected watershed yield. Therefore, Reach 1 is an appropriate supply reach.

Table 6.21 Transport Volume for San Juan Creek

San Juan Creek	2-year volume	25-year volume	100-year volume
	(m^3)	(m^3)	(m^3)
Transport Capacity	2,763 ¹	49,646 ¹	115,7021
MUSLE	1,200	47,200	122,800
LAD Debris Method	2,400	68,400	162,400

^{1.} Reach 1 hydraulics are not typical for upstream reach; results presented in this table are an average of the transport in Reach 3-5.

Moving downstream, the SAM model predicts significant degradation in Reach 2. This reach is characterized by an incised channel up to a depth of 5 meters. Reach 2 is part of the Conrock Mining Lease and this channel has most likely been created by mining extraction. The narrow channel creates high velocities and a high transport capacity which leads to degradation through the reach. The degradation depths predicted by the model in this reach are excessive compared to the historical trends. This is a result of the steady state limitation in SAM. As the reach experiences significant degradation, the flow velocity and sediment transport capacity decreases and the rate of degradation would slow or stop altogether. While the extent of degradation predicted by SAM is unlikely, the trend of degradation is consistent with what has been observed and what the existing conditions hydraulic characteristics indicate.

Aggradation is predicted in Reach 3 and Reach 4. Along these reaches the floodplain widens out, causing deposition of sediment. The historical trends show that these reaches are degrading. These reaches are within the Conrock Mining Lease. The historical lowering of the channel bed

^{2.} Note that watershed yield values are based on sediment sizes greater than 0.38mm

is likely a result of mining extraction rather than natural river processes. The sediment budget analysis does not address future mining. If mining continues in the future, then further degradation of the reaches is possible. If the mining were to cease, however, then the aggradation trends indicated by the sediment budget analysis could be expected.

The SAM model predicts degradation in Reach 5. This supports the trends shown by the historical data.

In Reach 6 aggradation is predicted by the SAM model. This is the most downstream end of the Conrock Mining Lease area. The downstream end has a large gravel pit that ponds water. This pond traps sediment and matches the SAM prediction for this reach. The historical data shows a degradation trend. Again, this is caused by the mining extraction rather than the river processes.

In Reach 7 degradation is predicted by the SAM model for all flows above the 2-year event. Because of the effect of the gravel pit on the sediment transport capacity, very little sediment is supplied to Reach 7 from the upstream reach. Part of this deficit is compensated for by the supply of sediment brought into San Juan Creek from Canada Gobernadora (which has been included in the sediment budget analysis). The trend of degradation is reflected in the historical data.

In Reach 8 SAM predicts degradation. In the past 15 years the historical data shows that there has been only minimal degradation. The SAM model does not account for the additional sediment transported into the main channel from Canada Chiquita which may account for the difference in extent of degradation. This tributary was not included in the overall study reach. The trend predicted by SAM matches the historical data.

In Reach 9 the SAM model predicts aggradation. This is consistent with the trend shown in the historical data. The sediment transport changes from degradation in the upstream reach to aggradation in this reach in part due to the reduction in velocity through this reach.

SAM predicts degradation during the lower flows and aggradation in the higher flows in Reach 10. The extent of aggradation or degradation tends to be minimal. This fluctuating trend and minimal changes would indicate that the reach is in an equilibrium state. This matches the historical trend which shows very little change in the channel invert over the past 15 years.

The SAM model predicts degradation through Reach 11. In this reach the floodplain changes from wide to a significantly more narrow floodplain. This geometric change leads to higher flow velocities which lead to higher transport rates. In addition a narrower floodplain leaves less area for the deficit to be spread over. Therefore, the extent of degradation increases. The historical data shows minimal degradation through this reach. The trend predicted by SAM and the historical data trend match.

In Reach 12 the SAM model predicts aggradation. The historical data shows minimal degradation over the past 15 years. The extent of aggradation predicted by SAM is a result of the significant amount of sediment transported into the reach from the upstream degradational reach.

In Reach 13 minimal degradation during lower flows and minimal aggradation during higher flow events is predicted. This indicates that the reach is in a fairly equilibrium state. This matches the historical data which shows very little change in the channel invert during the past 15 years.

The SAM model predicts aggradation through Reach 14. The floodplain width increases compared to the upstream widths through this reach. This tends to indicate an aggradational reach. The historical data shows aggradation over the past 15 years. There is also an aggradational trend between 1960 and 1970 in this reach.

The SAM model predicts degradation in Reach 15. The historical trend shows aggradation in this reach. The floodplain widens out in this area; however the velocities tend to increase as compared to the upstream reach. SAM calculates transport based only on the hydraulic

characteristics of the channel. Flows conveyed in the wider floodplain would tend to induce the aggradation effects seen in the historical trend.

In Reach 16 aggradation is predicted by the SAM model. The extent of aggradation is excessive in the higher flow events due to calculated backwater from the Camino Capistrano and Railroad bridges. Velocities tend to slow down and sediment is dropped in this area where the low flow channel loses its definition. The historical data shows some aggradation over the past 15 years.

In Reach 17 significant degradation is predicted by the SAM model. This is the beginning of the improved reach of San Juan Creek. An improved reach can usually carry sediment more efficiently than a natural reach. This efficiency leads to degradation. This degradational trend is reflected in the historical data. The extent of degradation predicted by the model is excessive. This is due to the small transport capacity determined by the model in the upstream Reach 16. Little sediment is being transported into this reach.

The SAM model predicts aggradation for all flows less than the 500-year flow event in Reach 18. The historical data shows degradation and aggradation in this reach over the past 15 years.

The SAM model predicts degradation in Reach 19. During the high flow events the degradation is minimal. The historical data shows minimal aggradation over the past 15 years.

In Reach 20 the SAM model predicts aggradation. This matches the historical trend over the past 15 years.

In Reach 21 the SAM model predicts minimal aggradation during the low flow events and degradation during the higher flow events. The trend seen in the historical data for the last 15 years matches the predicted trend for events less than the 50-year event.

In summary, the sediment budget analysis corresponds well with the historical trends. At some locations the magnitude of aggradation or degradation was overestimated by the model. This overestimation can affect the trend predicted in the downstream reach. The exception to the

good correlation is at the gravel mining areas where the channel invert has been significantly disturbed by the extraction of streambed material.

6.8.2 Trabuco Creek Aggradation / Degradation Trends

The transport capacity through Reach 1 was considered to be the supply reach to Reach 2. The following table shows the results of the transport capacity of Reach 1 compared to the watershed yield determined using the MUSLE procedure and the LAD Debris Method. Table 6.22 shows that the transport capacity based on the SAM results is close to an equilibrium state with the expected watershed yield. Therefore, Reach 1 is an appropriate supply reach.

Table 6.22 Transport Volume for Trabuco Creek

1 4010 0.22	2 Transport v	ordine for Traduco	CICCK
Trabuco Creek	2-year volume	25-year volume	100-year volume
	(m^3)	(m^3)	(m^3)
Transport Capacity	884	20,784	87,877
MUSLE	1,200	18,800	54,800
LAD Debris Method	4,000	35,200	91,600

^{1.} Note that watershed yield values are based on sediment sizes greater than 0.28mm

Moving downstream, the SAM model predicts slight degradation in Reach 2. This reach is characterized by a wide bottom width. Reach 2 has slightly higher velocities and depths than Reach 1 therefore the transport rate is higher causing degradation.

Degradation is predicted in Reach 3. This reach is characterized by a wide bottom width. The confluence with Tijeras Creek in Reach 3 produces higher velocities and depths than in Reach 2, thus degradation occurs.

The SAM model predicts slight aggradation in Reach 4 and Reach 5. These reaches are characterized by a wider bottom width than Reach 3. The wider floodplain produces lower velocities and depths for both reaches. Also a slightly coarser bed material gradation soil sample was used in the sediment transport calculation of Reach 5, causing Reach 5 to aggrade more than would be expected from only a hydraulic comparison.

The SAM model predicts Reach 6 and Reach 7 to be in equilibrium. These reaches are characterized by wide bottom widths. Similar hydraulic and sediment parameters in these two reaches produce a state of equilibrium.

Aggradation is predicted in Reach 8. This reach is characterized by a very wide bottom width and a mild invert slope. Reach 8 is part of the Livingston Graham Gravel Mine Lease and this channel has most likely been created by mining extraction. Trabuco Canyon Road crosses Trabuco Creek in Reach 8. This crossing is a constriction to the flow and causes backwater and slower velocities, which further contribute to the aggradation in this reach.

The SAM model predicts significant degradation in Reach 9 and Reach 10. These reaches are characterized by an incised channel with depths up to 5 meters. Steeper slopes and a narrower channel produce higher velocities and depths in these reaches, therefore higher transport rates cause degradation to occur. Since most of the sediment in Reach 8 aggrades there is minimal sediment supply to these reaches, which is also a cause of degradation. The historical data shows degradation in these reaches with the exception of improved control structures.

Aggradation is predicted in Reach 11. This reach is characterized by an incised channel at the upstream end and widening out at the downstream end. The downstream end is the Metro-Link Rail Road Bridge crossing. Under the bridge a grouted stone drop structure has been constructed to prevent the bridge pier from being eroded. This drop structure placement has caused a milder upstream slope and a wider bottom width. The milder slope produces slower velocities, causing aggradation to occur, which is consistent with the historical data.

The SAM model predicts Reach 12 to be in equilibrium. This reach is characterized by a wide bottom width. The upstream end is the Metro-Link Rail Road Bridge crossing. The Oso Creek confluence is also near the upstream end of Reach 12. The placement of the drop structure under the bridge and the inflow from Oso Creek produce hydraulic parameters which create a state of equilibrium in Reach 12. The historical data shows that his reach has had significant erosion just downstream of the drop structure which has made the slope milder for the reach.

Degradation is predicted in Reach 13. This reach is characterized by a narrow bottom width. The narrower bottom width and slightly steeper slope produce higher velocities and depths than in Reach 12, thus degradation occurs. The historical data shows degradation from the 1970 topography to the 1984 topography, but not much change from 1984 to the 1998 topography.

The SAM model predicts significant degradation in Reach 14. This reach is characterized by concrete lined channel banks and an earthen bottom. A steeper slope and a narrower channel produce higher velocities and depths in this reach, therefore higher transport rates cause degradation to occur. The historical data shows aggradation in this reach from the 1984 topography to the 1998 topography. While the transport rate is high in this reach Del Obispo bridge is probably acting as a control to the invert elevation upstream.

The SAM model predicts aggradation in Reach 15. This reach is characterized by concrete lined channel banks and an earthen bottom. Reach 15 has a milder slope than Reach 14, probably due to previous aggradation. The milder slope causes slower velocities, therefore aggradation occurs. Because the upstream reach supplies a significant volume, a small decrease in the Reach 15 velocities can cause aggradation. The historical data shows slight aggradation in this reach.

In summary, the sediment budget analysis corresponds well with the historical trends, where they are available. At some locations the magnitude of aggradation or degradation was overestimated by the model. The exception to the good correlation is at the grade control structure near the Metrolink Railroad and near the Del Obispo Bridge. These structures act as controls and have impacted the expected trend compared to the historical trend.

6.8.3 Oso Creek Aggradation / Degradation Trends

The supply reach transport (called Reach 0) was defined by combining the transport of La Paz Channel and Oso Creek upstream of the confluence of these two reaches. The following table shows the results of the transport capacity of Reach 0 compared to the watershed yield determined using the MUSLE procedure and the LAD Debris Method. Table 6.23 below shows that the transport capacity based on the SAM results is close to an equilibrium state with the expected watershed yield. Therefore, Reach 0 is an appropriate supply reach.

Table 6.23	Transport Vo	olume for Oso Creek
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Oso Creek	2-year volume	25-year volume	100-year volume						
	(m^3)	(m^3)	(m^3)						
Transport Capacity	76	325	502						
MUSLE	93	260	354						

- 1. Note that watershed yield values are based on sediment sizes greater than 0.28
- 2. The LAD Debris Method is not applicable due to the extent of development in the watershed

Moving downstream, the SAM model predicts slight aggradation in Reach 1. This reach is characterized by a narrow bottom width. Reach 1 has low velocities, therefore the transport rate is low causing aggradation.

Reach 2 is a concrete lined channel. The invert in the upstream end of this reach is also concrete while the downstream invert is a 1 meter (3-foot) thick layer of dumped stone. No degradation in this is expected, therefore the amount of sediment coming into the reach will be passed through to the next reach.

Reach 3 has concrete lined channel banks and an invert of dumped stone in the upstream section and a fully riprap lined channel in the downstream section. No degradation in this reach is expected, therefore the amount of sediment coming into the reach will be passed through to the next reach.

Reach 4 is a fully lined concrete channel. No degradation in this is expected, therefore the amount of sediment coming into the reach will be passed through to the next reach.

The SAM model predicts significant degradation in Reach 5. This reach is characterized by an incised channel. Reach 5 has high velocities, therefore the transport rate is high and with the small amount of supply that is passed through from the lined channels the model shows significant degradation. Although the model predicts significant degradation in Reach 5 and slight aggregation in Reach 6, it is likely that both reaches will act as one reach and degrade

accordingly. The steep sloughing banks noted from the field visit also confirm that there is degradation in both reaches.

6.8.4 Canada Gobernadora Aggradation / Degradation Trends

There is no historical data to which the predicted sediment transport capacities can be compared. Following is a description of the predicted trends and the expected trends based on the geometry of the channel and floodplain.

In the SAM model a generally equilibrium state is predicted in Reaches 1 through 4. The geometric aspects of the channel through these reaches is similar and little degradation or aggradation would be expected from reach to reach. The predicted aggradation during the high flow events is more extensive than the predicted degradation during these same events.

Significant degradation is predicted by the SAM model in Reach 5. In this reach the channel becomes confined and the velocities increase. These physical aspects would indicate a degradational reach in rivers where the supply is limited by an upstream reach with less transport capacity. The extent of degradation predicted by SAM is excessive. Again, this is a result of the steady state assumption inherent in SAM. No change in hydraulic parameters is accounted for as the erosion changes the channel geometry.

The SAM model predicts aggradation in Reach 6. Along this reach the floodplain widens and the velocities slow down. The sediment picked up in the previous reach would be expected to deposit in this reach.

The magnitudes of transport capacity are excessively overestimated. The SAM results are based on the channel hydraulics. The low flow channel contains extremely sandy soil. However, the low flow channel is a small portion of the entire floodplain for larger flows. This sandy, easy to transport sediment is not available in the overbank.

6.9 Sand Delivery to the Ocean

The sand delivery to the Pacific Ocean can be estimated based on the transport capacity of the most downstream reach (Reach 21) of San Juan Creek. The watershed yield is also a factor in determining the amount of sand that is delivered to the ocean. Previous discussion showed that the watershed yield is similar to the transport capacity of the upstream supply reach. As points further down the channel are investigated, supply to that reach is more dependent on the transport capacity of the upstream reach rather than the yield of the watershed. Therefore, it can be assumed that the sand delivery to the ocean is limited by the transport capacity of Reach 21. Table 6.18 shows the transport volumes (capacity) for this reach.

Two main factors can effect this volume of sand delivered to the ocean in the future. The first factor is the transport capacity of Reach 21. Clearly, significant physical changes in this reach will impact the amount of sediment delivered to the ocean. For example, if the downstream bridge (PCH) were modified to prevent backwater effects flow velocity would increase and more sand could be transported to the ocean. The second major factor is related to the watershed yield. If the amount of watershed yield were greatly reduced, the effects of sediment deprived flow could be carried downstream to the point where the amount of sand reaching the ocean could be impacted.

6.10 Non-Damaging Discharges for Structures

There are many bridges crossing San Juan Creek, Trabuco Creek and Oso Creek within the study area. There are also a number of reaches in these streams with bank and toe protection. The stability based on scour was evaluated at each of these structures. In general, standard design criteria require that structures be able to withstand the forces associated with a 50-year to 100-year storm. Significant crossings (for example, Interstate 5) often are often required to withstand

forces associated with a 100-year or larger storm. This criteria was used to determine if the structure represents a public safety issue.

The adequacy for public safety of each structure was evaluated by comparing computed scour depths for various events to the depth of each structure. In the case of bridges, scour depths were compared to a depth 1.5 meters below the bottom of the pier footing. This assumes that the bridge no longer has an adequate safety factor against structural failure once flood flows have exposed 1.5 meters of the piles that support the pier footing. In the case of bank protection, scour depth were compared to depth to the toe. This assumes that once the toe is undermined, the concrete will break away and expose the bank. A determination of whether the structure represents a public safety issue is based on the scour potential. Failure by other mechanisms is not considered.

The depth of scour is the sum of general scour, low flow incisement, bedform depth, bend scour, and local (pier, abutment) scour components. In those reaches in which the SAM sedimentation analysis predicts degradation, the general scour is taken to be the depth of degradation. In aggrading reaches, the general scour term is conservatively taken to be zero. A low flow channel incisement term of one meter is applied to the bridge and bank protection calculation to account for the potential of the thalweg to migrate over against a pier, abutment, or toe. The bed form depth term is one-half the height of dunes or antidunes and is computed as velocity head $(V^2/2g)$ multiplied by 0.88. Pier scour is computed using the Colorado State University dimensionless equation:

$$\frac{y_s}{Y_1} = 2.0K_1K_2K_3 \left(\frac{a}{Y_1}\right)^{0.65} Fr_1^{0.43}$$

Where:

 $y_s = \text{depth of scour}$

 Y_1 = depth of flow

 K_1 = pier coefficient (1.0 for round piers)

 K_2 = correction for angle of attack (1.0 for straight on)

 K_3 = correction for bed conditions (1.1 for small dunes)

a = pier width

 $Fr_1 = Froude Number (V/(gh)^{1/2})$

(Simons and Senturk, 1992)

The abutments for the bridges are either incorporated into concrete bank protection or are protected by other erosion control features. Consequently, calculations for abutment scour are not included. Bend scour was computed according to the USACE procedure in EM 1110-2-1601, Hydraulic Design of Flood Control Channels, 1 July 1991 with Change 1, 30 June 1994, Plate B-42 on p. B-45, and pp. 3-9 and 3-10.

The following Tables 6.24 and 6.25 compare the total scour for the 2-,25-,50-,100-,200-, and 500-year events with the known or estimated depth of footings and foundations at bridge structures and bank protection along San Juan Creek, Trabuco Creek, and Oso Creek. The values are potential scour depths and are not meant to be used as design values. In addition, failure is not likely to occur along the entire reach of a channel. The calculated scour is a conservative estimate which assumes that the worst case of each scour element occurs at the same time and same location. The computed scour depths are used only to make a determination as to whether the structure is a public safety risk. The structure is classified to be a public safety risk if the depth available for scour does not exceed the scour associated with a 50-year to 100-year flood flow. No attempt was made to predict what event would cause failure of a structure.

Table 6.24 Estimated Scour Depths at Bridge Structures

acific Coast H	ighway Bridge		San Juan Creek			Reach 21	
Return	General	Low Flow	Half Bedform	Pier	Total	Pier	
Interval	Scour	Incisement	Height	Scour	Scour	Depth	
(yr)	(m)	(m)	(m)	(m)	(m)	(m)	
2	0.00	1.00	0.08	2.83	3.91	5.33	
25	0.00	1.00	0.04	2.96	4.00	5.33	
50	0.00	1.00	0.02	2.70	3.72	5.33	
100	0.90	1.00	0.04	3.14	5.09	5.33	
200	2.10	1.00	0.07	3.53	6.70	5.33	
500	3.90	1.00	0.12	4.01	9.03	5.33	
Concrete lined of PUBLIC SA	channel protects AFETY RISK	abutments					
Camino Las Ramblas			San Juan Creek		Reach 21		
Return	General	Low Flow	Half Bedform	Pier	Total	Pier	
Interval	Scour	Incisement	Height	Scour	Scour	Depth	
(yr)	(m)	(m)	(m)	(m)	(m)	(m)	
2	0.00	1.00	0.12	2.40	3.52	5.78	
25	0.00	1.00	0.19	3.25	4.44	5.78	
50	0.00	1.00	0.17	3.36	4.53	5.78	
100	0.90	1.00	0.38	3.98	6.25	5.78	
200	2.10	1.00	0.69	4.56	8.34	5.78	
500	3.90	1.00	1.01	5.07	10.98	5.78	
Concrete lined of UBLIC SAFE	channel protects TY RISK	abutments					
tonehill Drive	in Reach 20		San Juan Creek			Reach 20	
Return	General	Low Flow	Half Bedform	Pier	Total	Pier	
Interval	Scour	Incisement	Height	Scour	Scour	Depth	
(yr)	(m)	(m)	(m)	(m)	(m)	(m)	
2	0.00	1.00	0.24	3.06	4.30	4.24	
25	0.00	1.00	0.69	4.43	6.12	4.24	
50	0.00	1.00	0.90	4.86	6.76	4.24	
100	0.00	1.00	0.45	4.52	5.97	4.24	
200	0.00	1.00	0.45	4.69	6.14	4.24	
	0.00	1.00	0.56				

Concrete lined channel protects abutments

Relatively shallow pier depth (per design plans); high flow velocities at frequent events lead to increased scour. PUBLIC SAFETY RISK

Table 6.24 Estimated Scour Depths at Bridge Structures

Metro Link Rai	lroad		San Juan Creek			Reach 17	
Return	General	Low Flow	Half Bedform	Pier	Total	Pier	
Interval	Scour	Incisement	Height	Scour	Scour	Depth	
(yr)	(m)	(m)	(m)	(m)	(m)	(m)	
2	0.00	1.00	0.03	2.94	3.98	n/a	
25	0.70	1.00	0.36	6.29	8.35	II/ a	
50	1.40	1.00	0.28	6.30	8.98		
100	2.60	1.00	0.28	6.46	10.34		
200	4.20	1.00	0.16	5.81	11.17		
500	5.70	1.00	0.10	5.53	12.35		
No plans were a							
	sk undetermined						
Camino Capistı	rano		San Juan Creek			Reach 17	
Return	General	Low Flow	Half Bedform	Pier	Total	Pier	
Interval	Scour	Incisement	Height	Scour	Scour	Depth	
(yr)	(m)	(m)	(m)	(m)	(m)	(m)	
2	0.00	1.00	0.04	1.67	0.71	5.27	
2	0.00	1.00	0.04	1.67	2.71	5.27	
25	0.70	1.00	0.44	3.45	5.59	5.27	
50	1.40	1.00	0.30	3.38	6.08	5.27	
100	2.60	1.00	0.23	3.26	7.09	5.27	
200	4.20	1.00	0.31	3.53	9.04	5.27	
500 Grade control s Concrete lined	5.70 tructure just d/s ochannel protects	1.00 of pier with 13.5' t	0.47	3.88	11.05	5.27	
500 Grade control s	5.70 tructure just d/s ochannel protects	1.00 of pier with 13.5' t	0.47	3.88	11.05	5.27 Reach 17	
500 Grade control s Concrete lined of the PUBLIC SAFE of the state 5	5.70 tructure just d/s ochannel protects TY RISK	1.00 of pier with 13.5' t abutments	0.47 toedown depth San Juan Creek			Reach 17	
500 Grade control s Concrete lined of the public SAFE of the state 5 Return	5.70 tructure just d/s ochannel protects TY RISK General	1.00 of pier with 13.5' tabutments Low Flow	0.47 toedown depth San Juan Creek Half Bedform	Pier	Total	Reach 17 Pier	
500 Grade control s Concrete lined of PUBLIC SAFE Interstate 5 Return Interval	5.70 tructure just d/s ochannel protects TY RISK General Scour	1.00 of pier with 13.5' tabutments Low Flow Incisement	0.47 toedown depth San Juan Creek Half Bedform Height	Pier Scour	Total Scour	Reach 17 Pier Depth	
500 Grade control s Concrete lined of the public SAFE of the state 5 Return	5.70 tructure just d/s ochannel protects TY RISK General	1.00 of pier with 13.5' tabutments Low Flow	0.47 toedown depth San Juan Creek Half Bedform	Pier	Total	Reach 17 Pier	
500 Grade control s Concrete lined o PUBLIC SAFE Interstate 5 Return Interval (yr)	5.70 tructure just d/s of channel protects TY RISK General Scour (m)	1.00 of pier with 13.5' tabutments Low Flow Incisement (m)	0.47 toedown depth San Juan Creek Half Bedform Height (m)	Pier Scour (m)	Total Scour (m)	Reach 17 Pier Depth (m)	
500 Grade control s Concrete lined of UBLIC SAFE Interstate 5 Return Interval (yr) 2	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05	Pier Scour (m) 2.37	Total Scour (m) 3.42	Reach 17 Pier Depth (m) 3.93	
500 Grade control s Concrete lined o PUBLIC SAFE Interstate 5 Return Interval (yr)	5.70 tructure just d/s of channel protects TY RISK General Scour (m)	1.00 of pier with 13.5' tabutments Low Flow Incisement (m)	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27	Pier Scour (m) 2.37 4.22	Total Scour (m) 3.42 6.18	Reach 17 Pier Depth (m) 3.93 3.93	
500 Grade control s Concrete lined of PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05	Pier Scour (m) 2.37	Total Scour (m) 3.42	Reach 17 Pier Depth (m) 3.93	
500 Grade control s Concrete lined of PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27 0.24 0.27	Pier Scour (m) 2.37 4.22 4.35 4.58	Total Scour (m) 3.42 6.18 6.99 8.45	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93	
500 Grade control s Concrete lined of PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27 0.24	Pier Scour (m) 2.37 4.22 4.35	Total Scour (m) 3.42 6.18 6.99	Reach 17 Pier Depth (m) 3.93 3.93 3.93	
500 Grade control s Concrete lined o PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined o Relatively shall	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects low pier depth (p	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27 0.24 0.27 0.40	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93	
500 Grade control s Concrete lined of PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined of Relatively shall PUBLIC SAFE	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects low pier depth (p.TY RISK	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27 0.24 0.27 0.40 0.64 ead to a low non-dan	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93 3.93	
Grade control s Concrete lined of PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined of Relatively shall PUBLIC SAFE La Novia Aven	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects ow pier depth (p TY RISK ue	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments er design plans) le	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27 0.24 0.27 0.40 0.64 ead to a low non-dan	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93 Reach 14	
500 Grade control s Concrete lined of PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined of Relatively shall PUBLIC SAFE a Novia Aven Return	tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects low pier depth (p TY RISK ue General	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments er design plans) le	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27 0.24 0.27 0.40 0.64 ead to a low non-dan San Juan Creek Half Bedform	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62 maging discharg	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93 Reach 14 Pier	
Grade control s Concrete lined of PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined of Relatively shall PUBLIC SAFE a Novia Aven Return Interval	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects low pier depth (p. TY RISK ue General Scour	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments er design plans) le	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27 0.24 0.27 0.40 0.64 ead to a low non-dan San Juan Creek Half Bedform Height	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62 maging discharg	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96 ge.	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93 Reach 14 Pier Depth	
500 Grade control s Concrete lined of PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined of Relatively shall PUBLIC SAFE a Novia Aven Return	tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects low pier depth (p TY RISK ue General	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments er design plans) le	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27 0.24 0.27 0.40 0.64 ead to a low non-dan San Juan Creek Half Bedform	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62 maging discharg	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93 Reach 14 Pier	
500 Grade control s Concrete lined o PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined o Relatively shall PUBLIC SAFE a Novia Aven Return Interval (yr)	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects ow pier depth (p TY RISK ue General Scour (m)	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments er design plans) le	O.47 toedown depth San Juan Creek Half Bedform Height (m) O.05 O.27 O.24 O.27 O.40 O.64 ead to a low non-dan San Juan Creek Half Bedform Height (m)	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62 maging discharg	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96 ge.	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93 Reach 14 Pier Depth (m)	
500 Grade control s Concrete lined of UBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined of Relatively shall PUBLIC SAFE La Novia Aven Return Interval (yr) 2	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects low pier depth (p TY RISK ue General Scour (m) 0.00	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments er design plans) le Low Flow Incisement (m) 1.00	O.47 toedown depth San Juan Creek Half Bedform Height (m) O.05 O.27 O.24 O.27 O.40 O.64 ead to a low non-dan San Juan Creek Half Bedform Height (m) O.02	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62 maging discharg	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96 ge.	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93 Reach 14 Pier Depth (m) 3.41	
500 Grade control s Concrete lined o PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined o Relatively shall PUBLIC SAFE a Novia Aven Return Interval (yr) 2 25 50 200 200 200 200 200 200 200 20	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects low pier depth (p TY RISK ue General Scour (m) 0.00 0.00 0.00	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments er design plans) le Low Flow Incisement (m) 1.00 1.00 1.00	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27 0.24 0.27 0.40 0.64 ead to a low non-dan San Juan Creek Half Bedform Height (m) 0.02 0.47	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62 maging discharg	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96 ge.	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93 Reach 14 Pier Depth (m) 3.41 3.41	
Grade control s Concrete lined of PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined of Relatively shall PUBLIC SAFE a Novia Aven Return Interval (yr) 2 25 50	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects low pier depth (p TY RISK ue General Scour (m) 0.00 0.00 0.00 0.00	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments er design plans) le Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 1.00 1.00	O.47 toedown depth San Juan Creek Half Bedform Height (m) O.05 O.27 O.24 O.27 O.40 O.64 ead to a low non-dan San Juan Creek Half Bedform Height (m) O.02 O.47 O.31	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62 maging discharg Pier Scour (m) 1.48 3.52 3.47	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96 ge.	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93 Reach 14 Pier Depth (m) 3.41 3.41 3.41	
500 Grade control s Concrete lined o PUBLIC SAFE Interstate 5 Return Interval (yr) 2 25 50 100 200 500 Concrete lined o Relatively shall PUBLIC SAFE a Novia Aven Return Interval (yr) 2 25 50 200 200 200 200 200 200 200 20	5.70 tructure just d/s of channel protects TY RISK General Scour (m) 0.00 0.70 1.40 2.60 4.20 5.70 channel protects low pier depth (p TY RISK ue General Scour (m) 0.00 0.00 0.00	1.00 of pier with 13.5' tabutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments er design plans) le Low Flow Incisement (m) 1.00 1.00 1.00	0.47 toedown depth San Juan Creek Half Bedform Height (m) 0.05 0.27 0.24 0.27 0.40 0.64 ead to a low non-dan San Juan Creek Half Bedform Height (m) 0.02 0.47	Pier Scour (m) 2.37 4.22 4.35 4.58 5.03 5.62 maging discharg	Total Scour (m) 3.42 6.18 6.99 8.45 10.63 12.96 ge.	Reach 17 Pier Depth (m) 3.93 3.93 3.93 3.93 3.93 3.93 Reach 14 Pier Depth (m) 3.41 3.41	

Concrete lined channel protects abutments PUBLIC SAFETY RISK

Table 6.24 Estimated Scour Depths at Bridge Structures

ower Ortega I	Highway		San Juan Creek			Reach 10	
Return	General	Low Flow	Half Bedform	Pier	Total	Pier	
Interval	Scour	Incisement	Height	Scour	Scour	Depth	
(yr)	(m)	(m)	(m)	(m)	(m)	(m)	
2	0.00	1.00	0.02	2.14	3.17	6.19	
25	0.20	1.00	0.33	4.80	6.34	6.19	
50	0.10	1.00	0.50	5.40	7.00	6.19	
100	0.00	1.00	0.69	5.95	7.63	6.19	
200	0.00	1.00	1.01	6.58	8.59	6.19	
500	0.00	1.00	0.69	6.47	8.17	6.19	
lan elevations UBLIC SAFE		a reduced Figure	in a previous report				
ntonio Parkwa	Parkway San Juan C		San Juan Creek			Reach 10	
Return	General	Low Flow	Half Bedform	Pier	Total	Pier	
Interval	Scour	Incisement	Height	Scour	Scour	Depth	
(yr)	(m)	(m)	(m)	(m)	(m)	(m)	
2	0.00	1.00	0.12	3.79	4.91	12.27	
25	0.20	1.00	0.31	5.45	6.96	12.27	
50	0.10	1.00	0.41	5.91	7.42	12.27	
100	0.00	1.00	0.38	5.99	7.37	12.27	
100	0.00	1.00					
200	0.00	1.00	0.47	6.37	/ X4	12.27	
200 500 O PUBLIC S.	0.00 0.00 AFETY RISK	1.00 1.00	0.47 0.60	6.37 6.87	7.84 8.47	12.27 12.27	
500 IO PUBLIC S.	0.00 AFETY RISK						
500 FO PUBLIC S. Del Obispo Stro	0.00 AFETY RISK eet	1.00	0.60 Trabuco Creek	6.87	8.47	12.27 Reach 14	
500 O PUBLIC S. Del Obispo Stre	0.00 AFETY RISK eet General	1.00 Low Flow	0.60 Trabuco Creek Half Bedform	6.87 Pier	8.47 Total	12.27 Reach 14 Pier	
500 O PUBLIC S. Del Obispo Stro	0.00 AFETY RISK eet	1.00	0.60 Trabuco Creek	6.87	8.47	12.27 Reach 14	
500 O PUBLIC S. Pel Obispo Stro Return Interval (yr)	0.00 AFETY RISK eet General Scour (m)	Low Flow Incisement (m)	0.60 Trabuco Creek Half Bedform Height (m)	Pier Scour (m)	Total Scour (m)	Reach 14 Pier Depth (m)	
500 O PUBLIC S. Del Obispo Stro Return Interval (yr) 2	O.00 AFETY RISK eet General Scour (m) O.10	Low Flow Incisement (m)	Trabuco Creek Half Bedform Height (m) 1.00	Pier Scour (m) 3.91	Total Scour (m) 6.02	Reach 14 Pier Depth (m) 2.88	
500 O PUBLIC S. Del Obispo Stro Return Interval (yr) 2 25	O.00 AFETY RISK eet General Scour (m) O.10 O.60	Low Flow Incisement (m) 1.00 1.00	Trabuco Creek Half Bedform Height (m) 1.00 1.86	Pier Scour (m) 3.91 4.97	Total Scour (m) 6.02 8.43	12.27 Reach 14 Pier Depth (m) 2.88 2.88	
500 O PUBLIC S. Del Obispo Stro Return Interval (yr) 2 25 50	O.00 AFETY RISK General Scour (m) O.10 O.60 O.90	Low Flow Incisement (m) 1.00 1.00 1.00	Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70	Pier Scour (m) 3.91 4.97 5.12	Total Scour (m) 6.02 8.43 8.72	12.27 Reach 14 Pier Depth (m) 2.88 2.88 2.88	
O PUBLIC S. el Obispo Stro Return Interval (yr) 2 25 50 100	0.00 AFETY RISK General Scour (m) 0.10 0.60 0.90 1.40	Low Flow Incisement (m) 1.00 1.00	Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01	Pier Scour (m) 3.91 4.97 5.12 5.50	Total Scour (m) 6.02 8.43 8.72 9.91	Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88	
500 O PUBLIC S. Del Obispo Stro Return Interval (yr) 2 25 50	O.00 AFETY RISK General Scour (m) O.10 O.60 O.90	Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00	Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70	Pier Scour (m) 3.91 4.97 5.12	Total Scour (m) 6.02 8.43 8.72	12.27 Reach 14 Pier Depth (m) 2.88 2.88 2.88	
SOO PUBLIC S. Return Interval (yr) 2 25 50 100 200 500 Concrete lined	0.00 AFETY RISK eet General Scour (m) 0.10 0.60 0.90 1.40 0.80 0.00 channel protects	1.00 Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 1.00	0.60 Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01 1.37	Pier Scour (m) 3.91 4.97 5.12 5.50 5.35	Total Scour (m) 6.02 8.43 8.72 9.91 8.52	Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88 2.88	
SOO PUBLIC S. Return Interval (yr) 2 25 50 100 200 500	0.00 AFETY RISK eet General Scour (m) 0.10 0.60 0.90 1.40 0.80 0.00 channel protects TY RISK	1.00 Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 1.00	0.60 Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01 1.37	Pier Scour (m) 3.91 4.97 5.12 5.50 5.35	Total Scour (m) 6.02 8.43 8.72 9.91 8.52	Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88 2.88	
SOO PUBLIC S. Return Interval (yr) 2 25 50 100 200 500 Concrete lined of UBLIC SAFE	O.00 AFETY RISK Deet General Scour (m) O.10 O.60 O.90 1.40 O.80 O.00 Channel protects TY RISK	1.00 Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 1.00	Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01 1.37 1.33	Pier Scour (m) 3.91 4.97 5.12 5.50 5.35 5.48	Total Scour (m) 6.02 8.43 8.72 9.91 8.52	12.27 Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88 2.88 2.88 2.88	
SOO PUBLIC S. Return Interval (yr) 2 25 50 100 200 500 Concrete lined of UBLIC SAFE	0.00 AFETY RISK eet General Scour (m) 0.10 0.60 0.90 1.40 0.80 0.00 channel protects TY RISK	Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 1.00 abutments	0.60 Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01 1.37 1.33	Pier Scour (m) 3.91 4.97 5.12 5.50 5.35	Total Scour (m) 6.02 8.43 8.72 9.91 8.52 7.81	Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88 2.88 2.88 2.88	
SOO PUBLIC S. Return Interval (yr) 2 25 50 100 200 500 Concrete lined of UBLIC SAFE Metro Link Rain Return	O.00 AFETY RISK Deet General Scour (m) O.10 O.60 O.90 1.40 O.80 O.00 Channel protects TY RISK Iroad General	Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 1.00 abutments	Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01 1.37 1.33 Trabuco Creek Half Bedform	Pier Scour (m) 3.91 4.97 5.12 5.50 5.35 5.48	Total Scour (m) 6.02 8.43 8.72 9.91 8.52 7.81	Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88 2.88 2.88 2.88	
Soo	O.00 AFETY RISK eet General Scour (m) O.10 O.60 O.90 1.40 O.80 O.00 channel protects TY RISK lroad General Scour (m)	Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments Low Flow Incisement (m)	Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01 1.37 1.33 Trabuco Creek Half Bedform Height (m)	Pier Scour (m) 3.91 4.97 5.12 5.50 5.35 5.48 Pier Scour (m)	Total Scour (m) 6.02 8.43 8.72 9.91 8.52 7.81 Total Scour (m)	Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88 2.88 2.88 2.88 Peach 11 Pier Depth (m)	
Soo	O.00 AFETY RISK eet General Scour (m) O.10 O.60 O.90 1.40 O.80 O.00 channel protects TY RISK Iroad General Scour (m) O.00	Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments Low Flow Incisement (m) 1.00	Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01 1.37 1.33 Trabuco Creek Half Bedform Height (m) 0.21	Pier Scour (m) 3.91 4.97 5.12 5.50 5.35 5.48 Pier Scour (m) 5.14	Total Scour (m) 6.02 8.43 8.72 9.91 8.52 7.81 Total Scour (m) 6.35	Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88 2.88 2.88 2.88	
Del Obispo Stro Return Interval (yr) 2 25 50 100 200 500 Concrete lined of UBLIC SAFE Metro Link Rai Return Interval (yr) 2 25 25 202 203 204 205 206 207 207 208 208 208 208 208 208 208 208 208 208	O.00 AFETY RISK eet General Scour (m) O.10 O.60 O.90 1.40 O.80 O.00 channel protects TY RISK Iroad General Scour (m) O.00 O.00	Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments Low Flow Incisement (m) 1.00 1.00	Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01 1.37 1.33 Trabuco Creek Half Bedform Height (m) 0.21 0.98	Pier Scour (m) 3.91 4.97 5.12 5.50 5.35 5.48 Pier Scour (m) 5.14 8.07	Total Scour (m) 6.02 8.43 8.72 9.91 8.52 7.81 Total Scour (m) 6.35 10.04	Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88 2.88 2.88 2.88 Peach 11 Pier Depth (m)	
SOO PUBLIC S. Return Interval (yr) 2 25 50 100 200 500 Concrete lined of UBLIC SAFE Metro Link Rai Return Interval (yr) 2 25 50	0.00 AFETY RISK eet General Scour (m) 0.10 0.60 0.90 1.40 0.80 0.00 channel protects TY RISK Iroad General Scour (m) 0.00 0.00 0.00 0.00	Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments Low Flow Incisement (m) 1.00 1.00 1.00 1.00	Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01 1.37 1.33 Trabuco Creek Half Bedform Height (m) 0.21 0.98 1.35	Pier Scour (m) 3.91 4.97 5.12 5.50 5.35 5.48 Pier Scour (m) 5.14 8.07 8.96	Total Scour (m) 6.02 8.43 8.72 9.91 8.52 7.81 Total Scour (m) 6.35 10.04 11.31	Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88 2.88 2.88 2.88 Peach 11 Pier Depth (m)	
SOO PUBLIC S. Return Interval (yr) 2 25 50 100 200 500 Concrete lined of PUBLIC SAFE Metro Link Rain Return Interval (yr) 2 25	O.00 AFETY RISK eet General Scour (m) O.10 O.60 O.90 1.40 O.80 O.00 channel protects TY RISK Iroad General Scour (m) O.00 O.00	Low Flow Incisement (m) 1.00 1.00 1.00 1.00 1.00 abutments Low Flow Incisement (m) 1.00 1.00	Trabuco Creek Half Bedform Height (m) 1.00 1.86 1.70 2.01 1.37 1.33 Trabuco Creek Half Bedform Height (m) 0.21 0.98	Pier Scour (m) 3.91 4.97 5.12 5.50 5.35 5.48 Pier Scour (m) 5.14 8.07	Total Scour (m) 6.02 8.43 8.72 9.91 8.52 7.81 Total Scour (m) 6.35 10.04	Reach 14 Pier Depth (m) 2.88 2.88 2.88 2.88 2.88 2.88 2.88 Peach 11 Pier Depth (m)	

Plans were not available

Grouted Stone Drop Structure just downstream of Pier Public Safety Risk undetermined

Table 6.24 Estimated Scour Depths at Bridge Structures

Oso Parkway			Trabuco Creek			Reach 3		
Return Interval (yr)	General Scour (m)	Low Flow Incisement (m)	Half Bedform Height (m)	Pier Scour (m)	Total Scour (m)	Pier Depth (m)		
2	0.00	1.00	0.56	6.27	7.83	n/a		
25	0.10	1.00	1.16	8.26	10.52			
50	0.50	1.00	1.53	8.96	11.99			
100	0.60	1.00	1.94	9.60	13.14			
200	0.50	1.00	2.52	10.40	14.42			
500	0.10	1.00	0.45	8.04	9.59			

Plans were not available Public Safety Risk undetermined

Table 6.25 Estimated Scour Depths at Bank Protection Toedown

Station 106+00			San Juan Creek		Reach 21		
Return	General	Low Flow	Half Bedform	Bend	Total	Toe	
Interval	Scour	Incisement	Height	Scour	Scour	Depth	
(yr)	(m)	(m)	(m)	(m)	(m)	(m)	
2	0.00	1.00	0.18	0.00	1.18	2.13	
25	0.00	1.00	0.65	0.00	1.65	2.13	
50	0.00	1.00	0.54	0.00	1.54	2.13	
100	0.90	1.00	1.31	0.00	3.21	2.13	
200	2.10	1.00	1.91	0.00	5.01	2.13	
500	3.90	1.00	2.52	0.00	7.42	2.13	
PUBLIC SAFE' Station 118+00	I I KISK		San Juan Creek			Reach 20	
Return	General	Low Flow	Half Bedform	Bend	Total	Toe	
Interval	Scour	Incisement	Height	Scour	Scour	Depth	
(yr)	(m)	(m)	(m)	(m)	(m)	(m)	
2	0.00	1.00	0.18	0.00	1.18	2.13	
25	0.00	1.00	0.81	0.00	1.81	2.13	
50	0.00	1.00	1.11	0.00	2.11	2.13	
100	0.00	1.00	0.75	0.00	1.75	2.13	
		1.00	0.75	0.00	4		
200	0.00	1.00	0.75	0.00	1.75	2.13	

Results only applicable to Reach 20 NO PUBLIC SAFETY RISK

Table 6.25 Estimated Scour Depths at Bank Protection Toedown

Station 125+50	Station 125+50		San Juan Creek			Reach 19		
Return Interval (yr)	General Scour (m)	Low Flow Incisement (m)	Half Bedform Height (m)	Bend Scour (m)	Total Scour (m)	Toe Depth (m)		
2	0.00	1.00	0.17	0.75	1.92	2.13		
25	0.60	1.00	0.84	2.51	4.95	2.13		
50	0.90	1.00	1.13	3.17	6.20	2.13		
100	0.90	1.00	1.46	4.20	7.56	2.13		
200	0.70	1.00	1.66	5.38	8.73	2.13		
500	0.40	1.00	1.92	6.99	10.32	2.13		

Results only applicable to Reach 19; Bend scour and degradation leads to high total scour PUBLIC SAFETY RISK

Station 136+00			San Juan Creek	Reach 18		
Return Interval (yr)	General Scour (m)	Low Flow Incisement (m)	Half Bedform Height (m)	Bend Scour (m)	Total Scour (m)	Toe Depth (m)
2	0.00	1.00	0.21	1.71	2.92	2.13
25	0.00	1.00	0.46	5.05	6.51	2.13
50	0.00	1.00	0.57	6.63	8.20	2.13
100	0.00	1.00	0.70	8.49	10.19	2.13
200	0.00	1.00	0.85	10.28	12.14	2.13
500	1.40	1.00	1.05	12.66	16.11	2.13

Results applicable only along bend (Station 134+00 – 138+00); Without bend scour applicable to straight portion of Reach 18 PUBLIC SAFETY RISK along bend; NO PUBLIC SAFETY RISK on straight reach.

Station 142+00			San Juan Creek	Reach 17		
Return	General	Low Flow	Half Bedform	Bend	Total	Toe
Interval	Scour	Incisement	Height	Scour	Scour	Depth
(yr)	(m)	(m)	(m)	(m)	(m)	(m)
2	0.00	1.00	0.14	0.27	1.41	2.13
25	0.70	1.00	1.01	2.02	4.73	2.13
50	1.40	1.00	0.95	3.25	6.60	2.13
100	2.60	1.00	1.14	4.13	8.87	2.13
200	4.20	1.00	1.03	5.30	11.54	2.13
500	5.70	1.00	0.74	6.39	13.83	2.13

Results only applicable to Reach 17; Bend scour and high degradation leads to high total scour PUBLIC SAFETY RISK

Station 106+00			Trabuco Creek	Reach 15		
Return	General	Low Flow	Half Bedform	Bend	Total	Toe
Interval	Scour	Incisement	Height	Scour	Scour	Depth
(yr)	(m)	(m)	(m)	(m)	(m)	(m)
2	0.00	1.00	0.41	0.00	1.41	2.13
25	0.00	1.00	1.10	0.00	2.10	2.13
50	0.00	1.00	0.99	0.00	1.99	2.13
100	0.00	1.00	1.35	0.00	2.35	2.13
200	0.00	1.00	1.93	0.00	2.93	2.13
500	0.00	1.00	0.34	0.00	1.34	2.13

Results only applicable to Reach 15 PUBLIC SAFETY RISK

Table 6.25 Estimated Scour Depths at Bank Protection Toedown

Station 113+50	Station 113+50		Trabuco Creek			Reach 14		
Return Interval (yr)	General Scour (m)	Low Flow Incisement (m)	Half Bedform Height (m)	Bend Scour (m)	Total Scour (m)	Toe Depth (m)		
2	0.10	1.00	0.33	3.14	4.57	2.13		
25	0.60	1.00	0.94	4.39	6.93	2.13		
50	0.90	1.00	1.19	5.49	8.58	2.13		
100	1.40	1.00	1.53	6.86	10.79	2.13		
200	0.80	1.00	1.51	7.80	11.11	2.13		
500	0.00	1.00	0.90	8.30	10.20	2.13		

Results only applicable to Reach 14; Bend scour and degradation leads to high total scour PUBLIC SAFETY RISK

Station 148+00			Oso Creek	Reach 2		
Return Interval (yr)	General Scour (m)	Low Flow Incisement (m)	Half Bedform Height (m)	Bend Scour (m)	Total Scour (m)	Toe Depth (m)
2	0.00	1.00	0.28	0.97	2.25	1.52
25	0.00	1.00	0.40	1.54	2.95	1.52
50	0.00	1.00	0.42	1.86	3.28	1.52
100	0.00	1.00	0.43	1.90	3.34	1.52
200	0.00	1.00	0.18	3.41	4.59	1.52
500	0.00	1.00	0.10	4.21	5.31	1.52

Results only applicable to Reach 2; Bend scour and lower toe depths leads to high total scour PUBLICK SAFETY RISK

It is estimated that the Federal government, the County, the cities, and other entities in the San Juan Creek watershed have suffered damages of \$29 million since 1969 (over \$1 million per year) for flooding, repairs to infrastructure, recreation loss, beach clean-up, and transportation damages. This figure is increasing with increasing development in the watershed. Approximately \$9.8 million in damages have been incurred during the past 6 years alone (\$1.64 million/year) in these categories. Expenditures in the future include bridge replacement due to undermining by channel degradation processes (\$4.2 million per year in the San Juan Creek watershed alone), road repair and bank stabilization, increased funds expenditure for flood control facilities due to channel instability, and other factors.

6.10.1 Recent Flood Damage to San Juan Creek Channel

As a result of the floods during February 1998 about 500 feet of slope paving was undermined and washed off the levee face, and a portion of the levee and embankment was washed out. The damage occurred along the south channel, approximately 1,200 feet downstream of the Trabuco Creek confluence. The flow during this storm was estimated to be approximately 590 cms. This corresponds to approximately a 25-year flow event. The preceding table shows that this bank is a public safety risk.. The risk was realized during the February 1998 storm at some locations. It was estimated to cost approximately \$560,000 to repair this 500 foot length of slope paving.

Orange County Flood Control District (OCFCD) reports that the slope paving on San Juan Creek has withstood long duration flows many times in the past, but past experiences show undermining of the slope paving during short term high peak flows. The estimated peak discharges in the 1998 storm leading to the failure were well below the design capacity of San Juan Creek shown on the as-built plans.

6.10.2 Recent Flood Damage to Trabuco Creek Channel

As a result of the floods during February 1998 a total of about 700 feet of slope paving in 6 different locations was undermined and washed off the levee face, and a portion of the levee and embankment was washed out. All of the damaged areas except one occurred immediately downstream from grouted stone grade stabilizers, indicating that the slope paving had insufficient toe depth to withstand the scour caused by the increased turbulence in these locations. The peak flow estimated during this flood was 230 cms. This corresponds to approximately a 25–year event. The preceding table shows that the bank is a public safety risk. The risk was realized during the February 1998 storm at some locations. It was estimated to cost approximately \$660,000 to repair the total 700 foot length of slope paving.

OCFCD reports that the slope paving has withstood long duration flows many times in the past, but past experiences show undermining of the slope paving during short term high peak flows. The estimated peak discharges during the storm events leading to the failure were well below the design capacity of Trabuco Creek.

7.0 Summary and Conclusion

This report presents hydraulic, geomorphic and erosion analyses in support of the San Juan Creek Watershed Study. The results can be used in the overall study goals of developing a watershed management plan that will enhance positive trends in maintaining a healthy San Juan Creek watershed system. The results are also the basis of establishing the baseline conditions that can be used to evaluate the hydraulic, geomorphic and sedimentation effects of project alternatives developed under "spin-off" feasibility studies. Results are summarized below.

Data collection included 1) determination of Manning's n-values for channel and overbanks, 2) collection of as-built plans or field measurement of bridge and culvert crossings, 3) generation of cross sectional data from 1998 topographic information to represent the geometry of the study reaches and 4) collection and analysis of sediment samples for use in the erosion analyses.

Floodplain analyses included computing water surface profiles for the 2-, 25-, 50-, 100-, 200-, and 500-year events, delineating the corresponding floodplains, and tabulating the relevant hydraulic parameters for use in the sediment analyses. Since the watershed is almost fully developed as allowed under the land use plan (with the exception of the Canada Gobernadora and a portion of the San Juan Creek watershed), the hydrologic input parameters for existing and ultimate conditions (especially near the ocean) vary little. The differences between the floodplain delineations for existing and ultimate conditions are indistinguishable.

Geomorphic analyses based on the current project mapping and mapping dating back to 1960 were used to describe the changes in the profile along the study reaches. There is no indication that significant plan form changes have occurred. Significant degradation of the channel profile has occurred during periods of large flood events. This type of degradation is to be expected where the profile is not checked with a grade control structure. Degradation that occurs in any one area can be carried up and down the stream if nothing is constructed to stop the migration of the degradation. The profile also shows that the trend of degradation has been reversed in some reaches in recent years. This process is slow but some aggradation can already be seen in many reaches. In reaches subject to gravel mining extraction, this reversal is not taking place. The degradational effects from the gravel mines can be expected to move downstream over time.

A sediment budget analysis based on the U.S. Army Corps of Engineers SAM (Sediment Analysis Module) was developed. A sediment transport function for each watercourse was combined with a sediment gradation curve applicable to that reach to determine the sediment transport capacity on a reach by reach basis. The results of the model correspond, in general, to qualitative findings from the available historical data. The SAM model can now be used to assess the effects of changes in the channel parameters or the hydrologic inputs that result from proposed project alternatives.

It should be noted that development in the San Juan Creek watershed can have a significant impact on the channel and its stability. For example, new construction can prevent sediment runoff from the watershed from reaching the channel. The channel will then pick up the lost sediment from the channel itself. In addition to the physical changes in the channel, the hydraulic parameters can also be impacted. This hydraulic change can impact the channel further downstream. In this way, impacts of development in one part of the watershed can cause channel instability at significant distances away from the development activity. Hydraulic changes can also occur by means other than watershed development / construction. For example changes to the stream itself, such as concrete lining a certain reach, can increase the flow velocity and impact the downstream transport capacity. Currently the Orange County Transportation Authority is considering a 1,400-foot extension of an existing concrete culvert along Oso Creek. This improvement may also include a large drop structure. These types of physical changes can have extensive downstream impacts. Another instream change that has been discussed in San Juan Creek is the construction of large crib walls along one bank of the channel. While this can protect that side of the stream from erosion the impact to the nonprotected section of the stream can be increased. In summary, caution should always be taken in providing piecemeal protection along a stream. Without a regional solution to address existing stability and erosion problems within the entire watershed, those problems can be magnified or simply transferred to another location.

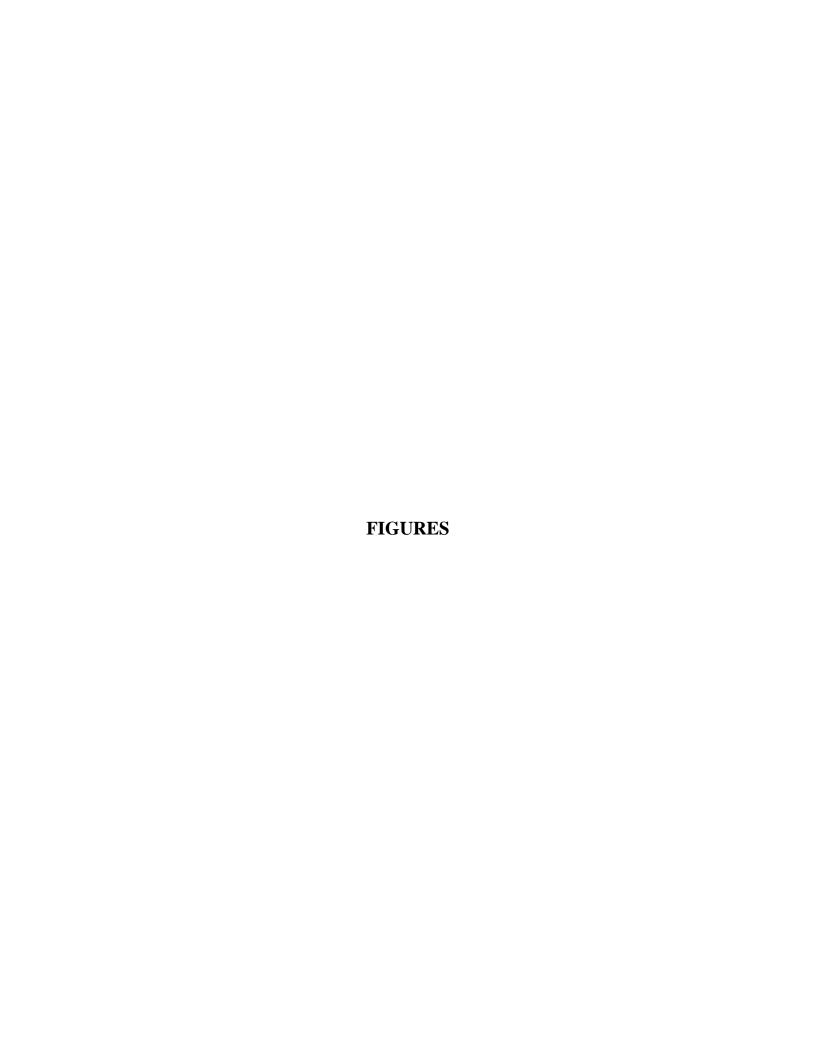
Sand delivery to the ocean was estimated on the basis of the channel transport capacity of the most downstream reach of San Juan Creek. Project alternatives can be evaluated to determine

the impact on the delivery of the sand that feeds Doheny State Beach. It should be noted that projects that impact channel reaches upstream of the sand delivery reach can have a significant impact of the channel

Estimates of whether a structure represents a public safety risk due to the potential scour were determined for a number of bridge crossings and bank protection locations. Channel bank instability has been seen in recent flood events and failure has occurred. It should be noted that the scour depths determined are conservative because they assume all elements of scour (low-flow incisement, pier scour, general scour, etc.) all occur at the same location at the same time. These scour depths were only used to determine if a structure meets standard design criteria and whether it represents a public safety issue.

8.0 References

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SAN JUAN CREEK WATERSHED MANAGEMENT STUDY

HYDRAULIC APPENDIX WITH-PROJECT ANALYSIS

U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT SOUTH PACIFIC DIVISION AUGUST 2002

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1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE), Los Angeles District is currently conducting the Feasibility Phase of the San Juan Creek Watershed Management Study. Plan formulation consisted of modeling the hydraulic effects of various detention basin sizes, levee heights, bridge modifications, and channel width modifications along San Juan Creek and Trabuco Creek in order to provide 100-year level of flood protection. Sediment analysis included slope protection and invert channel stability calculations along San Juan Creek, Trabuco Creek, and Oso Creek. Stage uncertainty calculations were performed for the economic analysis.

Six alternatives were examined in the plan formulation process. Alternative 1 is the no action alternative. Alternative 2 would be to construct necessary floodwalls and/or raised levees along both San Juan and Trabuco Creek to provide 100-year level of flood protection. Alternative 3 would be to construct a 5100 acre-ft detention basin on San Juan Creek with floodwalls/raised levees on San Juan Creek and Trabuco Creek to provide 100-year level of protection. Alternative 4 would be to construct a 2400 acre-ft detention basin on Trabuco Creek with floodwalls/raised levees on San Juan and Trabuco Creek to provide 100-year level of protection. Alternative 5 would be to construct a 5100 acre-ft detention basin on San Juan Creek and a 2400 acre-ft detention basin on San Juan Creek with floodwalls/raised levees on San Juan Creek and Trabuco Creek to provide 100-yr level of protection. Alternative 6 would be widening San Juan Creek and Trabuco Creek 20 meters with floodwalls/raised levees on San Juan Creek and Trabuco Creek to provide 100-year level of protection.

It should be noted that this analysis was conducted at a cursory level to determine if any of the alternatives would warrant federal interest for a flood control project. Should the watershed study indicate a potential project, then more detailed studies would be required as part of a feasibility/spin-off study.

2.0 REFERENCES

- a. Simons, Li & Associates, Inc., San Juan Creek Watershed Management Study F3 Feasibility Phase Appendices (Draft), July 1999.
- b. US Army Corps of Engineers, Risk-Based Analysis for Flood Damage Reduction Studies, Engineering Manual (EM) 1110-2-1619, 01 August 1996.

3.0 DESCRIPTION OF ALTERNATIVES

3.01 Alternative 1 - No Action

The No-Action Plan assumes that flooding continues to occur in a manner similar to that of the recent past, and that no added level of protection is provided to the flood control system, including measures to address the downcutting and potential panel failure in the existing channel.

3.02 Alternative 2

Floodwalls and/or raised levees would be constructed along San Juan Creek as necessary from just downstream of the Pacific Coast Highway Bridge to the Lower Ortega Highway Bridge to provide 100-year level flood protection. Floodwalls and/or raised levees would be constructed along Trabuco Creek as necessary from the San Juan Creek confluence to the terminus of the concrete trapezoidal channel upstream of Del Obispo Bridge to provide 100-year level flood protection. The Pacific Coast Highway Bridge would be raised a minimum of 2.5 meters and the total pier widths would be reduced from 16.9 m to 8.45 m. La Novia Bridge would be raised a minimum of 1.8 m. Del Obispo Bridge would be raised a minimum of 1.5 m.

3.03 Alternative 3

A 5,100 acre-foot detention basin on San Juan Creek would be constructed just upstream of Antonio Parkway to reduce downstream flood flows. Floodwalls and/or raised levees would be constructed along San Juan Creek as necessary from just downstream of the Pacific Coast Highway Bridge to the Lower Ortega Highway Bridge to provide 100-year level flood protection. Floodwalls and/or raised levees would be constructed along Trabuco Creek as necessary from the San Juan Creek confluence to the terminus of the concrete trapezoidal channel upstream of Del Obispo Bridge to provide 100-year level flood protection. The Pacific Coast Highway Bridge would be raised a minimum of 2.5 meters and the total pier widths would be reduced from 16.9 m to 8.45 m. La Novia Bridge would be raised a minimum of 1.8 m. Del Obispo Bridge would be raised a minimum of 1.5 m.

3.04 Alternative 4

A 2,400 acre-foot detention basin on Trabuco Creek would be constructed upstream of the gravel mining operation to reduce downstream flood flows. Floodwalls and/or raised levees would be constructed along San Juan Creek as necessary from just downstream of the Pacific Coast Highway Bridge to the Lower Ortega Highway Bridge to provide 100-year level flood protection. Floodwalls and/or raised levees would be constructed along Trabuco Creek as necessary from the San Juan Creek confluence to the terminus of the concrete trapezoidal channel upstream of Del Obispo Bridge to provide 100-year level flood protection. The Pacific Coast Highway Bridge would be raised a minimum of 2.5 meters and the total pier widths would be reduced from 16.9 m to 8.45 m. La Novia Bridge would be raised a minimum of 1.8 m. Del Obispo Bridge would be raised a minimum of 1.5 m.

3.05 Alternative 5

A 5,100 acre-foot detention basin on San Juan Creek would be constructed just upstream of Antonio Parkway to reduce downstream flood flows. A 2,400 acre-foot detention basin on Trabuco Creek would be constructed upstream of the gravel mining operation to reduce downstream flood flows. Floodwalls and/or raised levees would be constructed along San Juan Creek as necessary from just downstream of the Pacific Coast Highway Bridge to the Lower Ortega Highway Bridge to provide 100-year level flood protection. Floodwalls and/or raised levees would be constructed along Trabuco Creek as necessary from the San Juan Creek confluence to the terminus of the concrete trapezoidal channel upstream of Del Obispo Bridge to provide 100-year level flood protection. The Pacific Coast Highway Bridge would be raised a minimum of 2.5 meters and the total pier widths would be reduced from 16.9 m to 8.45 m. La Novia Bridge would be raised a minimum of 1.5 m.

3.06 Alternative 6

The channel would be widened 20 meters (near the centerline of the channel utilizing HEC-RAS to maximize conveyance) on San Juan Creek from just downstream of the Pacific Coast Highway Bridge to 600 meters upstream of La Novia Bridge. The channel would be widened 20 meters on Trabuco Creek from the San Juan Creek confluence to the terminus of the concrete

trapezoidal channel upstream of Del Obispo Bridge. The Pacific Coast Highway Bridge would be raised a minimum of 2.5 meters and the total pier widths would be reduced from 16.9 m to 8.45 m. La Novia Bridge would be raised a minimum of 1.8 m. Del Obispo Bridge would be raised a minimum of 1.5 m. The abutments would be expanded 20 meters for the Pacific Coast Highway, Stonehill, Metrolink RR, Camino Capistrano, La Novia, and Del Obispo bridges to minimize the dead storage areas (ineffective flow).

4.0 HEC-RAS ANALYSIS

All six alternatives were modeled using HEC-RAS using future conditions hydrology. Pertinent bank elevations, discharges, water surface elevations, channel velocities, and required levee heights for San Juan Creek are given in Tables 1 through 6 for Alternatives 1 through 6, respectively. Pertinent bank elevations, discharges, water surface elevations, channel velocities, and required levee heights for Trabuco Creek are given in Tables 7 through 12 for Alternatives 1 through 6, respectively.

Because of the constriction at the PCH Bridge, reduced flow velocities would potentially cause sediment aggradation in the PCH bridge vicinity, resulting in more of a conveyance constriction. This sediment issue is beyond the scope of this study, but would need to be considered in future feasibility/spin-off studies utilizing HEC-6.

Tabl	Table 1: San Juan Creek Required Levee Heights for Alternative 1 (100-yr									
				Discharg	ges)					
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Required Left Levee	Required Right Levee		
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)		
10020	2.7	2.38	1533	3.18	3.66	3.73	1.2	1.6		
10150	4.49	4.14	1533	3.8	4.78	4.38	0.1	0.4		
10275	4.32	3.69	1533	4.69	5.21	3.48	1.1	1.8		
10300	6.45	4.8	1533	5.09	5.66	3.95	0.0	1.0		
10310		oast Hwy	Bridge			,				
10320	6.52	4.87	1533	8.22	8.24	0.96	2.5	4.1		
10351	5.88	6.88	1533	7.93	8.37	2.94	2.8	1.8		
10365	Camino La	as Ramblas	Bridge							
10379	5.98	6.98	1533	8.34	8.61	2.43	3.1	2.1		
10450	6.21	7.21	1533	8.28	8.72	2.93	2.8	1.8		
10600	8.42	8.6	1533	7.89	9.25	5.17	0.2	0.0		
10750	8.84	9.72	1533	8.46	9.84	5.21	0.4	0.0		
10900	9.56	9.55	1533	9.13	10.41	5.01	0.3	0.3		
11050	10.34	9.89	1533	9.68	10.9	4.9	0.1	0.5		
11200	10.94	10.72	1533	10.08	11.51	5.3	0.0	0.1		
11350	11.46	11.55	1533	10.87	12.13	4.97	0.2	0.1		
11500	15.31	13.6	1533	11.33	12.76	5.3	0.0	0.0		
11520	15.4	13.69	1533	11.42	12.85	5.3	0.0	0.0		
11537.5		ill Drive	Bridge			,				
11555	15.78	12.44	1533	14.02	14.54	3.19	0.0	2.3		
11575	15.78	12.44	1533	14.05	14.56	3.18	0.0	2.4		
11650	13.02	12.55	1533	14.08	14.64	3.32	1.8	2.3		
11800	13.6	13.25	1533	14.07	14.94	4.13	1.2	1.6		
11950	14.2	14.01	1533	14.29	15.27	4.38	0.8	1.0		
12100	13.73	14.47	1533	14.58	15.68	4.64	1.6	0.9		
12250	14.56	15.18	1533	14.88	16.18	5.05	1.1	0.5		
12400	15.11	15.34	1533	15.28	16.8	5.46	0.9	0.7		
12550	15.99	16.57	1533	15.83	17.5	5.73	0.6	0.0		
12700	16.59	17.21	1533	16.84	18.1	4.98	1.0	0.4		
12850	17.1	17.97	1533	17.27	18.67	5.25	0.9	0.1		
13000	18.12	18.62	1533	17.8	19.35	5.52	0.4	0.0		
13150	18.69	19.28	1533	18.44	20	5.53	0.5	0.0		
13300	19.13	19.73	1533	19.02	20.77	5.86	0.6	0.0		
13450	20.4	20.28	1533	20.53	21.25	3.75	0.9	1.0		
13600	20.42	21.38	1533	20.74	21.54	3.99	1.1	0.1		
13750	21.86	21.63	1533	20.94	21.94	4.45	0.0	0.1		
13900	22.17	21.9	1036	21.23	22.49	4.97	0.0	0.1		
14050	23.22	22.47	1036	22.21	22.99	3.92	0.0	0.5		
14060	23.66	24.11	1036	22.37	23.05	3.65	0.0	0.0		
14070		Railroad	Bridge	22.07	22.07	0.40	0.0	0.2		
14080	23.66	24.11	1036	23.67	23.97	2.46	0.8	0.3		
14200	25.76	23.8	1036	23.46	24.72	4.96	0.0	0.4		
14220	25.85	23.89	1036	24.76	25.22	3.28	0.0	1.6		
14240		Capistrano	Bridge							
14240		Capistrano	Bridge	05.00	00.00	0.00	0.0	0.0		
14260	26.03	24.07	1036	25.88	26.06	2.22	0.6	2.6		
14350	27.46	24.07	1036	26.05	26.13	1.36	0.0	2.7		
14370	27.48	24.09	1036	26.05	26.13	1.37	0.0	2.7		
14422.5	Inters	state 5	Bridge							

Tabl	Table 1: San Juan Creek Required Levee Heights for Alternative 1 (100-yr										
			•	Discharg	ges)						
							Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
14475	25.33	30.43	1036	26.06	26.34	2.43	1.5	0.0			
14650	26.27	31.14	1036	26.07	26.58	3.16	0.6	0.0			
14800	24.42	24.87	1036	26.64	26.77	1.78	3.0	2.5			
14950	25.7	39.16	1036	26.75	26.87	1.62	1.8	0.0			
15100	27.1	27.55	1036	26.64	27.19	3.27	0.3	0.0			
15250	25.95	27.58	1036	27.18	27.86	3.83	2.0	0.4			
15400	27.6	29.27	1036	27.92	28.86	4.35	1.1	0.0			
15550	28.49	29.3	1036	28.99	29.9	4.32	1.3	0.4			
15700	30.72	30.18	1036	29.9	30.87	4.36	0.0	0.5			
15850	33.04	31.44	1036	30.98	31.57	3.38	0.0	0.3			
15950	33.26	31.49	1036	31.24	32.06	4.02	0.0	0.5			
16000	33.7	33.39	1036	31.96	33.26	5.04	0.0	0.0			
16020	La Novia	a Avenue	Bridge								
16040	39.7	39.39	1036	34.32	34.73	2.83	0.0	0.0			
16150	35.77	32.13	1036	34.78	34.88	1.54	0.0	3.4			
16300	35.5	33.13	974	34.84	34.97	1.81	0.1	2.5			
16450	36.43	34.16	974	34.84	35.17	2.68	0.0	1.4			
16600	32.66	35.82	974	35.01	35.56	3.39	3.1	0.0			
16750	34.6	35.87	974	35.52	36.02	3.14	1.7	0.4			
16900	35.55	36.87	974	35.98	36.71	3.79	1.2	0.0			
17050	37.21	35.35	974	36.84	37.44	3.43	0.4	2.2			
17200	36.78	38.16	974	37.54	38.03	3.16	1.5	0.1			
17350	38.76	39.5	974	38.28	39.29	4.46	0.3	0.0			
17500	41.82	40.6	974	39.72	40.37	3.55	0.0	0.0			
17650	42.44	41.08	974	40.42	41.67	4.95	0.0	0.1			
17800	42.1	42.03	974	41.99	42.74	3.83	0.6	0.7			
17950	42.7	43.04	974	42.76	43.55	3.94	0.8	0.5			
18100	44.44	43.84	974	43.71	44.09	2.71	0.0	0.6			
18250	44.98	44.41	974	43.93	44.74	3.99	0.0	0.3			
18400	46.01	46	974	44.97	45.61	3.55	0.0	0.0			
18550	48.57	48	974	45.73	46.87	4.74	0.0	0.0			
18700	48.1	48.88	974	47.18	47.77	3.38	0.0	0.0			
18850	48.2	49.98	974	48.2	49.41	4.87	0.8	0.0			
18910	51.2	50	974	48.97	49.88	4.21	0.0	0.0			
18917.5	Ortega	Higway									

Tabl	Table 2: San Juan Creek Required Levee Heights for Alternative 2 (100-yr									
				Discharg	ges)					
River Sta	LOB Elev	ROB Elev	Q Total (m3/s)	W.S. Elev	E.G. Elev	Vel Chnl (m/s)	Required Left Levee Height (m)	Required Right Levee Height (m)		
10000	2.7			3.19		3.72				
10020		2.38	1533		3.66		1.2	1.6		
10150 10275	4.49 4.32	4.14	1533	3.8	4.78	4.38	0.1	0.4		
10275	6.45	3.69 4.8	1533	4.69	5.22	3.47	1.1	1.8		
			1533	5.09	5.66	3.94	0.0	1.0		
10310 10320		oast Hwy	Bridge	7.07	0.06	0.76	2.4	2.0		
	6.52 5.88	4.87 6.88	1533 1533	7.87	8.26	2.76 2.99	2.1	3.8 1.7		
10351				7.85	8.31	2.99	2.7	1.7		
10365		as Ramblas	Bridge	0.07	0.55	2.47	2.0	2.0		
10379	5.98	6.98	1533	8.27	8.55	2.47	3.0	2.0		
10450	6.21	7.21	1533	8.21 7.8	8.66	2.97	2.8	1.8		
10600	8.42	8.6 9.72	1533		9.22	5.28 5.26	0.1	0.0		
10750 10900	8.84 9.56	9.72	1533	8.43 9.13	9.83 10.41	5.26	0.3	0.0		
11050	10.34	9.55	1533 1533	9.13	10.41	4.9	0.3	0.3		
11200	10.34	10.72	1533		11.51	5.3	0.0	0.5		
11350	11.46	11.55	1533	10.08 10.85	12.13	4.99	0.0	0.0		
11500	15.31	13.6	1533	11.34	12.13	5.3	0.0	0.0		
11520	15.4	13.69	1533	11.42	12.76	5.3	0.0	0.0		
11537.5		ill Drive	Bridge	11.42	12.00	5.5	0.0	0.0		
11557.5	15.78	12.44	1533	14.02	14.54	3.19	0.0	2.3		
11575		12.44	1533	14.02		3.18				
11650	15.78				14.56 14.64	3.32	0.0 1.8	2.4		
11800	13.02 13.6	12.55 13.25	1533 1533	14.08 14.07	14.04	4.13	1.0	1.6		
11950	14.2	14.01	1533	14.07	15.27	4.13	0.8	1.0		
12100	13.73	14.47	1533	14.29	15.68	4.64	1.6	0.9		
12250	14.56	15.18	1533	14.30	16.18	5.03	1.1	0.5		
12400	15.11	15.34	1533	15.29	16.81	5.45	0.9	0.7		
12550	15.11	16.57	1533	15.84	17.51	5.73	0.6	0.0		
12700	16.59	17.21	1533	16.84	18.1	4.98	1.0	0.4		
12850	17.1	17.21	1533	17.27	18.68	5.24	0.9	0.1		
13000	18.12	18.62	1533	17.27	19.35	5.52	0.4	0.0		
13150	18.69	19.28	1533	18.44	20	5.53	0.5	0.0		
13300	19.13	19.73	1533	19.03	20.77	5.84	0.7	0.1		
13450	20.4	20.28	1533	20.54	21.26	3.75	0.9	1.0		
13600	20.42	21.38	1533	20.74	21.55	3.98	1.1	0.1		
13750	21.86	21.63	1533	20.94	21.95	4.44	0.0	0.1		
13900	22.17	21.9	1036	21.23	22.49	4.96	0.0	0.1		
14050	23.22	22.47	1036	22.21	23	3.92	0.0	0.5		
14060	23.66	24.11	1036	22.37	23.05	3.66	0.0	0.0		
14070		Railroad	Bridge			0.00		1 0.0		
14080	23.66	24.11	1036	23.68	23.98	2.45	0.8	0.3		
14200	25.76	23.8	1036	23.47	24.72	4.95	0.0	0.4		
14220	25.85	23.89	1036	24.32	25.22	4.2	0.0	1.2		
14240		Capistrano	Bridge				0.0	1.2		
14240		Capistrano	Bridge							
14260	26.03	24.07	1036	26	26.53	3.2	0.7	2.7		
14350	27.46	24.07	1036	26.58	26.53	1.59	0.0	3.3		
14370	27.48	24.07	1036	26.58	26.71	1.59	0.0	3.2		
14422.5		tate 5	Bridge	20.00	20.71	1.00	0.0	0.2		
14422.5	25.33	30.43	1036	26.6	26.89	2.38	2.0	0.0		
14470	20.00	JU.4J	1030	20.0	20.03	2.30	2.0	0.0		

Tabl	Table 2: San Juan Creek Required Levee Heights for Alternative 2 (100-yr										
2000		0		Discharg	U			(200)2			
					·		Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
14650	26.27	31.14	1036	26.68	27.06	2.75	1.2	0.0			
14800	24.42	24.87	1036	26.95	27.25	2.39	3.3	2.8			
14950	25.7	39.16	1036	27.21	27.38	1.84	2.3	0.0			
15100	27.1	27.55	1036	27.25	27.61	2.65	0.9	0.4			
15250	25.95	27.58	1036	27.38	28.2	4	2.2	0.6			
15400	27.6	29.27	1036	28.15	29	4.08	1.3	0.0			
15550	28.49	29.3	1036	28.95	30.04	4.63	1.2	0.4			
15700	30.72	30.18	1036	30.16	30.97	3.99	0.2	0.7			
15850	33.04	31.44	1036	31	31.58	3.37	0.0	0.3			
15950	33.26	31.49	1036	31.24	32.06	4.01	0.0	0.5			
16000	33.7	33.39	1036	31.95	33.26	5.06	0.0	0.0			
16020	La Novia	a Avenue	Bridge								
16040	39.7	39.39	1036	32.42	33.41	4.4	0.0	0.0			
16150	35.77	32.13	1036	33.45	33.83	2.75	0.0	2.1			
16300	35.5	33.13	974	33.67	34.21	3.27	0.0	1.3			
16450	36.43	34.16	974	34.06	34.78	3.77	0.0	0.7			
16600	32.66	35.82	974	34.72	35.39	3.72	2.8	0.0			
16750	34.6	35.87	974	35.42	35.96	3.26	1.6	0.3			
16900	35.55	36.87	974	35.95	36.7	3.84	1.2	0.0			
17050	37.21	35.35	974	36.84	37.44	3.44	0.4	2.2			
17200	36.78	38.16	974	37.54	38.03	3.16	1.5	0.1			
17350	38.76	39.5	974	38.27	39.29	4.47	0.3	0.0			
17500	41.82	40.6	974	39.73	40.37	3.55	0.0	0.0			
17650	42.44	41.08	974	40.42	41.67	4.94	0.0	0.1			
17800	42.1	42.03	974	41.99	42.74	3.84	0.6	0.7			
17950	42.7	43.04	974	42.76	43.55	3.94	0.8	0.5			
18100	44.44	43.84	974	43.71	44.09	2.71	0.0	0.6			
18250	44.98	44.41	974	43.93	44.74	3.99	0.0	0.3			
18400	46.01	46	974	44.97	45.61	3.55	0.0	0.0			
18550	48.57	48	974	45.73	46.87	4.74	0.0	0.0			
18700	48.1	48.88	974	47.18	47.77	3.38	0.0	0.0			
18850	48.2	49.98	974	48.2	49.41	4.88	0.8	0.0			
18910	51.2	50	974	48.96	49.87	4.23	0.0	0.0			
18917.5	Ortega	Higway	Bridge								

Tabl	Table 3: San Juan Creek Required Levee Heights for Alternative 3 (100-yr										
				Discharg	ges)						
River Sta	LOB Elev	ROB Elev	Q Total (m3/s)	W.S. Elev	E.G. Elev	Vel Chnl	Required Left Levee	Required Right Levee Height (m)			
40000	(m)	(m)		(m)	(m)	(m/s)	Height (m)				
10020	2.7	2.38	1435	3.15	3.6	3.61	1.2	1.5			
10150	4.49	4.14	1435	3.71	4.65	4.3	0.0	0.3			
10275	4.32	3.69	1435	4.56	5.1	3.49	1.0	1.6			
10300	6.45	4.8	1435	5.03	5.58	3.85	0.0	1.0			
10310		oast Hwy	Bridge	0.07	7.04	0.04	0.0	0.0			
10320	6.52	4.87	1435	6.37	7.04	3.61	0.6	2.3			
10351	5.88	6.88	1435	6.31	7.17	4.1	1.2	0.2			
10365		s Ramblas	Bridge	7.44	7.50	0.40	4.0	0.0			
10379	5.98	6.98	1435	7.11	7.59	3.18	1.9	0.9			
10450	6.21	7.21	1435	7.11	7.77	3.6	1.7	0.7			
10600	8.42	8.6	1435	7.13	8.9	5.9	0.0	0.0			
10750	8.84	9.72	1435	8.4	9.65	4.95	0.3	0.0			
10900	9.56	9.55	1435	8.97	10.18	4.87	0.2	0.2			
11050	10.34	9.89	1435	9.51	10.67	4.77	0.0	0.4			
11200	10.94	10.72	1435	9.89	11.28	5.22	0.0	0.0			
11350	11.46	11.55	1435	10.64	11.88	4.93	0.0	0.0			
11500	15.31	13.6	1435	11.12	12.52	5.24	0.0	0.0			
11520	15.4	13.69	1435	11.21	12.61	5.24	0.0	0.0			
11537.5		ill Drive	Bridge	40.04	1100	0.00		0.0			
11555	15.78	12.44	1435	13.84	14.33	3.08	0.0	2.2			
11575	15.78	12.44	1435	13.87	14.35	3.07	0.0	2.2			
11650	13.02	12.55	1435	13.91	14.43	3.21	1.6	2.1			
11800	13.6	13.25	1435	13.9	14.71	3.99	1.1	1.4			
11950	14.2	14.01	1435	14.11	15.04	4.26	0.7	0.9			
12100	13.73	14.47	1435	14.4	15.44	4.52	1.4	0.7			
12250	14.56	15.18	1435	14.71 15.12	15.94	4.91 5.32	0.9	0.3			
12400	15.11	15.34	1435		16.56		0.8	0.5			
12550 12700	15.99 16.59	16.57 17.21	1435 1435	15.66 16.64	17.25 17.85	5.59 4.87	0.4	0.0			
12700	17.1	17.21	1435	17.07	18.44	5.18	0.8	0.0			
13000	18.12	18.62	1435	17.63	19.1	5.38	0.7	0.0			
13150				18.25		5.43	0.3				
	18.69	19.28 19.73	1435 1435		19.76 20.52	5.73	0.5	0.0			
13300 13450	19.13 20.4			18.85 20.32		3.67	0.5				
13600	20.42	20.28 21.38	1435 1435	20.53	21.01 21.3	3.91	0.7	0.8			
	21.86		1435		21.7						
13750 13900	22.17	21.63 21.9	939	20.73 21.09	22.21	4.37	0.0	0.0			
14050	23.22	22.47	939	21.09	22.21	4.68 3.81	0.0	0.0			
14060	23.66	24.11	939	22.02	22.69	3.72	0.0	0.2			
14060		Railroad	Bridge	22.02	22.13	3.12	0.0	0.0			
14070	23.66	24.11	939	23.33	23.64	2.47	0.4	0.0			
14200	25.76	23.8	939		24.35	4.83		0.0			
14200	25.76	23.89	939	23.16 24.01	24.35	4.83	0.0	0.1			
				∠ 4 .∪1	24.00	4.00	0.0	0.9			
14240		Capistrano	Bridge								
14240		Capistrano	Bridge	25.52	26.00	2.45	0.0	2.2			
14260	26.03	24.07	939	25.52	26.02	3.15	0.2	2.2			
14350	27.46	24.07	939	26.08	26.2	1.57	0.0	2.8			
14370	27.48	24.09	939	26.08	26.21	1.57	0.0	2.7			
14422.5		tate 5	Bridge	26.4	26.20	2.20	1.5	0.0			
14475	25.33	30.43	939	26.1	26.39	2.36	1.5	0.0			

Tabl	Table 3: San Juan Creek Required Levee Heights for Alternative 3 (100-yr										
14.02				Discharg	0	3 101 1110		(100)1			
				•	,		Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
14650	26.27	31.14	939	26.18	26.58	2.79	0.7	0.0			
14800	24.42	24.87	939	26.49	26.79	2.41	2.8	2.4			
14950	25.7	39.16	939	26.77	26.95	1.87	1.8	0.0			
15100	27.1	27.55	939	26.82	27.22	2.78	0.5	0.0			
15250	25.95	27.58	939	27.06	27.9	4.06	1.9	0.2			
15400	27.6	29.27	939	27.97	28.77	3.96	1.1	0.0			
15550	28.49	29.3	939	28.8	29.8	4.45	1.1	0.3			
15700	30.72	30.18	939	29.95	30.72	3.88	0.0	0.5			
15850	33.04	31.44	939	30.79	31.33	3.27	0.0	0.1			
15950	33.26	31.49	939	31.04	31.82	3.93	0.0	0.3			
16000	33.7	33.39	939	31.78	32.97	4.84	0.0	0.0			
16020	La Novia	a Avenue	Bridge								
16040	39.7	39.39	939	32.2	33.12	4.26	0.0	0.0			
16150	35.77	32.13	939	33.16	33.54	2.7	0.0	1.8			
16300	35.5	33.13	877	33.4	33.92	3.19	0.0	1.0			
16450	36.43	34.16	877	33.82	34.51	3.67	0.0	0.4			
16600	32.66	35.82	877	34.49	35.13	3.63	2.6	0.0			
16750	34.6	35.87	877	35.21	35.73	3.18	1.4	0.1			
16900	35.55	36.87	877	35.77	36.48	3.72	1.0	0.0			
17050	37.21	35.35	877	36.67	37.22	3.31	0.2	2.1			
17200	36.78	38.16	877	37.35	37.83	3.09	1.3	0.0			
17350	38.76	39.5	877	38.12	39.09	4.35	0.1	0.0			
17500	41.82	40.6	877	39.56	40.16	3.43	0.0	0.0			
17650	42.44	41.08	877	40.23	41.41	4.81	0.0	0.0			
17800	42.1	42.03	877	41.78	42.49	3.73	0.4	0.5			
17950	42.7	43.04	877	42.56	43.31	3.83	0.6	0.3			
18100	44.44	43.84	877	43.5	43.85	2.63	0.0	0.4			
18250	44.98	44.41	877	43.73	44.51	3.91	0.0	0.1			
18400	46.01	46	877	44.8	45.4	3.44	0.0	0.0			
18550	48.57	48	877	45.56	46.64	4.6	0.0	0.0			
18700	48.1	48.88	877	46.99	47.53	3.25	0.0	0.0			
18850	48.2	49.98	877	47.91	49.14	4.91	0.5	0.0			
18910	51.2	50	877	48.85	49.64	3.94	0.0	0.0			
18917.5	Ortega	Higway	Bridge								

Tabl	Table 4: San Juan Creek Required Levee Heights for Alternative 4 (100-yr Discharges)										
River Sta	LOB Elev	ROB Elev	Q Total (m3/s)	W.S. Elev	E.G. Elev	Vel Chnl (m/s)	Required Left Levee Height (m)	Required Right Levee Height (m)			
10020	2.7	2.38	1389	3.14	3.57	3.53	1.2	1.5			
10150	4.49	4.14	1389	3.66	4.59	4.27	0.0	0.3			
10275	4.32	3.69	1389	4.5	5.05	3.5	0.0	1.6			
10300	6.45	4.8	1389	5.01	5.55	3.8	0.0	1.0			
10310		oast Hwy	Bridge	3.01	0.00	5.0	0.0	1.0			
10320	6.52	4.87	1389	6.3	6.94	3.57	0.5	2.2			
10351	5.88	6.88	1389	6.23	7.08	4.07	1.1	0.1			
10365		as Ramblas	Bridge	0.20	7.00	1.07	1.1	0.1			
10379	5.98	6.98	1389	6.69	7.3	3.51	1.5	0.5			
10450	6.21	7.21	1389	6.75	7.5	3.85	1.3	0.3			
10600	8.42	8.6	1389	7.05	8.79	5.84	0.0	0.0			
10750	8.84	9.72	1389	8.31	9.54	4.91	0.0	0.0			
10900	9.56	9.55	1389	8.89	10.07	4.81	0.1	0.1			
11050	10.34	9.89	1389	9.42	10.55	4.72	0.0	0.3			
11200	10.94	10.72	1389	9.79	11.16	5.18	0.0	0.0			
11350	11.46	11.55	1389	10.53	11.76	4.91	0.0	0.0			
11500	15.31	13.6	1389	11.02	12.4	5.21	0.0	0.0			
11520	15.4	13.69	1389	11.11	12.49	5.21	0.0	0.0			
11537.5		ill Drive	Bridge		12.10	0.21	0.0	0.0			
11555	15.78	12.44	1389	11.94	12.93	4.4	0.0	0.3			
11575	15.78	12.44	1389	12.07	13	4.26	0.0	0.4			
11650	13.02	12.55	1389	12.22	13.23	4.45	0.0	0.4			
11800	13.6	13.25	1389	12.41	13.88	5.37	0.0	0.0			
11950	14.2	14.01	1389	13.15	14.52	5.18	0.0	0.0			
12100	13.73	14.47	1389	13.84	15.11	5.01	0.9	0.1			
12250	14.56	15.18	1389	14.36	15.73	5.19	0.5	0.0			
12400	15.11	15.34	1389	14.9	16.41	5.43	0.5	0.3			
12550	15.99	16.57	1389	15.53	17.12	5.59	0.3	0.0			
12700	16.59	17.21	1389	16.55	17.73	4.81	0.7	0.1			
12850	17.1	17.97	1389	16.97	18.32	5.15	0.6	0.0			
13000	18.12	18.62	1389	17.54	18.98	5.32	0.2	0.0			
13150	18.69	19.28	1389	18.16	19.64	5.38	0.2	0.0			
13300	19.13	19.73	1389	18.76	20.4	5.67	0.4	0.0			
13450	20.4	20.28	1389	20.22	20.89	3.64	0.6	0.7			
13600	20.42	21.38	1389	20.42	21.19	3.88	0.8	0.0			
13750	21.86	21.63	1389	20.63	21.59	4.33	0.0	0.0			
13900	22.17	21.9	1036	20.74	22.41	5.71	0.0	0.0			
14050	23.22	22.47	1036	22.26	23.02	3.87	0.0	0.5			
14060	23.66	24.11	1036	22.42	23.08	3.6	0.0	0.0			
14070	Metrolink	Railroad	Bridge				·				
14080	23.66	24.11	1036	23.7	24	2.44	0.8	0.3			
14200	25.76	23.8	1036	23.49	24.73	4.93	0.0	0.4			
14220	25.85	23.89	1036	24.32	25.22	4.2	0.0	1.2			
14240	Camino C	Capistrano	Bridge								
14260	26.03	24.07	1036	26.01	26.53	3.2	0.7	2.7			
14350	27.46	24.07	1036	26.58	26.71	1.59	0.0	3.3			
14370	27.48	24.09	1036	26.58	26.71	1.59	0.0	3.2			
14422.5	Inters	tate 5	Bridge								
14475	25.33	30.43	1036	26.6	26.89	2.38	2.0	0.0			

Tabl	Table 4: San Juan Creek Required Levee Heights for Alternative 4 (100-yr										
			-	Discharg	_						
					·		Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
14650	26.27	31.14	1036	26.68	27.06	2.75	1.2	0.0			
14800	24.42	24.87	1036	26.96	27.25	2.39	3.3	2.8			
14950	25.7	39.16	1036	27.21	27.39	1.84	2.3	0.0			
15100	27.1	27.55	1036	27.25	27.61	2.65	0.9	0.4			
15250	25.95	27.58	1036	27.39	28.2	4	2.2	0.6			
15400	27.6	29.27	1036	28.15	29	4.08	1.3	0.0			
15550	28.49	29.3	1036	28.95	30.04	4.63	1.2	0.4			
15700	30.72	30.18	1036	30.16	30.97	3.99	0.2	0.7			
15850	33.04	31.44	1036	31	31.58	3.37	0.0	0.3			
15950	33.26	31.49	1036	31.24	32.06	4.01	0.0	0.5			
16000	33.7	33.39	1036	31.95	33.26	5.06	0.0	0.0			
16020	La Novia	a Avenue	Bridge	•		•					
16040	39.7	39.39	1036	32.42	33.41	4.4	0.0	0.0			
16150	35.77	32.13	1036	33.45	33.83	2.75	0.0	2.1			
16300	35.5	33.13	974	33.67	34.21	3.27	0.0	1.3			
16450	36.43	34.16	974	34.06	34.78	3.77	0.0	0.7			
16600	32.66	35.82	974	34.72	35.39	3.72	2.8	0.0			
16750	34.6	35.87	974	35.42	35.96	3.26	1.6	0.3			
16900	35.55	36.87	974	35.95	36.7	3.84	1.2	0.0			
17050	37.21	35.35	974	36.84	37.44	3.44	0.4	2.2			
17200	36.78	38.16	974	37.54	38.03	3.16	1.5	0.1			
17350	38.76	39.5	974	38.27	39.29	4.47	0.3	0.0			
17500	41.82	40.6	974	39.73	40.37	3.55	0.0	0.0			
17650	42.44	41.08	974	40.42	41.67	4.94	0.0	0.1			
17800	42.1	42.03	974	41.99	42.74	3.84	0.6	0.7			
17950	42.7	43.04	974	42.76	43.55	3.94	0.8	0.5			
18100	44.44	43.84	974	43.71	44.09	2.71	0.0	0.6			
18250	44.98	44.41	974	43.93	44.74	3.99	0.0	0.3			
18400	46.01	46	974	44.97	45.61	3.55	0.0	0.0			
18550	48.57	48	974	45.73	46.87	4.74	0.0	0.0			
18700	48.1	48.88	974	47.18	47.77	3.38	0.0	0.0			
18850	48.2	49.98	974	48.2	49.41	4.88	0.8	0.0			
18910	51.2	50	974	48.96	49.87	4.23	0.0	0.0			
18917.5	Ortega	Higway	Bridge								

Tabl	Table 5: San Juan Creek Required Levee Heights for Alternative 5 (100-yr Discharges)									
	1	1	1	Discharg	ges)	1				
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Required Left Levee	Required Right Levee		
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)		
10020	2.7	2.38	1291	3	3.48	3.68	1.1	1.4		
10150	4.49	4.14	1291	3.56	4.46	4.19	0.0	0.2		
10275	4.32	3.69	1291	4.38	4.93	3.49	0.8	1.4		
10300	6.45	4.8	1291	4.94	5.47	3.7	0.0	0.9		
10310	Pacific C	oast Hwy	Bridge							
10320	6.52	4.87	1291	6.12	6.74	3.48	0.4	2.0		
10351	5.88	6.88	1291	6.06	6.87	3.99	0.9	0.0		
10365	Camino La	s Ramblas	Bridge			•				
10379	5.98	6.98	1291	6.52	7.11	3.46	1.3	0.3		
10450	6.21	7.21	1291	6.6	7.31	3.74	1.1	0.1		
10600	8.42	8.6	1291	6.88	8.54	5.71	0.0	0.0		
10750	8.84	9.72	1291	8.12	9.29	4.8	0.0	0.0		
10900	9.56	9.55	1291	8.7	9.82	4.68	0.0	0.0		
11050	10.34	9.89	1291	9.23	10.3	4.59	0.0	0.1		
11200	10.94	10.72	1291	9.59	10.91	5.08	0.0	0.0		
11350	11.46	11.55	1291	10.31	11.5	4.82	0.0	0.0		
11500	15.31	13.6	1291	10.81	12.15	5.14	0.0	0.0		
11520	15.4	13.69	1291	10.9	12.24	5.14	0.0	0.0		
11537.5	Stoneh	ill Drive	Bridge							
11555	15.78	12.44	1291	11.73	12.68	4.31	0.0	0.0		
11575	15.78	12.44	1291	11.86	12.75	4.17	0.0	0.2		
11650	13.02	12.55	1291	12.01	12.98	4.36	0.0	0.2		
11800	13.6	13.25	1291	12.23	13.63	5.24	0.0	0.0		
11950	14.2	14.01	1291	12.95	14.26	5.08	0.0	0.0		
12100	13.73	14.47	1291	13.63	14.86	4.91	0.7	0.0		
12250	14.56	15.18	1291	14.16	15.48	5.07	0.4	0.0		
12400	15.11	15.34	1291	14.72	16.15	5.3	0.4	0.1		
12550	15.99	16.57	1291	15.35	16.86	5.45	0.1	0.0		
12700	16.59	17.21	1291	16.34	17.46	4.7	0.5	0.0		
12850	17.1	17.97	1291	16.75	18.07	5.09	0.4	0.0		
13000	18.12	18.62	1291	17.35	18.72	5.19	0.0	0.0		
13150	18.69	19.28	1291	17.96	19.38	5.27	0.0	0.0		
13300	19.13	19.73	1291	18.57	20.14	5.55	0.2	0.0		
13450	20.4	20.28	1291	19.98	20.63	3.56	0.3	0.4		
13600	20.42	21.38	1291	20.19	20.93	3.81	0.5	0.0		
13750	21.86	21.63	1291	20.41	21.33	4.26	0.0	0.0		
13900	22.17	21.9	939	20.52	22.09	5.55	0.0	0.0		
14050	23.22	22.47	939	21.98	22.71	3.78	0.0	0.3		
14060	23.66	24.11	939	22.06	22.74	3.68	0.0	0.0		
14070		Railroad	Bridge		1	1				
14080	23.66	24.11	939	23.35	23.65	2.45	0.4	0.0		
14200	25.76	23.8	939	23.18	24.36	4.81	0.0	0.1		
14220	25.85	23.89	939	24.02	24.85	4.05	0.0	0.9		
14240		Capistrano	Bridge		1	T				
14260	26.03	24.07	939	25.52	26.03	3.14	0.2	2.2		
14350	27.46	24.07	939	26.08	26.2	1.57	0.0	2.8		
14370	27.48	24.09	939	26.08	26.21	1.57	0.0	2.7		
14422.5		tate 5	Bridge		1	1				
14475	25.33	30.43	939	26.1	26.39	2.36	1.5	0.0		

Tabl	le 5: San	Juan Cre	ek Requ	uired Leve	ee Height	s for Alto	ernative 5	(100-yr
			•	Discharg	_			
					,		Required	Required
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)
14650	26.27	31.14	939	26.18	26.58	2.79	0.7	0.0
14800	24.42	24.87	939	26.49	26.79	2.41	2.8	2.4
14950	25.7	39.16	939	26.77	26.95	1.87	1.8	0.0
15100	27.1	27.55	939	26.83	27.22	2.77	0.5	0.0
15250	25.95	27.58	939	27.06	27.9	4.06	1.9	0.2
15400	27.6	29.27	939	27.97	28.77	3.96	1.1	0.0
15550	28.49	29.3	939	28.8	29.8	4.45	1.1	0.3
15700	30.72	30.18	939	29.95	30.72	3.88	0.0	0.5
15850	33.04	31.44	939	30.79	31.33	3.27	0.0	0.1
15950	33.26	31.49	939	31.04	31.82	3.93	0.0	0.3
16000	33.7	33.39	939	31.78	32.97	4.84	0.0	0.0
16020	La Novia	a Avenue	Bridge	•	•	•		
16040	39.7	39.39	939	32.2	33.12	4.26	0.0	0.0
16150	35.77	32.13	939	33.16	33.54	2.7	0.0	1.8
16300	35.5	33.13	877	33.4	33.92	3.19	0.0	1.0
16450	36.43	34.16	877	33.82	34.51	3.67	0.0	0.4
16600	32.66	35.82	877	34.49	35.13	3.63	2.6	0.0
16750	34.6	35.87	877	35.21	35.73	3.18	1.4	0.1
16900	35.55	36.87	877	35.77	36.48	3.72	1.0	0.0
17050	37.21	35.35	877	36.67	37.22	3.31	0.2	2.1
17200	36.78	38.16	877	37.35	37.83	3.09	1.3	0.0
17350	38.76	39.5	877	38.12	39.09	4.35	0.1	0.0
17500	41.82	40.6	877	39.56	40.16	3.43	0.0	0.0
17650	42.44	41.08	877	40.23	41.41	4.81	0.0	0.0
17800	42.1	42.03	877	41.78	42.49	3.73	0.4	0.5
17950	42.7	43.04	877	42.56	43.31	3.83	0.6	0.3
18100	44.44	43.84	877	43.5	43.85	2.63	0.0	0.4
18250	44.98	44.41	877	43.73	44.51	3.91	0.0	0.1
18400	46.01	46	877	44.8	45.4	3.44	0.0	0.0
18550	48.57	48	877	45.56	46.64	4.6	0.0	0.0
18700	48.1	48.88	877	46.99	47.53	3.25	0.0	0.0
18850	48.2	49.98	877	47.91	49.14	4.91	0.5	0.0
18910	51.2	50	877	48.85	49.64	3.94	0.0	0.0
18917.5	Ortega	Higway	Bridge					

Table 6: San Juan Creek Required Levee Heights for Alternative 6 (100-yr Discharges)										
				2 1501101 8	333		Required	Required		
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee		
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)		
10020	2.7	2.38	1533	3.45	4.45	4.44	1.5	1.8		
10150	4.49	4.14	1533	4.41	4.85	2.94	0.7	1.0		
10275	4.32	3.69	1533	4.43	5.24	3.99	0.9	1.5		
10300	6.45	4.8	1533	4.87	6.13	4.98	0.0	0.8		
10310		oast Hwy	Bridge							
10320	6.52	4.87	1533	5.92	6.57	3.57	0.2	1.8		
10351	5.88	6.88	1533	5.87	6.7	4.04	0.7	0.0		
10365		s Ramblas	Bridge				-			
10379	5.98	6.98	1533	6.49	7.1	3.46	1.3	0.3		
10450	6.21	7.21	1533	6.61	7.26	3.56	1.2	0.2		
10600	8.42	8.6	1533	6.52	8.09	5.56	0.0	0.0		
10750	8.84	9.72	1533	7.83	8.76	4.26	0.0	0.0		
10900	9.56	9.55	1533	8.13	9.34	4.86	0.0	0.0		
11050	10.34	9.89	1533	8.85	9.86	4.45	0.0	0.0		
11200	10.94	10.72	1533	9.19	10.49	5.05	0.0	0.0		
11350	11.46	11.55	1533	9.99	11.1	4.67	0.0	0.0		
11500	15.31	13.6	1533	10.46	11.73	5.01	0.0	0.0		
11520	15.4	13.69	1533	10.55	11.82	5.01	0.0	0.0		
11537.5	Stoneh	ill Drive	Bridge		•	·				
11555	15.78	12.44	1533	11.16	12.15	4.41	0.0	0.0		
11575	15.78	12.44	1533	11.34	12.24	4.2	0.0	0.0		
11650	13.02	12.55	1533	11.51	12.48	4.38	0.0	0.0		
11800	13.6	13.25	1533	11.79	13.13	5.14	0.0	0.0		
11950	14.2	14.01	1533	12.54	13.77	4.92	0.0	0.0		
12100	13.73	14.47	1533	13.15	14.35	4.85	0.2	0.0		
12250	14.56	15.18	1533	13.7	14.95	4.95	0.0	0.0		
12400	15.11	15.34	1533	14.24	15.63	5.23	0.0	0.0		
12550	15.99	16.57	1533	14.97	16.31	5.12	0.0	0.0		
12700	16.59	17.21	1533	15.77	16.89	4.68	0.0	0.0		
12850	17.1	17.97	1533	16.17	17.59	5.28	0.0	0.0		
13000	18.12	18.62	1533	17.04	18.25	4.86	0.0	0.0		
13150	18.69	19.28	1533	17.57	18.85	5.01	0.0	0.0		
13300	19.13	19.73	1533	18.11	19.57	5.36	0.0	0.0		
13450	20.4	20.28	1533	19.37	20.08	3.73	0.0	0.0		
13600	20.42	21.38	1533	19.63	20.41	3.93	0.0	0.0		
13750	21.86	21.63	1533	19.85	20.93	4.59	0.0	0.0		
13900	22.17	21.9	1036	20.66	21.42	3.86	0.0	0.0		
14050	23.22	22.47	1036	21.05	21.88	4.03	0.0	0.0		
14060	23.66	24.11	1036	21.15	21.92	3.91	0.0	0.0		
14070	Metrolink	Railroad	Bridge							
14080	23.66	24.11	1036	22.21	22.63	2.87	0.0	0.0		
14200	25.76	23.8	1036	22.24	23.26	4.48	0.0	0.0		
14220	25.85	23.89	1036	23.03	23.74	3.73	0.0	0.0		
14240	Camino C	Capistrano	Bridge							
14260	26.03	24.07	1036	24.24	24.69	2.97	0.0	0.9		
14350	27.46	24.07	1036	24.7	24.86	1.81	0.0	1.4		
14370	27.48	24.09	1036	24.71	24.88	1.81	0.0	1.4		
14422.5	Inters	tate 5	Bridge							
14475	25.33	30.43	1036	24.74	25.09	2.63	0.2	0.0		

Tabl	Table 6: San Juan Creek Required Levee Heights for Alternative 6 (100-yr Discharges)										
		ı	T	Discharg	ges)	T	T =				
							Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
14650	26.27	31.14	1036	24.84	25.4	3.31	0.0	0.0			
14800	24.42	24.87	1036	25.38	25.81	2.89	1.7	1.3			
14950	25.7	39.16	1036	25.85	26.13	2.37	0.9	0.0			
15100	27.1	27.55	1036	26.08	26.64	3.32	0.0	0.0			
15250	25.95	27.58	1036	26.68	27.52	4.06	1.5	0.0			
15400	27.6	29.27	1036	27.7	28.44	3.8	0.8	0.0			
15550	28.49	29.3	1036	28.53	29.45	4.25	0.8	0.0			
15700	30.72	30.18	1036	29.63	30.34	3.73	0.0	0.2			
15850	33.04	31.44	1036	30.42	30.96	3.26	0.0	0.0			
15950	33.26	31.49	1036	30.75	31.44	3.7	0.0	0.0			
16000	33.7	33.39	1036	31.45	32.38	4.27	0.0	0.0			
16020	La Novia	a Avenue	Bridge								
16040	39.7	39.39	1036	34.11	34.36	2.19	0.0	0.0			
16150	35.77	32.13	1036	34.34	34.45	1.53	0.0	3.0			
16300	35.5	33.13	974	34.39	34.54	1.81	0.0	2.0			
16450	36.43	34.16	974	34.44	34.72	2.43	0.0	1.0			
16600	32.66	35.82	974	34.55	35.07	3.26	2.6	0.0			
16750	34.6	35.87	974	34.95	35.74	3.93	1.1	0.0			
16900	35.55	36.87	974	35.9	36.68	3.92	1.1	0.0			
17050	37.21	35.35	974	36.84	37.44	3.43	0.4	2.2			
17200	36.78	38.16	974	37.54	38.03	3.16	1.5	0.1			
17350	38.76	39.5	974	38.28	39.29	4.46	0.3	0.0			
17500	41.82	40.6	974	39.72	40.37	3.55	0.0	0.0			
17650	42.44	41.08	974	40.42	41.67	4.95	0.0	0.1			
17800	42.1	42.03	974	41.99	42.74	3.83	0.6	0.7			
17950	42.7	43.04	974	42.76	43.55	3.94	0.8	0.5			
18100	44.44	43.84	974	43.71	44.09	2.71	0.0	0.6			
18250	44.98	44.41	974	43.93	44.74	3.99	0.0	0.3			
18400	46.01	46	974	44.97	45.61	3.55	0.0	0.0			
18550	48.57	48	974	45.73	46.87	4.74	0.0	0.0			
18700	48.1	48.88	974	47.18	47.77	3.38	0.0	0.0			
18850	48.2	49.98	974	48.2	49.41	4.87	0.8	0.0			
18910	51.2	50	974	48.97	49.88	4.21	0.0	0.0			
18917.5	Ortega	Higway	Bridge								

Tab	Table 7: Trabuco Creek Required Levee Heights for Alternative 1 (100-yr										
lub	10 / 1 I I I	buco erec	n nequ	Discharg	_	101 11100	induive i v	(100 J1			
							Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
10000	21.94	21.75	1502	20.19	21.52	5.1	0.0	0.0			
10150	21.91	22.25	1502	21.16	22.03	4.13	0.0	0.0			
10300	22.98	23.2	468	22.17	23.45	5.01	0.0	0.0			
10450	23.67	24.1	468	23.05	24.31	4.98	0.1	0.0			
10600	25.1	25.4	468	24.19	25.48	5.03	0.0	0.0			
10750	26.17	26.41	468	25.1	26.4	5.05	0.0	0.0			
10900	27.6	27.73	468	26.24	27.56	5.09	0.0	0.0			
10975	29.5	29.47	468	26.87	28.25	5.21	0.0	0.0			
10985.5	Del Obis	po Street	Bridge								
10996	29.79	29.71	468	29.49	29.79	2.42	0.4	0.5			
11050	28.66	28.61	468	29.75	29.83	1.55	1.8	1.9			
11200	29.59	29.74	468	29.79	29.91	1.95	0.9	0.8			
11350	30.86	31.2	468	29.48	30.84	5.16	0.0	0.0			
11500	32.06	32.46	468	30.52	31.88	5.17	0.0	0.0			
11650	32.76	32.21	468	32.09	32.36	2.28	0.1	0.6			
11800	33.19	31.48	468	32.37	32.6	2.15	0.0	1.6			
11950	36.1	39.2	468	32.72	33.09	2.71	0.0	0.0			
12100	37.5	39.74	468	33.62	34.52	4.21	0.0	0.0			
12250	38.27	36.2	468	34.91	36.09	4.81	0.0	0.0			
12400	36.16	37.7	468	36.43	37.1	3.62	1.0	0.0			
12550	40.33	44.58	468	37.11	37.82	3.72	0.0	0.0			
12700	39.57	47.2	468	37.98	38.15	1.86	0.0	0.0			
12850	41.45	42.5	468	38.07	38.51	2.94	0.0	0.0			
13000	41.33	43.33	468	38.87	39.18	2.47	0.0	0.0			
13150	45.54	44.03	468	39.54	40.06	3.21	0.0	0.0			
13300	51.31	42.31	468	40.59	40.86	2.29	0.0	0.0			
13450	48	41.42	468	41.65	42.47	4.06	0.0	1.0			
13600	47.2	44.69	352	42.84	42.99	1.75	0.0	0.0			
13660	43.57	43.31	352	43.56	44.57	4.44	0.7	1.0			
13695	53.43	51.2	352	47.83	48.82	4.41	0.0	0.0			
13702.5	Metrolink	Railroad	Bridge								

Tab	Table 8: Trabuco Creek Required Levee Heights for Alternative 2 (100-yr										
				Discharg	ges)						
							Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
10000	21.94	21.75	1502	20.19	21.52	5.1	0.0	0.0			
10150	21.91	22.25	1502	21.16	22.03	4.13	0.0	0.0			
10300	22.98	23.2	468	22.17	23.45	5.01	0.0	0.0			
10450	23.67	24.1	468	23.05	24.31	4.98	0.1	0.0			
10600	25.1	25.4	468	24.19	25.48	5.03	0.0	0.0			
10750	26.17	26.41	468	25.1	26.4	5.05	0.0	0.0			
10900	27.6	27.73	468	26.24	27.56	5.09	0.0	0.0			
10975	29.5	29.47	468	26.87	28.25	5.21	0.0	0.0			
10985.5	Del Obis	po Street	Bridge								
10996	29.79	29.71	468	29.25	29.59	2.58	0.2	0.3			
11050	28.66	28.61	468	29.26	29.66	2.81	1.4	1.4			
11200	29.59	29.74	468	29.28	30.02	3.81	0.4	0.3			
11350	30.86	31.2	468	29.48	30.84	5.16	0.0	0.0			
11500	32.06	32.46	468	30.52	31.88	5.17	0.0	0.0			
11650	32.76	32.21	468	32.09	32.36	2.28	0.1	0.6			
11800	33.19	31.48	468	32.37	32.6	2.15	0.0	1.6			
11950	36.1	39.2	468	32.72	33.09	2.71	0.0	0.0			
12100	37.5	39.74	468	33.62	34.52	4.21	0.0	0.0			
12250	38.27	36.2	468	34.91	36.09	4.81	0.0	0.0			
12400	36.16	37.7	468	36.43	37.1	3.62	1.0	0.0			
12550	40.33	44.58	468	37.11	37.82	3.72	0.0	0.0			
12700	39.57	47.2	468	37.98	38.15	1.86	0.0	0.0			
12850	41.45	42.5	468	38.07	38.51	2.94	0.0	0.0			
13000	41.33	43.33	468	38.87	39.18	2.47	0.0	0.0			
13150	45.54	44.03	468	39.54	40.06	3.21	0.0	0.0			
13300	51.31	42.31	468	40.59	40.86	2.29	0.0	0.0			
13450	48	41.42	468	41.65	42.47	4.06	0.0	1.0			
13600	47.2	44.69	352	42.84	42.99	1.75	0.0	0.0			
13660	43.57	43.31	352	43.56	44.57	4.44	0.7	1.0			
13695	53.43	51.2	352	47.83	48.82	4.41	0.0	0.0			
13702.5	Metrolink	Railroad	Bridge								

Tab	Table 9: Trabuco Creek Required Levee Heights for Alternative 3 (100-yr										
				Discharg	ges)						
							Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
10000	21.94	21.75	1405	20.19	21.35	4.77	0.0	0.0			
10150	21.91	22.25	1405	20.98	21.82	4.06	0.0	0.0			
10300	22.98	23.2	468	22.17	23.45	5.01	0.0	0.0			
10450	23.67	24.1	468	23.05	24.31	4.98	0.1	0.0			
10600	25.1	25.4	468	24.19	25.48	5.03	0.0	0.0			
10750	26.17	26.41	468	25.1	26.4	5.05	0.0	0.0			
10900	27.6	27.73	468	26.24	27.56	5.09	0.0	0.0			
10975	29.5	29.47	468	26.87	28.25	5.21	0.0	0.0			
10985.5	Del Obis	po Street	Bridge								
10996	29.79	29.71	468	29.25	29.59	2.58	0.2	0.3			
11050	28.66	28.61	468	29.26	29.66	2.81	1.4	1.4			
11200	29.59	29.74	468	29.28	30.02	3.81	0.4	0.3			
11350	30.86	31.2	468	29.48	30.84	5.16	0.0	0.0			
11500	32.06	32.46	468	30.52	31.88	5.17	0.0	0.0			
11650	32.76	32.21	468	32.09	32.36	2.28	0.1	0.6			
11800	33.19	31.48	468	32.37	32.6	2.15	0.0	1.6			
11950	36.1	39.2	468	32.72	33.09	2.71	0.0	0.0			
12100	37.5	39.74	468	33.62	34.52	4.21	0.0	0.0			
12250	38.27	36.2	468	34.91	36.09	4.81	0.0	0.0			
12400	36.16	37.7	468	36.43	37.1	3.62	1.0	0.0			
12550	40.33	44.58	468	37.11	37.82	3.72	0.0	0.0			
12700	39.57	47.2	468	37.98	38.15	1.86	0.0	0.0			
12850	41.45	42.5	468	38.07	38.51	2.94	0.0	0.0			
13000	41.33	43.33	468	38.87	39.18	2.47	0.0	0.0			
13150	45.54	44.03	468	39.54	40.06	3.21	0.0	0.0			
13300	51.31	42.31	468	40.59	40.86	2.29	0.0	0.0			
13450	48	41.42	468	41.65	42.47	4.06	0.0	1.0			
13600	47.2	44.69	352	42.84	42.99	1.75	0.0	0.0			
13660	43.57	43.31	352	43.56	44.57	4.44	0.7	1.0			
13695	53.43	51.2	352	47.83	48.82	4.41	0.0	0.0			
13702.5	Metrolink	Railroad	Bridge								

Tabl	Table 10: Trabuco Creek Required Levee Heights for Alternative 4 (100-yr										
				Discharg	ges)						
							Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
10000	21.94	21.75	1359	20.19	21.28	4.62	0.0	0.0			
10150	21.91	22.25	1359	20.91	21.73	4.01	0.0	0.0			
10300	22.98	23.2	327	21.54	22.61	4.58	0.0	0.0			
10450	23.67	24.1	327	22.52	23.47	4.32	0.0	0.0			
10600	25.1	25.4	327	23.56	24.64	4.6	0.0	0.0			
10750	26.17	26.41	327	24.5	25.54	4.53	0.0	0.0			
10900	27.6	27.73	327	25.59	26.69	4.66	0.0	0.0			
10975	29.5	29.47	327	26.19	27.34	4.76	0.0	0.0			
10985.5	Del Obis	po Street	Bridge								
10996	29.79	29.71	327	28.31	28.6	2.39	0.0	0.0			
11050	28.66	28.61	327	28.34	28.67	2.54	0.4	0.5			
11200	29.59	29.74	327	28.34	29.06	3.75	0.0	0.0			
11350	30.86	31.2	327	28.8	29.94	4.74	0.0	0.0			
11500	32.06	32.46	327	29.83	30.98	4.75	0.0	0.0			
11650	32.76	32.21	327	31.26	31.48	2.09	0.0	0.0			
11800	33.19	31.48	327	31.56	31.82	2.27	0.0	0.8			
11950	36.1	39.2	327	32.23	32.6	2.7	0.0	0.0			
12100	37.5	39.74	327	33.29	33.94	3.58	0.0	0.0			
12250	38.27	36.2	327	34.41	35.29	4.17	0.0	0.0			
12400	36.16	37.7	327	35.67	36.27	3.41	0.3	0.0			
12550	40.33	44.58	327	36.44	37.02	3.4	0.0	0.0			
12700	39.57	47.2	327	37.22	37.36	1.7	0.0	0.0			
12850	41.45	42.5	327	37.3	37.79	3.13	0.0	0.0			
13000	41.33	43.33	327	38.48	38.76	2.33	0.0	0.0			
13150	45.54	44.03	327	39.23	39.6	2.69	0.0	0.0			
13300	51.31	42.31	327	40.2	40.45	2.21	0.0	0.0			
13450	48	41.42	327	41.09	41.91	3.99	0.0	0.4			
13600	47.2	44.69	352	42.36	42.6	2.16	0.0	0.0			
13660	43.57	43.31	352	43.56	44.57	4.44	0.7	1.0			
13695	53.43	51.2	352	47.83	48.82	4.41	0.0	0.0			
13702.5	Metrolink	Railroad	Bridge								

Tabl	Table 11: Trabuco Creek Required Levee Heights for Alternative 5 (100-yr										
				Discharg	ges)						
							Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
10000	21.94	21.75	1262	20.19	21.13	4.29	0.0	0.0			
10150	21.91	22.25	1262	20.76	21.54	3.89	0.0	0.0			
10300	22.98	23.2	327	21.54	22.61	4.58	0.0	0.0			
10450	23.67	24.1	327	22.52	23.47	4.32	0.0	0.0			
10600	25.1	25.4	327	23.56	24.64	4.6	0.0	0.0			
10750	26.17	26.41	327	24.5	25.54	4.53	0.0	0.0			
10900	27.6	27.73	327	25.59	26.69	4.66	0.0	0.0			
10975	29.5	29.47	327	26.19	27.34	4.76	0.0	0.0			
10985.5	Del Obis	po Street	Bridge								
10996	29.79	29.71	327	28.31	28.6	2.39	0.0	0.0			
11050	28.66	28.61	327	28.34	28.67	2.54	0.4	0.5			
11200	29.59	29.74	327	28.34	29.06	3.75	0.0	0.0			
11350	30.86	31.2	327	28.8	29.94	4.74	0.0	0.0			
11500	32.06	32.46	327	29.83	30.98	4.75	0.0	0.0			
11650	32.76	32.21	327	31.26	31.48	2.09	0.0	0.0			
11800	33.19	31.48	327	31.56	31.82	2.27	0.0	0.8			
11950	36.1	39.2	327	32.23	32.6	2.7	0.0	0.0			
12100	37.5	39.74	327	33.29	33.94	3.58	0.0	0.0			
12250	38.27	36.2	327	34.41	35.29	4.17	0.0	0.0			
12400	36.16	37.7	327	35.67	36.27	3.41	0.3	0.0			
12550	40.33	44.58	327	36.44	37.02	3.4	0.0	0.0			
12700	39.57	47.2	327	37.22	37.36	1.7	0.0	0.0			
12850	41.45	42.5	327	37.3	37.79	3.13	0.0	0.0			
13000	41.33	43.33	327	38.48	38.76	2.33	0.0	0.0			
13150	45.54	44.03	327	39.23	39.6	2.69	0.0	0.0			
13300	51.31	42.31	327	40.2	40.45	2.21	0.0	0.0			
13450	48	41.42	327	41.09	41.91	3.99	0.0	0.4			
13600	47.2	44.69	352	42.36	42.6	2.16	0.0	0.0			
13660	43.57	43.31	352	43.56	44.57	4.44	0.7	1.0			
13695	53.43	51.2	352	47.83	48.82	4.41	0.0	0.0			
13702.5	Metrolink	Railroad	Bridge								

Tabl	Table 12: Trabuco Creek Required Levee Heights for Alternative 6 (100-yr										
				Discharg	ges)						
							Required	Required			
River Sta	LOB Elev	ROB Elev	Q Total	W.S. Elev	E.G. Elev	Vel Chnl	Left Levee	Right Levee			
	(m)	(m)	(m3/s)	(m)	(m)	(m/s)	Height (m)	Height (m)			
10000	21.94	21.75	1502	20.19	21.01	4.01	0.0	0.0			
10150	21.91	22.25	1502	20.61	21.37	3.85	0.0	0.0			
10300	22.98	23.2	468	21.19	22.2	4.46	0.0	0.0			
10450	23.67	24.1	468	22.17	23.02	4.1	0.0	0.0			
10600	25.1	25.4	468	23.2	24.22	4.47	0.0	0.0			
10750	26.17	26.41	468	24.17	25.07	4.19	0.0	0.0			
10900	27.6	27.73	468	25.16	26.2	4.52	0.0	0.0			
10975	29.5	29.47	468	25.7	26.77	4.58	0.0	0.0			
10985.5	Del Obis	po Street	Bridge								
10996	29.79	29.71	468	26.83	27.33	3.15	0.0	0.0			
11050	28.66	28.61	468	26.85	27.51	3.61	0.0	0.0			
11200	29.59	29.74	468	27.73	28.79	4.56	0.0	0.0			
11350	30.86	31.2	468	28.77	29.46	3.68	0.0	0.0			
11500	32.06	32.46	468	29.31	30.38	4.58	0.0	0.0			
11650	32.76	32.21	468	30.62	31.38	3.86	0.0	0.0			
11800	33.19	31.48	468	31.83	32.22	2.78	0.0	1.1			
11950	36.1	39.2	468	32.59	33.03	2.95	0.0	0.0			
12100	37.5	39.74	468	33.62	34.52	4.21	0.0	0.0			
12250	38.27	36.2	468	34.91	36.09	4.81	0.0	0.0			
12400	36.16	37.7	468	36.43	37.1	3.62	1.0	0.0			
12550	40.33	44.58	468	37.11	37.82	3.72	0.0	0.0			
12700	39.57	47.2	468	37.98	38.15	1.86	0.0	0.0			
12850	41.45	42.5	468	38.07	38.51	2.94	0.0	0.0			
13000	41.33	43.33	468	38.87	39.18	2.47	0.0	0.0			
13150	45.54	44.03	468	39.54	40.06	3.21	0.0	0.0			
13300	51.31	42.31	468	40.59	40.86	2.29	0.0	0.0			
13450	48	41.42	468	41.65	42.47	4.06	0.0	1.0			
13600	47.2	44.69	352	42.84	42.99	1.75	0.0	0.0			
13660	43.57	43.31	352	43.56	44.57	4.44	0.7	1.0			
13695	53.43	51.2	352	47.83	48.82	4.41	0.0	0.0			
13702.5	Metrolink	Railroad	Bridge								

5.0 DETENTION BASINS

The design water volume of the detention basin on San Juan Creek (T1) would be 5,100 acre-ft. The design water volume of the detention basin on Trabuco Creek (T4) would be 2,400 acre-ft. Both detention basins would be configured with design volumes at the spillway crest elevation. The PMF flow on San Juan Creek is 2,692 cms (95,000 cfs). The PMF flow on Trabuco Creek is 1,814 cms (64,000 cfs).

Several assumptions were made for the detention basins. Both detention basins were assumed to be on-line. Sediment storage was assumed to be 10%. Embankment slopes were assumed to be 3:1. Outlet flows from the detention basins, when combined with downstream runoff and attenuating flood flows, would need to sum to less than channel capacity, either existing or proposed.

A cursory analysis was performed to determine the pipe sizes of the outlet works. The detention basins were assumed to be able to empty over a two-day period under this analysis to determine outlet pipe sizes. For this level of detail, it was determined that four 96" pipes would be placed at the San Juan Creek detention basin outlet and two 96" pipes would be placed at the Trabuco Creek detention basin outlet. Appropriate energy dissipation would need to be constructed downstream before flows would enter the natural channel. The pipes were sized based on a cursory analysis using the continuity equation, Q=VA, and the orifice equation at various assumed heads, Q=A*(2gh)^{0.5}.

6.0 CHANNEL STABILITY

Channel stability in terms of (a) the existing concrete panels slope protection, and (b) the invert stability from scour in non-improved or natural reaches, were analyzed separately from the flood control alternatives. The reason is that the channel failure mode is not only from a single rare event (100-yr), but could occur from more frequent events, and this failure mode would require invert stabilization. The effects of the stabilization scenarios would need to be modeled in future studies for those alternatives with a federal interest.

6.01 San Juan Creek and Trabuco Creek Trapezoidal Concrete Panel Failure Analysis

Trapezoidal concrete panels are located along San Juan Creek from station 104+00 to 145+00 and along Trabuco Creek from station 100+00 to 116+00. A cursory analysis was performed so that construction costs to meet minimum stabilization standards for the trapezoidal concrete panels could be estimated. Tables 13 and 14 show the degradation for an average event and a 100-yr event based on the F3 SAM (Hydraulic Design Package for Channels) analysis for San Juan Creek and Trabuco Creek, respectively. Aggradation occurs in the reaches where the degradation is equal to zero.

Table 13: San Juan Creek Degradation

Reach	Stations	Avg. Event Deg (m)	100-yr Event Deg (m)
21	115+00 to 104+00	0.04	0.93
20	122+00 to 115+00	0.00	0.00
19	130+00 to 122+00	0.30	0.89
18	138+50 to 130+00	0.00	0.00
17	145+00 to 138+50	0.46	2.61

Table 14: Trabuco Creek Degradation

Reach	Stations	Avg. Event Degradation (m)	100-yr Event Degradation (m)
15	108+00 to 100+00	0.00	0.00
14	116+00 to 108+00	0.31	1.36

A geotechnical and structural analysis evaluation would be necessary in future spin-off studies to assess the condition of the existing trapezoidal concrete panels. Based on the results from Tables 13 and 14, a minimum of 2550 m along San Juan Creek (Reaches 17, 19, and 21) would require

stabilization measures and a minimum of 800 m along Trabuco Creek (Reach 14) would require stabilization measures. The trapezoidal concrete panels would need to be replaced, pinned, toed down (using rip rap), etc., and invert channel stabilizers/drop structures (reference sections 6.02 and 6.03) would need to be constructed.

6.02 San Juan Creek Invert Channel Stability Analysis

The locations of 0.33 m drop structures along San Juan Creek were determined based on previously performed F3 SAM sediment analyses. The average sediment aggradation and degradation depths for designated reaches were analyzed and drop structure locations were determined for San Juan Creek. Drop structure locations would be placed at or near the cross-sections in Table 15 (reference [a] – Hydraulics Appendix, pg 33-36).

Table 15: San Juan Creek Drop Structure Locations Based on Previous F4 Analysis

Creek	Cross-Section	Reach No.
San Juan	122+00	19
San Juan	138+50	17
San Juan	152+00	15
San Juan	182+00	11
San Juan	204+00	8
San Juan	212+00	7
San Juan	233+50	5

6.03 Trabuco Creek Invert Channel Stability Analysis

Due to the headcutting on Oso Creek and upstream portions of Trabuco Creek, analyses were performed to determine a stable slope based on hydraulic and sediment characteristics. On Trabuco Creek, slope stabilization would begin at the Metrolink Railroad Bridge (Station 137+00). The drop structure/channel stabilizer locations would be placed every 50 m until the stable slope terminated to existing grade. Downstream of the initial termination to existing grade, drop structures/channel stabilizers would be placed at locations to optimize cut/fill quantities.

Table 16: Trabuco Creek Pertinent Data

Reach	Station	Station Length Width		Slope	
12	136+00 to 126+00	1000 m	50-140 m	0.6%	
13	126+00 to 116+00	1000 m	40-80 m	0.6%	

TRB4 adjusted curve sediment data based on the F3 report [a] was used to define the sediment gradation curve.

Table 17: Trabuco Creek Sediment Gradation Curve Based on TRB4 sediment data

Percent Finer (%)	Grain Size (mm)
100	600
97	512
87	256
82	128
77	64
73	32
67	16
63	8
59	4
55	2
50	1
22	0.5
5	0.25
2	0.125

Two different methods of determining the inflowing loads were considered. One method was to consider the results of Reach 4 from previously performed F4 SAM analysis. Another method was to calculate the inflowing load based on inputted hydraulic and sediment information utilizing SAM. A composite n-value of 0.055 was used as representative for the reach analyzed. The 2-yr, 25-yr, 50-yr, and 100-yr discharges were used in the SAM analysis to determine the stable slope. A stable slope of approximately 0.002 was determined assuming a bottom width of 40 m. Profiles of the existing grade and stable slope were plotted (reference Figure 1). Based on the 0.002 stable slope, 14 one-meter channel stabilizers/drop structures would be necessary on Trabuco Creek.

6.04 Oso Creek Invert Channel Stability Analysis

On Oso Creek, the culvert at approximately station 121+50 would be the upstream limit for slope stabilization measures. The drop structure/channel stabilizer locations would be placed every 50 m until the stable slope terminated to existing grade. Downstream of termination to existing grade, drop structures/channel stabilizers would be placed at locations to optimize cut/fill quantities.

Table 18: Oso Creek Pertinent Data

Reach	Station	Station Length Width		Slope	
5	121+00 to 110+00	1100 m	20 m	0.01	
6	110+00 to 100+00	1000 m	20-50 m	0.008	

OSO2 sediment data based on the F3 report [a] was used to define the sediment gradation curve.

Table 19: Oso Creek Sediment Gradation Curve Based on OSO2 sediment data

Percent Finer (%)	Grain Size (mm)
100	13
98	8
96	4
90	2
77	1
54	0.5
25	0.25
15	0.125
10	0.0625

Two different methods of determining the inflowing loads were considered. One method was to consider the results of Reach 4 from previously performed F4 SAM analysis. Another method was to calculate the inflowing load based on inputted hydraulic and sediment information utilizing SAM. A composite n-value of 0.06 was used as representative for the reach analyzed. The 2-yr, 25-yr, 50-yr, and 100-yr discharges were used in the SAM analysis to determine the stable slope. A stable slope of approximately 0.0015 was determined assuming a bottom width of 20 m. Profiles of the existing grade and stable slope were plotted (reference Figure 2). Based on the 0.0015 stable slope, 13 one-meter channel stabilizers/drop structures would be necessary.

An additional scenario is shown in Figure 3, again utilizing 13 one-meter invert stabilizers/drop structures while raising the channel invert in the vicinity of the Schuler property. The Schuler property and the Metrolink Railroad are located in the vicinity of the culvert downstream to station 117+00. To better protect those interests, fill would be required and the creek would begin to have drop structures downstream of that area. The outer bank would need to be armored from roughly 116+00 to 117+00. Downstream of the Schuler property and Metrolink Railroad control points, the drop structures/channel stabilizers would be placed every 50 m until the stable

slope terminated to existing grade. Downstream of the initial termination to existing grade, drop structures/channel stabilizers would be placed at locations to optimize cut/fill quantities.

Channel improvements to develop sideslope stability and prevent headcutting were considered. Choice of slope protection (vegetation type, logs, and/or rip-rap) would be important. The bottom widths for a possible channel improvement scenario are 10 m along Oso Creek and 20 m along Trabuco Creek. Both creeks would have 3:1 sideslopes to the 10-year water surface elevation where 5 m terraces would be placed. Both creeks would continue with 3:1 slopes to the 100-year event where 5 m terraces could be placed. Terraces would transition to existing ground.

7.0 CONTRIBUTION TO THE ECONOMIC ANALYSIS

The future conditions were modeled using HEC-RAS for the 2, 5, 10, 25, 50, 100, 200, and 500-year discharge events for both San Juan Creek and Trabuco Creek. Alternatives 1 through 6 were modeled and results were saved in a text format compatible with the HEC-FDA input requirements for economic analysis.

7.01 Stage Uncertainty Calculations

Uncertainties in the stage for the economic analysis were calculated based on EM 110-2-1619 (Chapter 5, reference b). The stage uncertainty was calculated for the 2-yr, 5-yr, 10-yr, 25-yr, 50-yr, 100-yr, 200-yr, and 500-yr discharge events. Uncertainties are summarized in Table 20.

Table 20: Discharge vs. Uncertainty

Discharge	Standard Deviation of Uncertainty
Event	(m)
500-yr	0.35
200-yr	0.33
100-yr	0.31
50-yr	0.29
25-yr	0.28
10-yr	0.28
5-yr	0.27
2-yr	0.27

8.0 HEC-RAS ADJUSTMENTS

8.01 HEC-RAS Files

The HEC-RAS files provided for this analysis were broken into separate projects each alternative on San Juan and Trabuco Creek. To facilitate modifications in the levee assumptions (described below) it was much more convenient to combine the project file into two separate projects, one for San Juan Creek and one for Trabuco Creek, in which the alternatives were broken out as plans. By doing so, it is much easier to edit input since some of the base geometries and discharge-frequency relations are common to more than one alternative. It is also easier to directly compare water surface profiles and output from selected alternatives. The two projects are labeled "sjcall.prj" and "traball.prj". The individual alternatives for both present and future conditions have self-explanatory names within the projects.

8.02 Starting Water Surface Elevations in Trabuco Creek

Ideally, the two projects HEC-RAS projects could be combined into a single project with Trabuco Creek coded as a tributary to San Juan. Given the time and scope constraints, this could not be accomplished. As a result, the starting water surface elevations for Trabuco Creek were extracted from the San Juan Creek output (Station 137+50) and coded into the Trabuco Creek input files. The starting water surface elevations for the most current models are compared to those that were in the HEC-RAS files that provided for this analysis (Tables 21 and 22). Note that the previous values were the same for each alternative and did not vary much between return intervals.

Table 21: Comparison of Starting Water Surface Elevations in Trabuco Creek – Present Conditions

	Alt 1		Alt	2	Alt 3		Alt	4	Alt	5	Alt	6
	Previous	Current										
2	19.85	16.61	19.85	16.61	19.85	16.61	19.85	16.61	19.85	16.61	19.85	16.4
5	20.19	17.01	20.19	17.01	20.19	16.92	20.19	17	20.19	16.91	20.19	16.78
10	20.27	17.58	20.27	17.58	20.27	17.42	20.27	17.57	20.27	17.4	20.27	17.24
25	20.31	18.72	20.31	18.72	20.31	18.41	20.31	18.69	20.31	18.37	20.31	18.1
50	20.54	19.72	20.54	19.72	20.54	19.48	20.54	19.72	20.54	19.31	20.54	18.87
100	20.58	20.88	20.58	20.88	20.58	20.67	20.58	20.57	20.58	20.35	20.58	19.82
200	20.64	22.21	20.64	22.21	20.64	21.85	20.64	21.93	20.64	21.38	20.64	20.93
500	20.89	23.96	20.89	23.96	20.89	23.4	20.89	23.7	20.89	23.13	20.89	22.34

Table 22: Comparison of Starting Water Surface Elevations in Trabuco Creek – Future Conditions

	Alt 1 Alt 2		Alt 1 Alt 2 Alt 3 Alt 4		4	Alt 5		Alt 6				
	Previous	Current	Previous	Current	Previous	Current	Previous	Current	Previous	Current	Previous	Current
2	19.85	16.73	19.85	16.73	19.85	16.73	19.85	16.73	19.85	16.73	19.85	16.51
5	20.19	17.03	20.19	17.03	20.19	16.94	20.19	17.01	20.19	16.92	20.19	16.8
10	20.27	17.62	20.27	17.62	20.27	17.46	20.27	17.59	20.27	17.43	20.27	17.27
25	20.31	18.8	20.31	18.8	20.31	18.48	20.31	18.74	20.31	18.42	20.31	18.15
50	20.54	19.78	20.54	19.78	20.54	19.55	20.54	19.58	20.54	19.35	20.54	18.92
100	20.58	20.94	20.58	20.94	20.58	20.72	20.58	20.62	20.58	20.4	20.58	19.85
200	20.64	22.28	20.64	22.28	20.64	21.93	20.64	22.0	20.64	21.64	20.64	20.99
500	20.89	24.0	20.89	24.0	20.89	23.43	20.89	23.74	20.89	23.16	20.89	22.38

8.03 HEC-RAS Levee Coding

The HEC-RAS files provided for this analysis included without- and with-project condition files. The files included different kinds of coding to define the levees. In some cases, levees were coded using the "obstruction option" while in others, the "levee option" was applied. The difference is important since in the case of the levee option, once the levee is overtopped, all of the area in the overbank is available to convey flow. When permanent obstructions are used, the overbank area beneath the top of the obstruction is not available to contain flow. To provide for a consistent approach in coding levees, the obstruction option was replaced with the levee option.

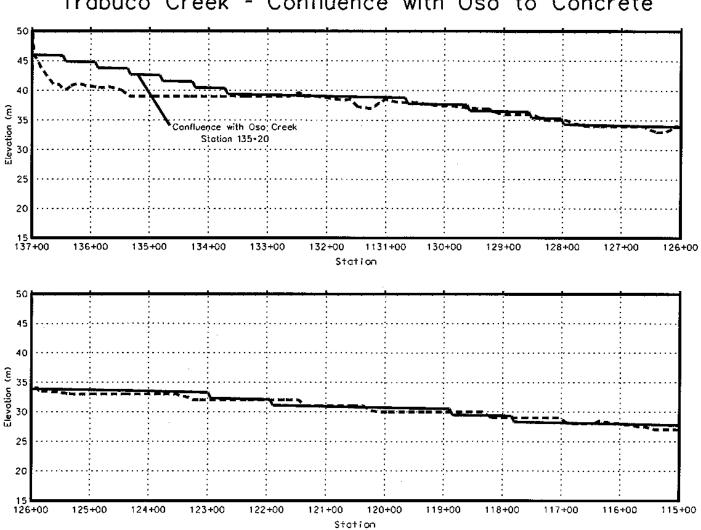
The levees in the provided files were not consistent in terms of the assumed top of levee. In some cases, the levee (or obstruction) record had a top elevation that was high enough to contain the 500-year event while in others the top of levee was only high enough to contain the 100-year water surface, with the Q200 and Q500 breaking out. In general, the existing levees in the first three damage reaches of San Juan were coded with elevations that were high enough to contain all floods. This was done intentionally to provide a conservative estimate of the Q200 and Q500 water surface elevations for without-project floodplain analyses. The with-project levees in damage reaches 4 and 5 for San Juan Creek and reaches 1 and 2 for Trabuco Creek were not consistently coded with levees high enough to contain the Q200 and Q500.

The inconsistent coding of levees led to Q200 and Q500 water surface profiles that were very erratic within a given alternative. There were cross sections where the Q500 WSEL was lower than the Q200, or the Q200 was lower than the Q100. The profiles between alternatives were also erratic and it was common to see a with-project Q500 WSEL higher than the corresponding with-project value. The problem became apparent during initial FDA runs when the results showed negative damage reduction in some reaches. This was especially true in the first three reaches of San Juan Creek, where the existing levees are already fairly high. In the case where only overtopping is considered, (i.e., no geotechnical failure) most of the damages in these reaches result from overtopping in fairly infrequent events and the effect of an increase in WSEL for the with-project Q200 and Q500 is noticeable.

One approach to solving the problem was to revise all of the models so that proposed levees were coded at height that was equal to greater of the Q100 WSEL + 0.75m or the existing levee. This would contain the Q100 water surface profile but would allow the Q200 and Q500 to overtop. The approach was fairly successful in reaches 4 and 5 on San Juan Creek and on Trabuco Creek. However, on reaches 1-3 in San Juan, it again lead to erratic water surface profiles. Consequently, in the lower three reaches of San Juan Creek, the levees coded in HEC-RAS were given enough height to fully contain all of the water surface profiles. This is essentially modeling as if the overbank offered no effective conveyance. It provides a conservative estimate of the water surface elevations, but more importantly, it provides water surface elevations that are consistent within a given profile, and between alternatives. The true levee heights, whether they are based on the Q100 or the existing levee bank, are coded into the FDA model and the effects of overtopping are expressed in terms of damages.

Figure 1

Trabuco Creek - Confluence with Oso to Concrete



Existing Grade

Stable Slope (0.002), 1.0 m (3.0 ft) Drop Structures

Figure 2
Oso Creek - Culvert to Confluence

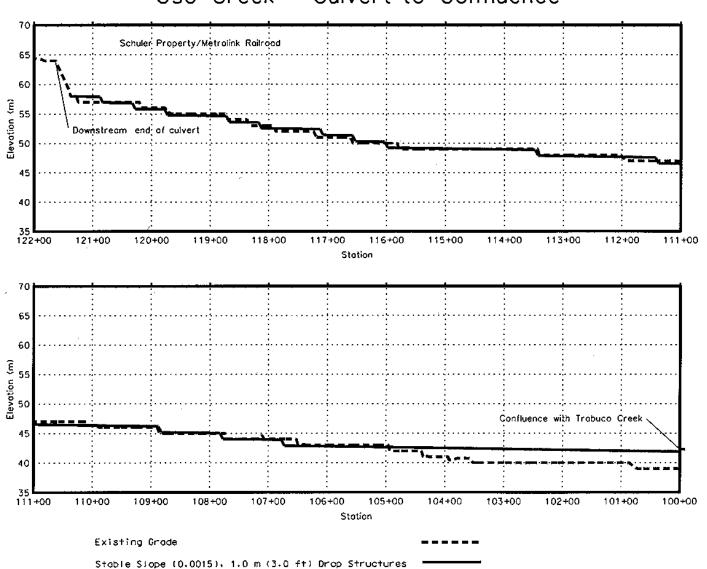


Figure 3 (Protect Schuler Property)
Oso Creek - Culvert to Confluence

