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SAN JUAN CREEK WATERSHED MANAGEMENT STUDY
ORANGE COUNTY, CALIFORNIA

FEASIBILITY PHASE

ENGINEERING DESIGN APPENDIX

AUGUST 2002

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1. INTRODUCTION

This engineering design appendix has been developed to support the Feasibility Phase of San Juan Creek Watershed Management Study that the United States Army Corps of Engineers (USACE), Los Angeles District, is currently conducting. The goal of this project is to provide 100-year level of flood protection and to create more stable channel condition in three major streams in the San Juan Creek Watershed: San Juan Creek, Trabuco Creek, and Oso Creek. The process involves the engineering analysis and design, and cost estimates of the Flood Control components (i.e., floodwalls, detention basins, and bridge replacements) and of the Channel Stability components (i.e., drop structures, bank side-slope grading, and bridge widening) in the watershed.

Although there has been an increasing number of developments constructed in the San Juan Creek Watershed, the existing condition of most of reaches in the three creeks are generally considered as natural and unimproved. However, the San Juan creek reach between Pacific Coast Highway Bridge and just upstream of La Novia Avenue Bridge, and the Trabuco Creek reach from the San Juan Creek Confluence to 600 meters upstream of Del Obispo Bridge are currently trapezoidal channels with soft-earthen bottom and concrete lined banks.

Six Flood Control Alternatives (FC-1 through 6) were developed. The FC-1 represents the "No Action" alternative in which no engineering improvements would take place within the watershed. In addition, three Channel Stability Alternatives (CS-1 through 3) were considered.

All of the engineering design alternatives were based on the Hydrology and Hydraulic Without-Project Conditions studies, performed by the USACE. See Hydrology and Hydraulics Appendices for reference.

2. DESCRIPTION OF DESIGN COMPONENTS

2.1 Flood Control Components

2.1.1 Floodwalls

A reinforced concrete floodwall is recommended for four flood control alternatives (FC-2 through 5). The floodwalls are to be constructed along the creeks at locations where the existing floodwalls and/or levees do not provide 100-year level of flood protection. These locations are determined by comparing the existing top of bank elevations to with-project water surface elevations of each alternative. The with-project water surface elevations were obtained by running HEC-RAS models for 100-year discharges (performed by the USACE). Both sides of bank would be 0.75 meters (2.46 ft) above the calculated water surface elevations at all places.

Floodwalls were categorized by their aboveground heights of the wall structures with a 0.5-meter increment, from 0.5-meter high to 4.0-meter high structures. In order to achieve structural stability, "L-type" floodwalls were designed for those equal or less than 1.5 meters in height, while "T-type" was considered for taller floodwalls. The structural dimensions, including footing designs, were achieved, using the computer software X0153 (CTWALL) and based on the design recommendations of the USACE Flood Control Design Manual (April 1995, EM 1110-2-2007). The structural information is presented in the Design Plate Sheet 12 of FC-2 through FC-5.

2.1.2 Detention Basins

Two separate on-line detention basins are considered for floodwater attenuation purposes. A detention basin with the storage volume of 5,700 acre-feet is proposed approximately 1,400 meters upstream of Antonio Parkway in San Juan Creek. Another basin is considered approximately 700 meters upstream of the gravel mining operation and east of the Saddleback College in Trabuco Creek with the storage volume of 2,715 acre-feet. The PMF flows on San Juan Creek and Trabuco Creek are 2,692 cubic meters per second (cms) (95,000 cfs) and 1,814 cms (64,000 cfs), respectively. A dam for each basin would consist of compacted earthen embankment with an 18-inch thick riprap blanket, a low-level outlet, and an emergency spillway. The compacted earth fill and riprap would extend 5 meters below the streambed.

2.1.3 Bridge Replacement

Analysis for bridge replacement was performed on Pacific Coast Highway Bridge, La Novia Bridge, and 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 meters to 3.6 meters. La Novia Bridge would be raised a minimum of 1.8 meters, while Del Obispo Bridge would be raised a minimum of 1.5 meters. The design plates for the bridge replacement will be included in the subsequent submittal of this Design Appendix.

2.1.4 Channel Widening

Widening of the channel bottom, while keeping the same cross-sectional configuration, was analyzed in FC-6 in order to increase the channel capacity. Downstream reaches of San Juan Creek and Trabuco Creek, most of which are concrete-lined under existing condition, are widened by 20 meters on either side of channel, depending on the availability of lands, feasibility of obtaining real-estate, and the degree of achievable hydraulic advantage.

On the side-slopes of the channel, the existing concrete lining with 2.13 meters (7 feet) of toe-down depth below the existing invert elevations would be stripped and replaced by new concrete linings with 3.05 meters (10 feet) of toe-down depth.

Pacific Coast Highway Bridge, La Novia Bridge, and Del Obispo Bridge would be replaced under the same design criteria mentioned in Section 2.1.3. Six bridges need to be lengthened to

meet the new dimensions of the channel, altered by the channel widening. These bridges would include Stonehill Drive Bridge, Metrolink Railroad Bridge, Camino Capistrano Bridge on San Juan Creek, and the three aforementioned bridges that are to be replaced.

2.2   Channel Stability Components

2.2.1   Drop Structures

Drop structures are recommended in order to improve the channel invert stability and protect it from scouring in non-improved or natural reaches for all three creeks. However, in the case of San Juan Creek, the stability improvement and locations of the structures extend all the way down to the Pacific Coast Highway and include the downstream reach of the creek, where the channel has concrete-lined banks and soft bottom. The location and elevation of the structures have been determined by the previous SAM analysis, topographic constraints, and engineering judgment (See Hydraulic Appendix). A total of seven (7), fourteen (14), and eleven (11) drop structures are proposed to be constructed on San Juan Creek (CS-1), Trabuco Creek (CS-2), and Oso Creek (CS-3), respectively.

A drop structure for this study is similar to the "Pool and Riffle" structure of another project in the same geological vicinity, *Aliso Creek Watershed Management Study, Orange County, CA, - F5 Report, February 2001,* conducted by the USACE. The alternative includes a series of low riprap drop structures (i.e., riffles), with pools with the minimum distance of 50 meters in between. The pools would have the long-term equilibrium slopes necessary for a stable channel, while the drops would provide the fall necessary to meet the existing gradient of the creek. These drop structures, which include a fish passage feature, are intended to allow access for aquatic, amphibious, and terrestrial wildlife. Based on the results of the Hydraulic study, drop heights of the structures vary from one creek to another.

Each structure would consist of a buried soil cement grade stabilizer, a grouted riprap riffle slope, a dumped riprap apron (scour pad), and side-slopes protected with an open-cell articulated concrete revetment, Armoflex, which extends to the top of banks. The Armoflex would be placed from the upper end of the riffle to the lower end of riprap apron and would provide approximately 20% open space to allow vegetation to grow on the side-slopes.

2.2.2   Bank Side-Slope Grading

In the Channel Stability Alternatives, slopes of channel banks are proposed to be flattened to 3H:1V slope, where the slopes are steeper. This would exclude the concrete-lined sections near the downstream of San Juan Creek. Oso Creek (CS-3) was the only stream that would be fixed by this stability component. Either side of the bank was chosen for the grading, depending on the existing utility lines, structures, and availability of lands. The modified section would reduce

erosion potential by slowing stream velocity and lowering unit discharge. The flattened slopes would also provide a mere stable surface for establishment of riparian and upland habitats.

3. DESIGN CONSIDERATIONS FOR PROPOSED ALTERNATIVES

3.1 FC-1

3.1.1 Description

This alternative represents the "No Action" alternative. This involves no design improvements or new facilities to be installed in the San Juan Creek Watershed areas. The extent and magnitude of damages in the areas by the 100-year level storm in this alternative would provide a basis to which the benefits and losses of each alternative (i.e. Flood Control Alternatives and Channel Stability Alternatives) are to be compared, in order for plan selection later.

3.2 FC-2

3.2.1 Description

This alternative would provide protection against 100-year level flood events and involves only the Floodwall Component along San Juan Creek and Trabuco Creek. Floodwalls are to be constructed along San Juan Creek from just downstream of Pacific Coast Highway Bridge up to the Lower Ortega Highway Bridge at the locations where existing bank elevations are not sufficient for 100-year level flood protection. In addition, floodwalls would be installed along Trabuco Creek from its confluence with San Juan Creek to the Metro Link SCRRA Bridge, where they are necessary to provide the desired level of protection.

Three bridges, namely Pacific Coast Highway Bridge and La Novia Bridge on San Juan Creek, and Del Obispo Bridge on Trabuco Creek, will be raised above 100-year water surface elevations after floodwalls are placed along the creeks. This bridge replacement would prevent bridges from obstructing waterways, creating backwaters in the events of 100-year level storms. See Section 2.1.3 for details.

3.2.2 Engineering Considerations

Floodwalls are proposed along San Juan Creek and Trabuco Creek to contain 100-year flood within the channels. It was decided at the beginning of the design phase that floodwall constructions were to be located only where the existing banks and/or levees were not sufficiently high enough for the required protection levels, thus were distributed sporadically along each creek. The protection requirement for each bank was determined to be 0.75 meter (2.46 feet) above the 100-year water surface elevations at each station. The 100-year water surface elevations were modeled by the USACE, using HEC-RAS software. (See Hydrology and Hydraulic Appendices) When the existing bank elevation did not meet the aforementioned

protection requirement, floodwalls of different heights were proposed by an increment of 0.5 meters, varying from 0.5 meters high to 4.0 meters high, until the requirement was satisfied. 'L-Type' floodwall was used for floodwalls less than 2.0 meters high and 'T-Type' wall for anything equal or greater. See Section 2.1.1 for the structural details of floodwalls. These floodwalls are recommended to be constructed as close as possible to the creek in order to minimize the affected right-of-way and probable easement.

San Juan Creek is a concrete-lined trapezoidal channel from Pacific Coast Highway Bridge to just downstream of I-5 Bridge at Station 143+50. Within this reach, floodwalls would be proposed on tops of existing levees. Between I-5 Bridge and Ortega Highway, where the creek exists as a natural stream, the walls would be constructed on top of the channel side slopes. Immediately upstream of I-5 crossing, the San Juan Hills golf course is located on the left side of the channel from Station 145+00 to Station 157+00, within the 100-year floodplain and already prone to any kind of flooding due to its low ground elevation. High floodwalls over 2 meters high along this reach are proposed. Between Station 169+00 and Station 175+00, there is a low natural floodplain ground on the left bank area, thus the new left bank floodwall meanders away from the channel centerline until the higher grounds are found but before residential areas.

The Trabuco channel is concrete-lined from the San Juan Creek confluence to about 600 meter upstream of Del Obispo Bridge. The same design criteria were used for floodwall construction as for San Juan Creek. At the terminus of concrete lining, a small tributary and low-ground park are located on the left bank. On the right bank, a 20-foot wide dirt road exists underneath a steep hill area with a residential complex and extends from Station 116+00 to Station 118+00. Although the elevation of the hill area is high enough, high floodwalls are placed between the creek and the dirt road, which goes under the 100-year floodwater surface elevation, to protect constant traffic over the dirt road during the flood events. For the 500-meter reach just downstream of the confluence with Oso Creek, the right bank area is a natural floodplain with a mild slope at the foothills of mountains. Floodwalls are not proposed at this location. The 100-year flood would be allowed to inundate up to the existing ground, creating the right side boundary of the floodplain to be as far as 100 meters from the creek centerline.

The total lengths and concrete volumes, including reinforcement, of the floodwalls for different heights on San Juan Creek and Trabuco Creek are shown in Table 3.1.

Table 3.1   Total Lengths and Volumes of Floodwalls in San Juan Creek and Trabuco Creek (FC-2)

Stream	Length/volume	Floodwall Heights (m)							
		0.5 m	1.0 m	1.5 m	2.0 m	2.5 m	3.0 m	3.5 m	4.0 m
San Juan	Length (m)	3190	3970	1900	1040	710	370	420	40
	Volume (m³)	724	1368	1229	1091	996	767	1034	112
Trabuco	Length (m)	323	382	432	0	0	0	0	0
	Volume (m³)	73	132	280	0	0	0	0	0

This alternative does not include any detention basin to reduce downstream flows, which was considered in the other the flood control alternatives, excluding FC-1, "No Action" Alternative. Thus, it has higher water surface elevations along the profiles than any of them. Consequently, this alternative requires the most amounts of floodwall quantities.

The existing bridge at Pacific Coast Highway would be replaced by a proposed 5-span reinforced concrete box girder bridge. The low chord of the new bridge would be 2.5 meters higher than the existing low chord. The new bridge would be 20 meters wide and 132 meters long, approximately the same as the existing bridge. The total width of the four bridge piers would be 3.6 meters.

The existing bridge at La Novia Avenue would be replaced by a proposed 3-span reinforced concrete box girder bridge. The low chord of the new bridge would be 1.8 meters higher than the existing low chord. The new bridge would be 9.75 meters wide and 69 meters long, approximately the same as the existing bridge. The total width of the four bridge piers would be 1.8 meters.

The existing bridge at Del Obispo Street would be replaced by a proposed 2-span reinforced concrete box girder bridge. The low chord of the new bridge would be 1.5 meters higher than the existing low chord. The new bridge would be 20.5 meters wide and 46.5 meters long, approximately the same as the existing bridge. The total width of the four bridge piers would be 0.9 meters.

3.3   FC-3

3.3.1   Description

This alternative would also provide protection against 100-year level flood events, the construction of floodwalls along San Juan Creek and Trabuco Creek, and the construction of a detention basin in San Juan Creek. Floodwalls are to be constructed along San Juan Creek from just downstream of Pacific Coast Highway Bridge up to the Lower Ortega Highway Bridge at the locations where existing bank elevations are not sufficient for 100-year level flood protection. In addition, floodwalls would be installed along Trabuco Creek from its confluence

with San Juan Creek to the Metro Link SCRRA Bridge, where they are necessary to provide the desired level of protection.

An on-line detention basin would be constructed approximately 1,400 meters upstream of Antonio Parkway along San Juan Creek to reduce the amount of peak flood flows during the storm events. The storage volume and PMF flow of the basin were determined in the Hydrology and Hydraulic Appendices and were proposed at approximately 5,700 acre-feet and 2,692 cms (95,000 cfs), respectively.

This alternative has the same bridge replacement requirements (i.e., raising of bridge deck elevation) of the three bridges, namely Pacific Coast Highway Bridge and La Novia Bridge on San Juan Creek and Del Obispo Bridge on Trabuco Creek, as the alternative FC-2 does. See Section 2.1.3 for details.

3.3.2 Engineering Considerations

As far as the floodwall design, this alternative has the same engineering considerations as described in FC-2 (See Section 3.2.2.) However, because of the on-line detention basin located along San Juan Creek, upstream of Antonio Parkway, the water surface elevations and floodwall heights at downstream stations are lower than those of FC-2. Some of the locations, however, immediately upstream of a bridge, where the water surface elevation is also controlled by the chocking by the bridge deck and/or piers, still show the high floodwall elevations. The total lengths and concrete volumes, including reinforcement, of the floodwalls for different heights for San Juan Creek and Trabuco Creek are shown in Table 3.2.

Table 3.2   Total Lengths and Volumes of Floodwalls in San Juan Creek and Trabuco Creek (FC-3)

Stream	Length/volume	Floodwall Heights (m)							
		0.5 m	1.0 m	1.5 m	2.0 m	2.5 m	3.0 m	3.5 m	4.0 m
San Juan	Length (m)	2965	2660	1640	915	720	200	0	0
	Volume (m^3)	673	917	1061	960	1010	414	0	0
Trabuco	Length (m)	329	384	428	0	0	0	0	0
	Volume (m^3)	75	132	277	0	0	0	0	0

A dam for the detention basin would consist of compacted earthen embankment, a low-level outlet, and an emergency spillway. The embankment width is 140 meters at the base, 6.1 meters wide at the crest, 400 meters in length, 24 meters in height and 3H:1V side-slopes covered with an 18-inch thick blanket of riprap. The compacted earth fill and riprap would extend 5 meters below the streambed.

The purpose of the dam is to provide temporary storage of floodwater to reduce the 100-year peak discharge. Attenuated outflows from the reservoir in combination with downstream channel

improvements would provide 100-year level of flood protection. The dam was designed to provide 5,700 acre-feet of storage (includes 10% bulking for debris) at the 100-year stage. Based on natural topography, a reservoir stage-storage curve was developed to determine the 100-year reservoir stage. An elevation of 77.2 meters (MSL) was selected as the 100-year stage based on the required 5,700 acre-feet storage. A double 12 feet by 9 feet reinforced concrete box (RCB) culvert would attenuate the outflow from the reservoir resulting in a maximum 100-year stage of 77.2 meters (MSL).

The spillway was designed to pass the discharge resulting from the probable maximum flood (PMF) with future land use condition. The proposed spillway is 137.2 meters (450 feet) wide on a 3H:1V slope and lined with 38 cm (15 inches) thick reinforced concrete slab on the invert.

Spillway elevation of 77.5 meters (MSL) was determined by adding 0.3 meters to the 100-year reservoir stage elevation.

Embankment height of 83.7 meters was determined by adding 1 meter to the PMF stage. The PMF stage was determined by using the un-attenuated PMF discharge of 95,000 cfs to calculate the head (H) on the 137.2-meter length (L) spillway. A weir coefficient (C) of 3.0 was used in the following equation:

$$Q = C*L*(H)^{3/2}$$

A head (H) of 5.2 meters was calculated to pass the PMF discharge and was added to the spillway elevation to determine the PMF stage of 82.7 meters (MSL).

The invert of the spillway is extended 3.05 meters (10 feet) below the existing ground to form the energy dissipator. A 9.2-meter (30 feet) wide riprap blanket is placed immediately downstream of the energy dissipator to minimize the scouring potentials. The geometry and physical dimensions of the energy dissipator are determined to ensure the occurrence of the hydraulic jump within the energy dissipator. The energy dissipator is 137.2 meters long, 21.35 meters wide and 3.05 meters deep.

The three bridges (i.e., Pacific Coast Highway Bridge, La Novia Bridge, and Del Obispo Bridge) would be replaced as those in FC-2 to raise the bridges over the 100-year level with-project water surface elevations and to increase the river conveyance. See Section 3.2.2 for details on bridge replacement.

3.4   FC-4

3.4.1   Description

This flood control alternative provides protection against 100-year level flood events in the watershed areas and consists of the construction of floodwalls along San Juan Creek and Trabuco Creek and construction of a detention basin in Trabuco Creek. Floodwalls are to be constructed along San Juan Creek from just downstream of Pacific Coast Highway up to the Lower Ortega Highway Bridge at the locations where existing bank elevations are not sufficient for 100-year level flood protection. In addition, floodwalls would be installed along Trabuco Creek from its confluence with San Juan Creek to the Metro Link SCRRA Bridge, where they are necessary to provide the desired level of protection.

An on-line detention basin would be constructed approximately 700 meters upstream of the gavel mining operation site and east of the Saddleback College along Trabuco Creek to reduce the amount of peak flood flows during the storm events. The storage volume and PMF flow of the basin were determined in the Hydrology and Hydraulic Appendices and were proposed at approximately 2,715 acre-feet and 1,814 cms (64,000 cfs), respectively.

This alternative has the same bridge replacement requirements (i.e., raising of bridge deck elevation) of the three bridges, such as Pacific Coast Highway Bridge and La Novia Bridge on San Juan Creek and Del Obispo Bridge on Trabuco Creek, as the alternative FC-2 does. See Section 2.1.3 for details.

3.4.2   Engineering Considerations

This alternative has the same engineering considerations for floodwall designs as described for FC-2 (See Section 3.2.2.) However, because of the on-line detention basin, located along Trabuco Creek upstream of the gravel-mining pit, the water surface elevations and floodwall heights at downstream stations are lower than those of FC-2. Some of the locations, however, immediately upstream of a bridge, where the water surface elevation is also controlled by the chocking by the bridge deck and/or piers, still show the high floodwall elevations. The total lengths and concrete volumes, including reinforcement, of the floodwalls for different heights for San Juan Creek and Trabuco Creek are shown in Table 3.3.

Table 3.3   Total Lengths and Volumes of Floodwalls in San Juan Creek and Trabuco Creek (FC-4)

Stream	Length/volume	Floodwall Heights (m)							
		0.5 m	1.0 m	1.5 m	2.0 m	2.5 m	3.0 m	3.5 m	4.0 m
San Juan	Length (m)	3470	2795	360	1320	340	425	0	0
	Volume (m³)	787	963	233	1384	477	880	0	0
Trabuco	Length (m)	428	0	0	0	0	0	0	0
	Volume (m³)	97	0	0	0	0	0	0	0

A dam for the detention basin would consist of compacted earthen embankment, a low-level outlet, and an emergency spillway. The embankment width is 130 meters at the base, 6.1 meters wide at the crest, 510 meters in length, 19.2 meters in height, and 3H:1V side-slopes covered with an 18-inch thick blanket of riprap. The compacted earth fill and riprap would extend 5 meters below the streambed.

The purpose of the dam is to provide temporary storage of floodwater in order to reduce the 100-year peak discharge. Attenuated outflows from the reservoir in combination with downstream channel improvements would provide 100-year level of flood protection. The dam was designed to provide 2,715 acre-feet of storage (includes 10% bulking for debris) at the 100-year stage. Based on natural topography, a reservoir stage-storage curve was developed to determine the 100-year reservoir stage. An elevation of 87.7 meters (MSL) was selected as the 100-year stage based on the required 2,715 acre-feet storage. A 12 feet by 9 feet reinforced concrete box (RCB) culvert would attenuate the outflow from the reservoir resulting in a maximum 100-year stage of 87.7 meters (MSL).

The spillway was designed to pass the discharge resulting from the probable maximum flood (PMF) with future land use condition. The proposed spillway is 91.4 meters (300 feet) wide on a 3H:1V slope and lined with 38 cm (15 inches) thick reinforced concrete slab on the invert.

Spillway elevation of 88.0 meters (MSL) was determined by adding 0.3 meters to the 100-year reservoir stage elevation.

Embankment elevation of 94.2 meters was determined by adding 1 meter to the PMF stage. The PMF stage was determined by using the un-attenuated PMF discharge of 65,000 cfs to calculate the head (H) on a 91.4-meter length (L) spillway. A weir coefficient (C) of 3.0 was used in the following equation:

$$Q = C * L * (H)^{3/2}$$

A head (H) of 5.2 meters was calculated to pass the PMF discharge and was added to the spillway elevation to determine the PMF stage of 93.2 meters (MSL).

The invert of the spillway is extended 3.05 meters (10 feet) below the existing ground to form the energy dissipator. A 9.2-meter (30 feet) wide riprap blanket is placed immediately downstream of the energy dissipator to minimize the scouring potentials. The geometry and physical dimensions of the energy dissipator are determined to ensure the occurrence of the hydraulic jump within the energy dissipator. The energy dissipator is 91.4 meters long, 21.35 meters wide and 3.05 meters deep.

The three bridges (i.e., Pacific Coast Highway Bridge, La Novia Bridge, and Del Obispo Bridge) would be replaced as those in FC-2 to raise the bridges over the 100-year level with-project water surface elevations and to increase the river conveyance. See Section 3.2.2 for details on bridge replacement.

3.5   FC-5

3.5.1   Description

This alternative proposes protection against 100-year level flood events in the watershed by providing the construction of floodwalls along San Juan Creek and Trabuco Creek and construction of detention basins in both San Juan Creek and Trabuco Creek. Floodwalls are to be constructed along San Juan Creek from just downstream of Pacific Coast Highway up to the Lower Ortega Highway Bridge at the locations where existing bank elevations are not sufficient for 100-year level flood protection. In addition, floodwalls would be installed along Trabuco Creek from its confluence with San Juan Creek to Lower Ortega Highway Bridge, where they are necessary to provide the desired level of protection.

The two separate detention basins in San Juan Creek and Trabuco Creek, similar to those in the FC-3 and FC-4, would be constructed concurrently to combine the hydraulic benefits of both basins. The information on the two detention basins is detailed in Sections 3.3 and Section 3.4, respectively.

This alternative has the same bridge replacement requirements (i.e., raising of bridge deck elevation) of the three bridges, such as Pacific Coast Highway Bridge and La Novia Bridge on San Juan Creek and Del Obispo Bridge on Trabuco Creek, as the alternative FC-2 does. See Section 2.1.3 for details.

3.5.2   Engineering Considerations

For floodwall designs, this alternative is based on the same engineering considerations as described in FC-2 (See Section 3.2.2.). However, because of the two on-line detention basins located along San Juan Creek upstream of Antonio Parkway and along Trabuco Creek upstream of the gravel mining pit, the water surface elevations and floodwall heights at downstream stations are significantly lower than those of FC-2. The total lengths and concrete volumes,

including reinforcement, of the floodwalls for different heights for San Juan Creek and Trabuco Creek are shown in Table 3.4.

Table 3.4   Total Lengths and Volumes of Floodwalls in San Juan Creek and Trabuco Creek (FC-5)

Stream	Length/volume	Floodwall Heights (m)							
		0.5 m	1.0 m	1.5 m	2.0 m	2.5 m	3.0 m	3.5 m	4.0 m
San Juan	Length (m)	3795	970	1130	440	420	330	0	0
	Volume (m^3)	861	334	731	461	589	684	0	0
Trabuco	Length (m)	428	0	0	0	0	0	0	0
	Volume (m^3)	97	0	0	0	0	0	0	0

The two detention basins are proposed in San Juan Creek and Trabuco Creek, respectively, to provide temporary storage of floodwater in order to reduce the 100-year peak discharge. These basins are independent of each other and do not affect each other's design criteria, when they are constructed concurrently to maximize the flood attenuation efforts in the watershed areas. The engineering considerations and design details of the basins in San Juan Creek and Trabuco Creek are presented in Section 3.3.2 and Section 3.4.2, respectively.

The three bridges (i.e., Pacific Coast Highway Bridge, La Novia Bridge, and Del Obispo Bridge) would be replaced as those in FC-2 to raise the bridges over the 100-year level with-project water surface elevations and to increase the river conveyance. See Section 3.2.2 for details on bridge replacement.

3.6   FC-6

3.6.1   Description

This flood control alternative involves the widening of the channel to provide 100-year level flood protection by increasing the river conveyance. The reaches, affected by this alternative, extend from just downstream of Pacific Coast Highway Bridge to 600 meters upstream of La Novia Bridge on San Juan Creek, and from the San Juan Creek confluence to the terminus of the concrete trapezoidal channel upstream of Del Obispo Bridge on Trabuco Creek. These reaches are mostly concrete-lined and comprise of channelized sections of the creeks. Only one side of channel banks is chosen for the widening, based on the availability of lands, feasibility of obtaining real estates, and the degree of achievable hydraulic advantage. When either side of the banks is chosen, the existing levee would be demolished, and a new levee would be placed 20 meters from the existing levee.

Pacific Coast Highway Bridge and La Novia Bridge on San Juan Creek and Del Obispo Bridge on Trabuco Creek are required to have the same bridge replacement (i.e., raising of bridge deck elevation) as those in the previous Flood Control Alternatives (See Section 3.2.1 for details). In

addition to the aforementioned bridge replacement, the same three bridges, along with three additional bridges on Stonehill Drive, Metrolink Railroad, and Camino Capistrano, would have their bridge abutments expanded 20 meters to incorporate the change in the channel widths.

3.6.2   Engineering Considerations

The concrete-lined reach of San Juan Creek from Pacific Coast Highway Bridge to just downstream of I-5 was widened 20 meters on either side, where it was more appropriate. Existing concrete lining with the toe-down elevation of 2.13 meters (7 feet) under the invert lines would be removed and replaced with the similar lining of 3.05 meters (10 feet) deep toe-down. The new toe-down elevation was determined for channels with the flow velocity between 16 to 20 feet per second (fps). The new levees would have the same geometric configurations and features, including the same top of the bank elevations and a 20-foot access ramp on top of the bank, as the existing levees. The left bank of the short reach on San Juan Creek between Station 134+00 and Station 138+00 near the confluence with Trabuco Creek changes its side-slope from 2H:1V to 1.5H:1V for the existing levee. The new widened channel section also keeps the same slope transition in this area.

In the natural reach of San Juan Creek, upstream of I-5, the golf course is located on the left bank of the creek between Station 146+00 and Station 151+00. The natural slope of the area is approximately 7H:1V and has very low top-of-bank elevations. A new earthen levee would be raised to provide 100-year level protection and sloped to 2H:1V. Imported fill for the new levee would be easily accommodated due to excessive cut dirt volume from the channel widening grading. The right side of this same reach was not considered for widening because that area was a hydraulically ineffective area in terms of water conveyance, behind the I-5 Bridge constriction, and would not help to lower water surface elevations by much, if chosen.

The levees on Trabuco Creek would also be pushed back 20 meters from the watercourse for the reach from the San Juan Creek confluence up to approximately Station 116+00, with a new toe-down elevation of 3.05 meters (10 feet) deep.

The top of bank elevations of the new levee on the widened side would be the same as those of the existing levees. In some cases, the elevation would not be sufficient to contain the 100-year with-project water surface elevations. In addition, the opposite side of the widened side was left untouched for this alternative. Construction of floodwalls and/or raising levees with sufficient heights should be looked into later on.

The existing bridge at Stonehill Drive is a 2-span cast-in-place prestressed concrete box girder bridge. The existing bridge is 29.26 meters (96 feet) wide and 65.84 meters (216 feet) long. The existing bridge pier is 0.76 meters (2.5 feet) thick. The proposed 20-meter bridge lengthening would maintain the same bridge section and general characteristics of the existing bridge. One of

the existing bridge abutment would be replaced by a new bridge pier, and a new abutment would be built at the new terminus point of the bridge.

The existing Metrolink Bridge is a 3-span steel girder bridge set on top of the concrete piers and abutments. The existing bridge is 5.38 meters (17.67 feet) wide on the western two spans and 5.84 meters (19.17 feet) wide on the eastern span. The total length of the existing bridge is 92.86 meters (304.67 feet). The existing bridge piers are 2.13 meters (7 feet) at the top and 2.74 meters (9 feet) at the river invert, approximately. The proposed 20-meter bridge lengthening would maintain the same bridge section and general characteristics of the existing bridge. One of the existing bridge abutment would be replaced by a new bridge pier, and a new abutment would be built at the new terminus point of the bridge.

The existing bridge at Camino Capistrano is a 2-span cast-in-place prestressed concrete box girder bridge. The existing bridge is 27.74 meters (91 feet) wide and 82.91 meters (272 feet) long. The existing bridge pier is 0.61 meters (2 feet) thick. The proposed 20-meter bridge lengthening would maintain the same bridge section and general characteristics of the existing bridge. One of the existing bridge abutment would be replaced by a new bridge pier, and a new abutment would be built at the new terminus point of the bridge.

3.7   CS-1

3.7.1   Description

This alternative proposes to construct 1-foot drop structures along San Juan Creek between Pacific Coast Highway Bridge and just upstream of the Canada Gobernadora Creek confluence and includes a total of seven (7) drop structures. This process would improve the channel invert stability and protect it from scouring in non-improved or natural reaches. Each drop structure would be a "Pool and Riffle" type structure. See Section 2.2.1 for structural details.

3.7.2   Engineering Considerations

The approximate station locations of seven (7) 1-foot high drop structures were determined in the Hydraulic Appendix. Then, depending on existence of side-drains, tributaries, and other features, the actual locations have been moved small distances. The balancing between cut and fill earthwork quantities in placing the structures was the main driving factor to decide the elevations of all seven structures. The proposed channel bottoms, or pools, created between the drop structures, would begin from Pacific Coast Highway Bridge to just upstream of the confluence with Canada Gobernadora Creek near Station 235+00. The stability slope analysis was not performed for San Juan Creek for this feasibility study. The pool slopes between the structures vary from 0.0036 to 0.0068 (meter/meter).

The depth of the stabilizer of a drop structure consists of the ultimate scour depth and 1.8 meters (6 feet) of additional depth to protect the structure. The ultimate scour depth was estimated based on the assumption of vertical drops and failure of riprap. The ultimate scour depths were calculated, using the following equation:

$$D = 1.32 * H^{0.225} * q^{0.54}$$

where D is the ultimate scour depth in feet, H is the elevation of drop in feet, and q is the unit discharge in cubic feet per second per foot. The average toe-down depth of 6.9 meters was used for a soil cement stabilizer, which had a 1.8 meters (6 feet) of additional depth already added.

The maximum velocities over the structures range from 5 to 6 meters per second, calling for grouted stone. The stone on the slope would be hand-placed to minimize the appearance of the grout and approximately 8 meters long down to the beginning of a scour pad. A series of larger stones would be set to the side of each structure to create a series of stepped pools through which low flows could cascade and provide for fish passage up the structures. The riprap scour pads were estimated to be 10 meters long for San Juan Creek and, as already stated, assumed to fail and the components are likely to end up at the downstream after a large-scale storm.

The current plan for the San Juan Creek pool and riffle sequences include seven structures summarized in Table 3.5.

Table 3.5   Drop Structure Dimensions on San Juan Creek

Structure #	Station Upstream Edge (m)	Top Bank Left (m)	Top Bank Right (m)	Riffle Width (m)	Existing Channel Elevation (m)	Improved Downstream Elevation (m)	Improved Upstream Elevation (m)
1	122+00	25.0	25.0	49.0	9.1	9.35	9.7
2	138+50	25.0	25.0	69.9	15.7	15.85	16.2
3	152+00	26.0	27.6	68.2	23.4	23.2	23.55
4	182+00	45.0	44.4	78.0	39.5	39.85	40.2
5	204+00	58.5	58.9	245.0	54.5	55.3	55.65
6	212+00	67.3	72.2	139.0	60.2	61.55	61.9
7	233+50	77.9	78.7	80.2	69.8	69.55	69.9

For the side-slope stabilization of San Juan Creek, the reach upstream of Antonio Parkway is in its natural condition with an abundance of low flat banks where trees and vegetation already exist. From downstream of Antonio Parkway to I-5 Bridge, the Creek becomes narrower, and the residential communities exist on both sides of the banks, except for the golf course immediately upstream of I-5. This reach also consists of at least one side bank flatter than 3H:1V slope, installed already for vegetation to grow. The downstream of I-5 Bridge is a concrete-lined

trapezoidal channel with 2H:1V slopes. No ecosystem measure would be applied within this reach.

3.8   CS-2

3.8.1   Description

This alternative proposes the construction of a total of fourteen (14) 1-meter high drop structures along Trabuco Creek between the terminus of concrete trapezoidal channel near Station 117+00 and Metrolink SCRRA Bridge at Station 137+00. This process would improve the channel invert stability and protect it from scouring in non-improved or natural reaches. Each drop structure would be a "Pool and Riffle" type structure. See Section 2.2.1 for structural details.

3.8.2   Engineering Considerations

The approximate station locations of fourteen (14) 1-meter high drop structures were determined in the Hydraulic Appendix. Then, depending on existence of side-drains, tributaries, and other features, the actual locations have been moved small distances. It was also determined that the minimum distance between two structures (measured from the top of one stabilizer to another) would be 50 meters. The proposed with-project channel bottom starts from the top of the 6-meter steep natural invert drop, located just downstream of Metro Link SCRRA Bridge near Station 137+00, and extends downstream to the terminus of the concrete-lined reach at Station 116+75. Because the proposed invert elevation of San Juan Creek was lower than that of Trabuco Creek at their confluence, with-project conditions of Trabuco Creek was not directly affected by that of San Juan Creek. The stability slope analysis was performed for Trabuco Creek and determined to be 0.002 (meter/meter).

Near Stations 128+78 and 129+47, the drop structures would be placed over the existing dirt access road and/or horse trails across the channel bottom. These roads would be rerouted or replaced, if necessary.

The depth of the stabilizer of drop structures was calculated through the same procedure and assumptions as those of the San Juan Creek stability analysis, described in Section 3.7.2. The average toe-down depth of 6.8 meter was used for a soil cement stabilizer, which had 1.8 meters (6 feet) of additional depth already added.

The maximum velocities over the structures range from 5 to 6 meters per second, calling for grouted stone. The stone on the slope would be hand-placed to minimize the appearance of the grout and approximated 20 meters long down to the beginning of a scour pad. A series of larger stones would be set to the side of each structure to create a series of stepped pools through which low flows could cascade and provide for fish passage up the structures. The riprap scour pads

were estimated to be 15 meters long for Trabuco Creek and, as already stated, assumed to fail and the components are likely to end up downstream after a large-scale storm.

The current plan for the Trabuco Creek pool and riffle sequences include fourteen structures summarized in Table 3.6.

Table 3.6   Drop Structure Dimensions on Trabuco Creek

Structure #	Station Upstream Edge (m)	Top Bank Left (m)	Top Bank Right (m)	Riffle Width (m)	Existing Channel Elevation (m)	Improved Downstream Elevation (m)	Improved Upstream Elevation (m)
1	118+39	33.9	33.5	78.1	29.1	28.3	29.3
2	119+46	36.0	39.0	102.2	29.5	29.48	30.48
3	122+31	38.2	36.6	31.0	31.3	31.02	32.02
4	124+49	37.5	40.0	27.6	32.5	32.41	33.41
5	128+10	41.0	43.8	68.7	34.7	34.09	35.09
6	128+78	41.5	42.7	68.0	35.4	35.19	36.19
7	129+47	41.4	43.0	109.5	35.9	36.29	37.29
8	131+53	45.6	44.0	85.8	37.2	37.66	38.66
9	133+15	52.4	42.2	128.3	37.8	38.94	39.94
10	133+84	49.5	41.81	107.4	38.1	40.04	41.04
11	134+52	48.0	41.5	82.3	38.3	41.14	42.14
12	135+21	47.7	43.0	72.5	38.5	42.23	43.23
13	135+91	47.3	44.5	82.3	38.7	43.33	44.33
14	136+63	44.6	44.1	44.6	41.1	44.44	45.44

For the side-slope stabilization of Trabuco Creek, the entire reach, analyzed in this alternative, is in the natural condition. The bank slopes are already flatter than 3H:1V, and no additional grading would be required for revegetation of banks. The concrete lined reach is not included for the stabilization.

3.9   CS-3

3.9.1   Description

This alternative proposes both the construction of drop structures and side-slope grading along Oso Creek between the Trabuco confluence and just downstream of the double box culverts at Station 121+70 near the Schuler Property. Implementation of eleven (11) drop structures would improve the channel invert stability and protect it from scouring in non-improved or natural reaches. Each drop structure is the same type of structure, previously mentioned for CS-1 and CS-2. In addition, the process of bank side-slope grading to 3H:1V slope would reduce erosion potential on otherwise steep creek banks (approximately 1.5H:1V in some places) and would allow the installation of restoration measure to establish riparian and upland habitats.

3.9.2   Engineering Considerations

The approximate station locations of eleven (11) 1-meter high drop structures were determined in the Hydraulic Appendix. Then, depending on existence of side-drains, tributaries, and other features, the actual locations have been moved small distances. The two major constraints for vertical tie-ins for the proposed channel invert elevation were the downstream tie-in at the Trabuco Creek confluence, at approximately 43.5 meters, and the upstream tie-in at the downstream face invert of 4.3 meters by 4.57 meters double box culverts at Station 121+70. Thus, if future study affects the proposed channel invert for Trabuco, that of Oso creek would also be redesigned to reflect the impacts. The locations of the structures also reflect the efforts to protect the Schuler Property near the culverts. It was also determined that the minimum distance between two structures (measured from the top of one stabilizer to another) would be 50 meters.

The depth of the stabilizer of drop structures was calculated through the same procedure and assumptions as those of the Trabuco stability analysis, described in Section 3.8.2. The average toe-down depth of 6.8 meter was used for a soil cement stabilizer, which had 1.8 meters (6 feet) of additional depth already added.

The maximum velocities over the structures range from 5 to 6 meters per second, calling for grouted stone. The stone on the slope would be hand-placed to minimize the appearance of the grout and approximated 20 meters long down to the beginning of a scour pad. A series of larger stones would be set to the side of each structure to create a series of stepped pools through which low flows could cascade and provide for fish passage up the structures. The riprap scour pads were estimated to be 15 meters long for Oso Creek and, as already stated, assumed to fail and the components are likely to end up at the downstream after a large-scale storm.

The current plan for the Oso Creek pool and riffle sequences include fourteen structures summarized in Table 3.7.

Table 3.7   Drop Structure Dimensions on Oso Creek

Structure #	Station Upstream Edge (m)	Top Bank Left (m)	Top Bank Right (m)	Riffle Width (m)	Existing Channel Elevation (m)	Improved Downstream Elevation (m)	Improved Upstream Elevation (m)
1	110+30	60.7	60.9	12.3	46.1	44.94	45.94
2	111+00	61.3	61.7	8.3	46.5	46.02	47.02
3	113+00	61.9	63.3	7.2	47.8	47.29	48.29
4	115+91	62.5	62.0	11.5	49.1	48.69	49.69
5	116+61	62.3	62.9	14.4	48.3	49.77	50.77
6	117+31	60.7	62.8	13.0	51.0	50.84	51.84
7	118+00	59.1	62.7	11.1	52.4	51.92	52.92
8	118+71	62.3	62.8	9.7	53.3	52.99	53.99
9	119+41	65.5	62.9	13.0	54.6	54.07	55.07
10	120+11	64.9	62.9	14.9	55.5	55.14	56.14
11	121+10	63.3	63.0	10.4	56.8	56.26	57.26

Oso Creek is an unlined and natural creek with very high top of banks on both sides and side slopes that are as steep as 1.5H:1V in some locations. For the side-slope stabilization measure, the entire reach would be graded so either side of the banks is 3H:1V for plants and vegetation to grow. The lateral limit of the top of banks depends on the existing utility lines, structures, and availability of lands, and the determination of side to be graded must be evaluated accordingly. The ecosystem grading for the reach upstream of Station 116+50 needs to be performed on the right bank because the existing Metro Link SCRRA runs in very close proximity of Oso Creek on the left bank, even though the Schuler Property is located on the right bank. Filter fabric and Armoflex would cover the newly graded areas for re-vegetation from the proposed invert to the top of bank. In most of cases, flattening the side-slopes has the effect of shifting the stream invert, and the result actually straightens the current meander pattern. In terms of stream stabilization, the modified section would reduce erosion potential by slowing stream velocities and lowering unit discharges.

The excavated materials from the side-slope stabilization would be more than enough to be used as fill materials for the proposed with-project channel bottom near the Trabuco Creek confluence area, which otherwise would have required a huge amount of imported dirt material.

4.   PRELIMINARY COST ESTIMATES

Total project costs for each alternative include 20 percent contingency, Engineering and Design (E & D), and Supervision and Administration costs (S & A). Real estate costs are not included in this analysis. Tables 4.1 through 4.5 represent the Preliminary Cost Estimates for the Flood Control Alternatives (FC) 2 through 6, respectively. Tables 4.6 through 4.8 also represents the Preliminary Cost Estimates for the Channel Stability Alternatives (CS) 1 through 3. This opinion is based on the A-E's best professional judgment and experience and does not guarantee that

proposals, bids, or actual Total Project or Construction Costs will not vary from the Preliminary Cost Estimates.

5.   REFERENCES

State of California, Department of Transportation, (CALTRANS), January 1988. *Standard Plans*

U.S. Army Corps of Engineers, April 1995. *Structural Design of Concrete Lined Flood Control Channels*, EM 110-2-2007, Los Angeles District, California

Table 4.1				Preliminary Cost Estimates for Alternative FC-2	
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
San Juan Creek Channel					
Floodwall:					
Concrete floodwall (= or < 2m high)	M^3	4,349	$393.00	$1,709,160	
Concrete floodwall (> 2m high)	M^3	2,865	$523.00	$1,498,527	
Bridge Replacement:					
Pacific Coast Highway (PCH) Bridge	M^2	2640	$1,614	$4,260,960	
La Novia Avenue Bridge	M^2	672.75	$1,076	$723,879	
Construction Subtotal				$8,192,526	
Contingency	20%			$1,638,505	
Total Construction Cost				**$9,831,032**	
Engineering and Design	9%			$884,793	
Construction Inspection and Administration	6%			$589,862	
Total -San Juan Creek Channel				**$11,305,686**	
Trabuco Creek Channel					
Floodwall:					
Concrete floodwall	M^3	485	$393.00	$190,441	
Bridge Replacement:					
Del Obispo Street Bridge	M^2	953	$1,076	$1,025,697	
Construction Subtotal				$1,216,138	
Contingency	20%			$243,228	
Total Construction Cost				**$1,459,365**	
Engineering and Design	9%			$131,343	
Construction Inspection and Administration	6%			$87,562	
Total - Trabuco Creek Channel				**$1,678,270**	
Total - Alternative FC-2				**$12,983,957**	

Table 4.2	Preliminary Cost Estimates for Alternative FC-3				
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
San Juan Creek Channel					
Floodwall:					
Concrete floodwall (= or < 2m high)	M^3	3,804	$393.00	$1,495,022	
Concrete floodwall (> 2m high)	M^3	1,023	$523.00	$534,827	
Bridge Replacement:					
Pacific Coast Highway (PCH) Bridge	M^2	2640	$1,614	$4,260,960	
La Novia Avenue Bridge	M^2	672.75	$1,076	$723,879	
Detention basin:					
Dam Earthwork:					
Excavation	M^3	349,010	$4.94	$1,724,111	RSM, 21 cy scraper, 900 m haul
Structural fill with compaction (on-site)	M^3	296,933	$3.03	$899,707	
Structural fill with compaction (import)	M^3	346,182	$13.37	$4,628,455	
Common fill with compaction (on-site)	M^3	52,077	$2.21	$115,091	
Riprap protection on both sides of dam (0.46m thick, D50 = 0.3m)	M^3	17,366	$52.32	$908,602	
Spillway:					
Concrete lining on spillway	M^3	3,914	$177	$693,232	
Stilling Basin:					
Excavation	M^3	13,284	$4.94	$65,623	
Concrete lining on stilling basin	M^3	2,148	$180.00	$386,661	
Concrete retaining wall along stilling basin	M	120	$1,747	$209,587	6.1m high, 3.18m base, 0.46m thick
Riprap protection at the end of stilling basin (0.9m thick, D50 = 0.61m)	M^3	2,697	$47.09	$126,979	
Box Culvert:					
Double 3.66m x 2.74m (12' x 9') Box culverts	M	127	$697	$88,457	
Construction Subtotal				$16,861,192	
Contingency	20%			$3,372,238	
Total Construction Cost				**$20,233,431**	
Engineering and Design	9%			$1,821,009	
Construction Inspection and Administration	6%			$1,214,006	
Total -San Juan Creek Channel				**$23,268,445**	
Trabuco Creek Channel					
Floodwall:					
Concrete floodwall	M^3	484	$393.00	$190,132	
Bridge Replacement:					
Del Obispo Street Bridge	M^2	953	$1,076	$1,025,697	
Construction Subtotal				$1,215,829	
Contingency	20%			$243,166	

Table 4.2		Preliminary Cost Estimates for Alternative FC-3				
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks	
Total Construction Cost				**$1,458,995**		
Engineering and Design	9%			$131,310		
Construction Inspection and Administration	6%			$87,540		
Total -Trabuco Creek Channel				**$1,677,844**		
Total - Alternative FC-3				**$24,946,289**		

Table 4.3			Preliminary Cost Estimates for Alternative FC-4		
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
San Juan Creek Channel					
Floodwall:					
Concrete floodwall (= or < 2m high)	M^3	3,508	$393.00	$1,378,811	
Concrete floodwall (> 2m high)	M^3	1,305	$523.00	$682,295	
Bridge Replacement:					
Pacific Coast Highway (PCH) Bridge	M^2	2640	$1,614	$4,260,960	
La Novia Avenue Bridge	M^2	672.75	$1,076	$723,879	
Construction Subtotal				$7,045,945	
Contingency	20%			$1,409,189	
Total Construction Cost				**$8,455,134**	
Engineering and Design	9%			$760,962	
Construction Inspection and Administration	6%			$507,308	
Total - San Juan Creek Channel				**$9,723,404**	
Trabuco Creek Channel					
Floodwall:					
Concrete floodwall	M^3	97	$393.00	$38,160	
Bridge Replacement:					
Del Obispo Street Bridge	M^2	953	$1,076	$1,025,697	
Detention basin:					
Dam Earthwork:					
Excavation	M^3	397,863	$4.94	$1,965,445	RSM, 21 cy scraper, 900 m haul
Structural fill with compaction (on-site)	M^3	339,452	$3.03	$1,028,539	
Structural fill with compaction (import)	M^3	356,545	$13.37	$4,767,003	
Common fill with compaction (on-site)	M^3	58,412	$2.21	$129,090	
Riprap protection on both sides of dam (0.46m thick, D50 = 0.3m)	M^3	24,390	$52.32	$1,276,107	
Spillway:					
Concrete lining on spillway	M^3	2,475	$177	$438,339	
Stilling Basin:					
Excavation	M^3	8,050	$4.94	$39,769	
Concrete lining on stilling basin	M^3	1,432	$180.00	$257,774	
Concrete retaining wall along stilling basin	M	120	$1,747	$209,587	6.1m high, 3.18m base, 0.46m thick
Riprap protection at the end of stilling basin (0.9m thick, D50 = 0.61m)	M^3	1,798	$47.09	$84,652	
Box Culvert:					
Single 3.66m x 2.74m (12' x 9') Box culvert	M	110	$412	$45,350	

Table 4.3			Preliminary Cost Estimates for Alternative FC-4			
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
Construction Subtotal				$11,305,512	
Contingency	20%			$2,261,102	
Total Construction Cost				**$13,566,614**	
Engineering and Design	9%			$1,220,995	
Construction Inspection and Administration	6%			$813,997	
Total - Trabuco Creek Channel				**$15,601,606**	
Total - Alternative FC-4				**$25,325,010**	

Table 4.4   Preliminary Cost Estimates for Alternative FC-5

Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
San Juan Creek Channel					
Floodwall:					
Concrete floodwall (= or < 2m high)	M^3	2,435	$393.00	$957,033	
Concrete floodwall (> 2m high)	M^3	1,062	$523.00	$555,446	
Bridge Replacement:					
Pacific Coast Highway (PCH) Bridge	M^2	2640	$1,614	$4,260,960	
La Novia Avenue Bridge	M^2	672.75	$1,076	$723,879	
Detention basin:					
Dam Earthwork:					
Excavation	M^3	349,010	$4.94	$1,724,111	RSM, 21 cy scraper, 900 m haul
Structural fill with compaction (on-site)	M^3	296,933	$3.03	$899,707	
Structural fill with compaction (import)	M^3	346,182	$13.37	$4,628,455	
Common fill with compaction (on-site)	M^3	52,077	$2.21	$115,091	
Riprap protection on both sides of dam (0.46m thick, D50 = 0.3m)	M^3	17,366	$52.32	$908,602	
Spillway:					
Concrete lining on spillway	M^3	3,914	$177	$693,232	
Stilling Basin:					
Excavation	M^3	13,284	$4.94	$65,623	
Concrete lining on stilling basin	M^3	2,148	$180.00	$386,661	
Concrete retaining wall along stilling basin	M	120	$1,747	$209,587	6.1m high, 3.18m base, 0.46m thick
Riprap protection at the end of stilling basin (0.9m thick, D50 = 0.61m)	M^3	2,697	$47.09	$126,979	
Box Culvert:					
Double 3.66m x 2.74m (12' x 9') Box culverts	M	127	$697	$88,519	
Construction Subtotal				$16,343,885	
Contingency	20%			$3,268,777	
Total Construction Cost				**$19,612,662**	
Engineering and Design	9%			$1,765,140	
Construction Inspection and Administration	6%			$1,176,760	
Total - San Juan Creek Channel				**$22,554,561**	
Trabuco Creek Channel					
Floodwall:					
Concrete floodwall	M^3	97	$393.00	$38,160	
Bridge Replacement:					
Del Obispo Street Bridge	M^2	953	$1,076	$1,025,697	
Detention basin:					
Dam Earthwork:					

Table 4.4	Preliminary Cost Estimates for Alternative FC-5					
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
Excavation	M³	397,863	$4.94	$1,965,445	RSM, 21 cy scraper, 900 m haul
Structural fill with compaction (on-site)	M³	339,452	$3.03	$1,028,539	
Structural fill with compaction (import)	M³	356,545	$13.37	$4,767,003	
Common fill with compaction (on-site)	M³	58,412	$2.21	$129,090	
Riprap protection on both sides of dam (0.46m thick, D50 = 0.3m)	M³	24,390	$52.32	$1,276,107	
Spillway:					
Concrete lining on spillway	M³	2,475	$177	$438,339	
Stilling Basin:					
Excavation	M³	8,050	$4.94	$39,769	
Concrete lining on stilling basin	M³	1,432	$180.00	$257,774	
Concrete retaining wall along stilling basin	M	120	$1,747	$209,587	6.1m high, 3.18m base, 0.46m thick
Riprap protection at the end of stilling basin (0.9m thick, D50 = 0.61m)	M³	1,798	$47.09	$84,652	
Box Culvert:					
Single 3.66m x 2.74m (12' x 9') Box culvert	M	110	$412	$45,320	
Construction Subtotal				$11,305,482	
Contingency	20%			$2,261,096	
Total Construction Cost				**$13,566,578**	
Engineering and Design	9%			$1,220,992	
Construction Inspection and Administration	6%			$813,995	
Total - Trabuco Creek Channel				**$15,601,565**	
Total - Alternative FC-5				**$38,156,126**	

Table 4.5			Preliminary Cost Estimates for Alternative FC-6		
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
San Juan Creek Channel Widening					
Earthwork:					
Demolition of existing concrete lining	M³	19,218	$25.00	$480,455	Toe-down 2.13m (7') deep (Ex.)
Excavation	M³	647,969	$5.73	$3,712,865	RSM, Front end loader, 16,000 m haul (round trip)
Structural fill with compaction (on-site)	M³	78,089	$3.03	$236,610	
Common fill with compaction (on-site)	M³	117,902	$2.21	$260,563	
Concrete lining (proposed)	M³	34,354	$182.00	$6,252,352	Toe-down 3.05m (10') deep (Proposed)
Bridge Replacement/Modification:					
Replacement:					
Pacific Coast Highway (PCH) Bridge	M²	2640	$1,614	$4,260,960	
La Novia Avenue Bridge	M²	672.75	$1,076	$723,879	
Modification:					
Stonehill Drive Bridge	M²	585.2	$2,152	$1,259,350	
Metrolink Bridge	M²	122	$2,152	$262,544	
Camino Capistrano Bridge	M²	554.8	$2,152	$1,193,930	
Construction Subtotal				$18,643,508	
Contingency	20%			$3,728,702	
Total Construction Cost				**$22,372,209**	
Engineering and Design	9%			$2,013,499	
Construction Inspection and Administration	6%			$1,342,333	
Total - San Juan Creek Channel Widening				**$25,728,041**	
Trabuco Creek Channel Widening					
Earthwork:					
Demolition of existing concrete lining	M³	5,583	$25.00	$139,581	Toe-down 2.13m (7') deep (Ex.)
Excavation	M³	127,052	$5.73	$728,009	RSM, Front end loader, 16,000 m haul (round trip)
Structural fill with compaction (on-site)	M³	592	$3.03	$1,793	
Common fill with compaction (on-site)	M³	29,909	$2.21	$66,098	
Concrete lining (proposed)	M³	6,481	$182.00	$1,179,511	Toe-down 3.05m (10') deep (Proposed)
Bridge Replacement:					
Del Obispo Street Bridge	M²	953	$1,076	$1,025,697	
Construction Subtotal				$3,140,689	
Contingency	20%			$628,138	
Total Construction Cost				**$3,768,827**	
Engineering and Design	9%			$339,194	
Construction Inspection and Administration	6%			$226,130	

Table 4.5		Preliminary Cost Estimates for Alternative FC-6			
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
Total - Trabuco Creek Channel Widening				**$4,334,151**	
Total - Alternative FC-6				**$30,062,192**	

Table 4.6			Preliminary Cost Estimates for Alternative CS-1		
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
Alternative CS-1 - San Juan Creek Stabilization Plan					
Earthwork:					
Clearing and Stripping	Ha.	112	$6,420	$716,525	
Excavation	M^3	233,145	$6.50	$1,515,443	RSM, 14 cy scraper, 1500 m haul
Place, shape, and compact fill	M^3	201,964	$4.00	$807,855	
Soil Cement Cutoff:					
Excavate and stockpile	M^3	64837	$1.85	$119,949	FE Loader
SC installed	M^3	21503	$45.12	$970,211	Soil Cement @ $12/cy and $85/ton cement, 14% by weight
Structural backfill with compaction	M^3	43335	$3.25	$140,837	
Riffle Structures:					
Armorflex revetment	M^2	2781	$65.50	$182,136	Vendor quote on unit price
Handplaced grouted riprap (0.9m thick, D50 = 0.45m) on riffle slopes	M^2	4366	$89.25	$389,677	Includes setting large stone for fish pools
Dumped riprap (0.9m thick, D50 = 0.45m) on scour pads	M^2	8426	$42.00	$353,885	
Filter fabric	M^2	2781	$2.40	$6,674	
Revegetate side slopes	Ha.	0.3	$78,750	$21,898	Typical price by TTISG/COE
Construction Subtotal				$5,225,089	
Contingency	20%			$1,045,018	
Total Construction Cost				**$6,270,107**	
Engineering and Design	9%			$564,310	
Construction Inspection and Administration	6%			$376,206	
1-year cost to establish vegetation	Ha.	0.3	$62,000	$17,240	Water tubes @ $12,350/ha/trip x 5 trips/year
Total Management Alternative CS-1				**$7,227,864**	
Annual Maintenance:					
Road clean up 1-day/year on average				$1	
Fish Passage/ Culvert inspection and clean out				$2,000	2 laborers @ 4 days twice a year
Exotic species control	Ha.	0.3	$500	$139	
Total Annual Maintenance CS-1				**$2,140**	

Table 4.7			Preliminary Cost Estimates for Alternative CS-2		
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
Alternative CS-2 - Trabuco Creek Stabilization Plan					
Earthwork:					
Clearing and Stripping	Ha.	15	$6,420	$93,094	
Excavation	M³	42,677	$6.50	$277,400	RSM, 14 cy scraper, 1500 m haul
Place, shape, and compact fill	M³	55,153	$4.00	$220,611	
Soil Cement Cutoff					
Excavate and stockpile	M³	84812	$1.85	$156,901	FE Loader
SC installed	M³	32203	$45.12	$1,453,002	Soil Cement @ $12/cy and $85/ton cement, 14% by weight
Structural backfill with compaction	M³	52608	$3.25	$170,977	
Riffle Structures:					
Armorflex revetment	M²	10695	$65.50	$700,523	Vendor quote on unit price
Handplaced grouted riprap (0.9m thick, D50 = 0.45m) on riffle slopes	M²	19988	$89.25	$1,783,923	Includes setting large stone for fish pools
Dumped riprap (0.9m thick, D50 = 0.45m) on scour pads	M²	15479	$42.00	$650,128	
Filter fabric	M²	10695	$2.40	$25,668	
Revegetate side slopes	Ha.	1.1	$78,750	$84,223	Typical price by TTISG/COE
Construction Subtotal				$5,616,451	
Contingency	20%			$1,123,290	
Total Construction Cost				**$6,739,741**	
Engineering and Design	9%			$606,577	
Construction Inspection and Administration	6%			$404,384	
1-year cost to establish vegetation	Ha.	1.1	$62,000	$66,309	Water tubes @ $12,350/ha/trip x 5 trips/year
Total Management Alternative CS-2				**$7,817,011**	
Annual Maintenance:					
Road clean up 1-day/year on average				$1	
Fish Passage/ Culvert inspection and clean out				$2,000	2 laborers @ 4 days twice a year
Exotic species control	Ha.	1.1	$500	$535	
Total Annual Maintenance CS-2				**$2,536**	

Table 4.8		Preliminary Cost Estimates for Alternative CS-3			
Description	Unit	Total Project Quantity	Unit Cost	Total Project Cost	Remarks
Alternative CS-3 - Oso Creek Stabilization Plan					
Earthwork:					
Clearing and Stripping	Ha.	2	$6,420	$15,956	
Excavation	M^3	9,922	$6.50	$64,491	RSM, 14 cy scraper, 1500 m haul
Place, shape, and compact fill	M^3	34,496	$4.00	$137,984	
Soil Cement Cutoff					
Excavate and stockpile	M^3	11982	$1.85	$22,166	FE Loader
SC installed	M^3	3836	$45.12	$173,100	Soil Cement @ $12/cy and $85/ton cement, 14% by weight
Structural backfill with compaction	M^3	8145	$3.25	$26,472	
Riffle Structures:					
Armorflex revetment	M^2	17839	$65.50	$1,168,438	Vendor quote on unit price
Handplaced grouted riprap (0.9m thick, D50 = 0.45m) on riffle slopes	M^2	2165	$89.25	$193,204	Includes setting large stone for fish pools
Dumped riprap (0.9m thick, D50 = 0.45m) on scour pads	M^2	1542	$42.00	$64,753	
Filter fabric	M^2	17839	$2.40	$42,813	
Revegetate side slopes	Ha.	1.8	$78,750	$140,480	Typical price by TTISG/COE
Ecosystem Measure:					
Clearing and Stripping	Ha.	3.6	$6,419.75	$23,073	
Excavation	M^3	101,995	$5.15	$525,274	RSM, FE Loader, 2 mile haul round trip
Armorflex revetment	M^2	35940.6	$65.50	$2,354,112	Vendor quote on unit price
Filter fabric	M^2	35940.6	$2.40	$86,258	
Revegetate side slopes	Ha.	3.6	$78,750	$283,033	
Construction Subtotal				$5,321,606	
Contingency	20%			$1,064,321	
Total Construction Cost				**$6,385,927**	
Engineering and Design	9%			$574,733	
Construction Inspection and Administration	6%			$383,156	
1-year cost to establish vegetation	Ha.	5.4	$62,000	$333,432	Water tubes @ $12,350/ha/trip x 5 trips/year
Total Management Alternative CS-3				**$7,677,248**	
Annual Maintenance:					
Road clean up 1-day/year on average				$1	
Fish Passage/ Culvert inspection and clean out				$2,000	2 laborers @ 4 days twice a year
Exotic species control	Ha.	5.4	$500	$2,689	
Total Annual Maintenance CS-3				**$4,690**	

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