ALISO CREEK SUPER PROJECT
CONCEPT PLAN REPORT

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EXECUTIVE SUMMARY

Multiple studies have been performed in the Aliso Creek Watershed with various objectives depending on the agency preparing the report. The discussion of what are the priority projects for implementation (stream stabilization, water quality, recreation, etc.) varies depending on the mission statement of that agency.

The County of Orange Resources and Development Management Department (RDMD) Watershed and Coastal Resources Division requested that an expedited study be performed to evaluate alternatives for restoration of stream stability. The findings of the study were reviewd by a Technical Review Committee (TRC). The TRC included representatives from Surfrider Foundation, the City of Laguna Beach, the County of Orange, Moulton Niguel Water District (MNWD), Athens Group, South Orange County Wastewater Authority (SOCWA), and SOKA University. Comments from the TRC review as well as comments obtained through the public review were incorporated into this final version of the concept plan report.

This study focuses on stream stability as a priority project goal. Other project goals include reducing the beach postings at the mouth of Aliso Creek and improvement of the terrestrial restoration. This project has been identified as the Aliso SUPER (**S**ablization, **U**tility **P**rotection, and **E**nvironmental **R**estoration) Project.

Three stream stability alternatives were considered. The recommended solution, Alternative 3B, incorporates a series of grade control structures to stabilize the channel gradient. A total of twenty-four (24) 2-foot high drops are proposed with buried riprap protection placed along the utility corridor east of the main channel. Relatively low drop heights were selected to provide a sustainable solution that provides maximum reconnection of the channel and the adjacent floodplain as well as stability to the channel invert. The low profile also allows for further attention to aesthetics which consider the wilderness park setting. Protection at the utility corridor allows the low flow channel to meander in a natural state while still ensuring that the adjacent infrastructure is not in jeopardy from erosion. As part of the stabilization effort and to provide terrestrial restoration, floodplain restoration through exotic vegetation removal and revegetation is recommended. Alternative 3B meets the project goal of providing stream stability.

To meet the secondary goal of improvement of water quality improvement at the beach, a water quality project is recommended that would divert the low flow out of Aliso Creek at Pacific Coast Highway, treat the water to remove the bacteria which causes human health risks, and return the treated flow to the creek.

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The project cost for the Recommended Alternative is $43,967,600.

The Recommended Alternative consists of the stream stabilization project and associated floodplain and riparian restoration and the water quality project. It is recognized that additional projects are needed to complement the SUPER project in order to attain a holistic solution for the watershed. These additional projects include watershed-wide best management practices, beach outlet restoration, invasive removal outside of project footprint, public education, and recreation enhancements. The County intends to pursue the additional projects separate from the SUPER project.

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1.0 Introduction

1.1 Purpose

The Aliso Creek watershed is located in southern Orange County, California. The lower reach of the creek passes through the Aliso and Wood Canyons Wilderness Park. This is one of the few remaining large land reserves within a heavily urbanized area that has not been directly altered by development. The surrounding floodplain and upland area have been maintained largely in their natural condition. The Wilderness Park is heavily used by the public and is a tourist destination. The Wilderness Park is adjacent to the beach, another significant recreation area.

Historically, the watershed has experienced a variety of human-induced changes that have had adverse environmental and economic impacts. Large scale urbanization that began in the 1960s has led to a dramatic decline in the watershed stability and a trend of degradation in the Aliso Creek channel. Concern for the health of the watershed is in part based on the postings that are intermittently placed at the beach which identify potential health issues associated with water contact at the beach. These health risks are associated with the poor water quality in Aliso Creek.

The underlying premise of this study effort is that stability of the Aliso Creek channel is a fundamental need in the watershed. Once the stream is stabilized other investments, such as floodplain and riparian restoration and recreation, can be made with reasonable certainty that those investments can be sustained.

1.2 Study Area

Aliso Creek runs in a general north to south direction from its headwaters in the Cleveland National Forest’s Santiago Hills to the outlet at the Pacific Ocean near South Laguna Beach. The total stream length is approximately 19.5 miles. The project study area is limited to the reach from the Aliso Water Management Agency (AWMA) Road bridge to the Coastal Treatment Plant (CTP), a total stream length of 3.5 miles. The project study area is shown on Figure 1.

Though the stability of Aliso Creek has been altered by upstream development, the channel has not been directly altered. Unlike most streams in the area, including much of Aliso Creek upstream of the project area, Aliso Creek has not be channelized, realigned, placed in a concrete channel or heavily armored. Of equal significance is that its floodplain and surrounding uplands

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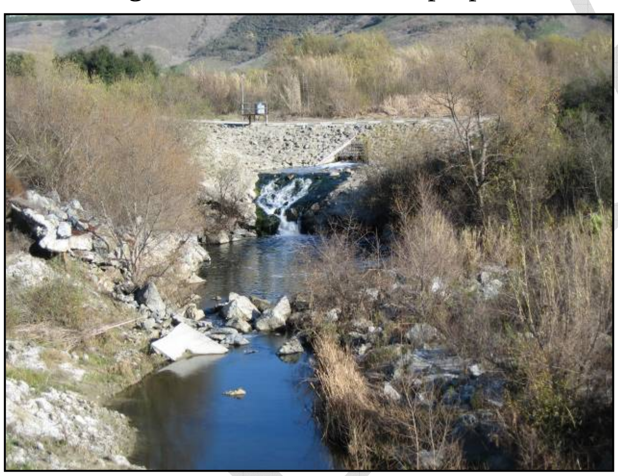
have not been developed. The only significant manmade features on Aliso Creek within the project study area are listed below.

Drop Structures near Aliso Creek Road: These drop structures are 10 feet high and are located 700 feet south and 1,000 feet north of Aliso Creek Road.

Aliso Creek Wildlife Habitat Enhancement Project (ACWHEP): ACWHEP, located near the center of the Aliso and Woods Canyon Wilderness Park, was a mitigation bank project. The project created new wetlands and enhanced existing marshland. A large headgate structure was constructed which captured Aliso Creek flows and rerouted water to downstream terraces planted with various riparian species. The ACWHEP project ultimately caused erosion problems due partially to improper design of the headgate structure and general channel degradation occurring in the channel. The irrigation lines are currently broken and no longer convey water to the terraces.

CTP Bridge: A bridge located at the South Orange County Wastewater Authority (SOCWA) coastal treatment plant (CTP) provides access to the plant from AWMA Road. It is the main access for the operations of the plant. Repair work has been done at the bridge to repair damage done during storm erosion. The riprap and concrete sill is visible in the channel bed.



Looking upstream at ACWHEP

Bank Protection under bridge at CTP

1.3 Previous Study Efforts

Two large studies that have been performed within this watershed are discussed below. These studies are largely focused on stream stability and water quality. The U.S. Army Corps of Engineers Watershed Management Study included both stream stability and water quality with

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an overall purpose for improvement of environmental and economic conditions in the watershed. The Aliso Creek 13225 Directive Quarterly Reports focused solely on water quality.

1.3.1 U.S. Army Corps of Engineers Watershed Management Study

In July 1999 the U.S. Army Corps of Engineers completed the Aliso Creek Watershed Management Feasibility Study. This study was sponsored by the Corps, County of Orange, and municipalities and water districts within the Aliso Creek watershed boundary. A wide range of technical studies were completed as part of the Feasibility Study. These studies, listed below, were relied on as the background information for the current study. These studies included:

- Hydrologic and Hydraulic Studies
- Geomorphic and Sedimentation Studies
- Social Studies
- Economic Studies
- Environmental Studies
- Cultural Resources Studies
- Geotechnical Studies
- Regulatory Studies
- Institutional Studies

The Feasibility Study identified watershed problems as well as watershed opportunities. The main problems identified included instability of Aliso Creek channel and associated erosion damages, poor water and environmental quality, and flooding damages.

In order to address the problems in the watershed, a range of structural and non-structural solutions were identified. The following Plan Components from the Feasibility Study are relevant to the current project area:

Plan Component A: Lower Aliso Creek Stabilization Plan
Located between the CTP and the AWMA Road Bridge. Includes 1) management measures of constructing a series of low riprap drop structures for grade control and reestablishment of aquatic habitat connectivity, 2) shaving of side slopes to reduce vertical banks, 3) riparian revegetation, and 4) restoration of floodplain moisture.

Plan Component I: Modification of Existing Drop Structures Plan
Located at the existing drop structure above AWMA Road bridge. Features include notching the crests of both 10-foot concrete structures to reduce solar gain by preventing shallow pooling of low flows.

Plan Component K: Spin-off Bank Stabilization Study (South Orange County Wastewater Authority Coast Treatment Plant Bridge)

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Located at the access bridge to the SOCWA Treatment Plant. Features include: 1) invert protection under the bridge and installation of downstream cutoff wall, 2) remove/protect abandoned sewer line under the creek to avoid breaching.

Plan Component M: Watershed Education Plan

Located throughout the watershed at schools in all communities. Features include 1) coordinated public outreach program, 2) K-12 curriculums specific to the Aliso Creek Watershed, 3) hands-on field exercises for restoration and monitoring, 4) development of stewardship for the watershed.

1.3.2 San Diego Regional Water Quality Control Board 13225 Directive

In 2001 the San Diego Regional Water Quality Control Board (Regional Board) issued a directive pursuant to California Water Code Section 13225 (Directive) to the County of Orange, Flood Control District, and Cities within the Aliso Creek Watershed. The Directive called for an investigation of high bacterial levels in urban runoff in the Aliso Creek Watershed. The directive requires weekly monitoring of bacterial indicators and quarterly progress reports.

As a result of the monitoring requirements, a large body of water quality information has been generated relative to bacteria levels in urban runoff in the Aliso Creek Watershed. Analysis of the monitoring data show that the bacteria levels in the runoff in the storm drain and in parts of Aliso Creek exceed the established limits for contact and non-contact recreational uses. Contact and non-contact recreational use are considered beneficial uses within this watershed.

Continued efforts to address the high bacteria levels in the Aliso Creek Watershed are underway. These efforts include regular facility inspections; cleaning and maintenance of catch basins, storm drains, and channels; additional structural and non-structural BMP implementation, and evaluation of the effectiveness of existing BMPs

1.4 Scope of Current Study Efforts

As discussed previously, the purpose of this study is to identify 3 alternatives within the study area that meet the following project goals:

Primary Project Goals: *Stream Stability*

Secondary Project Goals: *Improve Surface Water Quality to Prevent Beach Postings and Improve Terrestrial Restoration.*

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This project is identified as the Aliso Creek SUPER (Stabilization, Utility Protection, and Environmental Restoration) Project. This current study relies on existing information and field investigations to develop the alternatives. A field investigation was held on January 11, 2006 with County of Orange and Tetra Tech staff to review the existing field conditions. Many of the staff for the current study had been involved in the previous Aliso Creek watershed study and restoration feasibility investigations conducted in the late 1990s and had extensive experience with the watershed and stream.

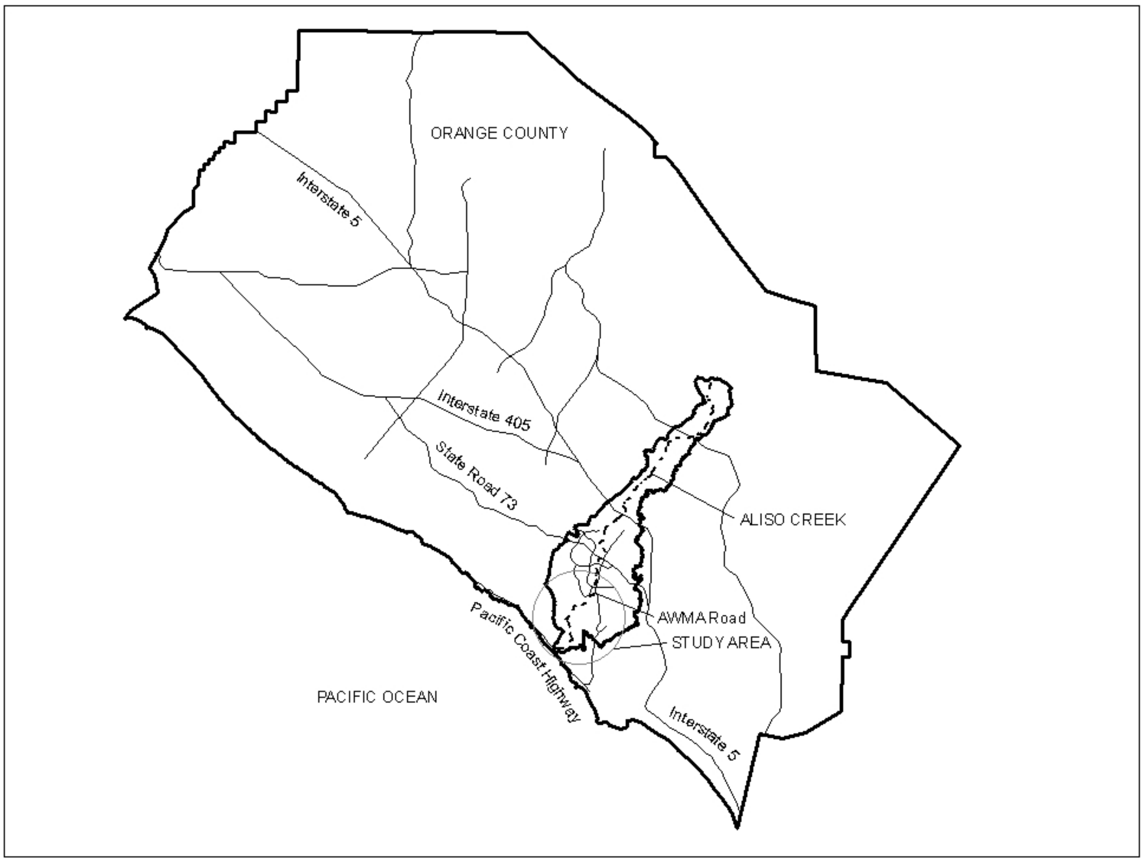

Figure 1. Study Area Location

2.0 Stream Stability Alternatives

This chapter presents a discussion of the stream stability, the factors contributing to the current condition, and potential approaches to restore stability. Three conceptual alternatives employing the stream stabilization approaches are then presented.

2.1 Stream Stability Overview

As stream stability is a primary goal of this project it is useful to review the stability of the stream, the factors that have lead to its current condition and the overall strategies that can be implemented to restore stream stability.

2.1.1 Stream Stability Assessment

Severe erosion of Aliso Creek in the project area regularly threatens adjacent infrastructure. This includes water lines, sewer lines and roadways. The erosion causes emergency situations for which emergency measures are put in place to protect the infrastructure. However, these measures have proven to be temporary. The erosion has also resulted in failure of the wetlands mitigation effort associated with ACWHEP and necessitated periodic maintenance of the grade control facility that at one time served as the water diversion for ACWHEP. Additionally, the erosion has degraded the riparian corridor in terms of its environmental quality. This includes dewatering of overbank areas due to the incised channel and rapid erosion of vegetation adjacent to the channel as the channel widens and shifts locations.

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Channel erosion downstream of ACWHEP

To assess the magnitude of the steam stability problems, previous studies were reviewed and a field visit made to assess the existing geomorphic conditions. This work resulted in the conclusion that significant channel incision of the Aliso Creek through the project area has occurred since 1971. This incision has been as much as 20 feet between 1971 and 1998 (Simons, Li and Associates 1999). Incision has continued since 1998 to present as evidenced by additional undermining of the ACWHEP grade control. Channel incision or downcutting has also resulted in widening of the channel topwidth as banks erode and collapse.

The channel incision is not uniform throughout the project area. There are two locations acting as controls in which the incision propagates upstream. The two control points are the bridge crossing and concrete sill at the CTP (Note: There may be a geologic control in this area that plays a role in the stability as the channel flows against the left side of the valley, but this was not evaluated during the current investigation) and the ACWHEP grade control. Degradation at these locations does not occur as the vertical location of the channel is fixed. However, channel incision upstream of these controls has resulted in two wedges of sediment eroded within the project area. The downstream wedge runs from about a quarter mile upstream of the CTP to the base of the ACWHEP structure. The second wedge runs from the ACWHEP structure to Sulphur Creek confluence. Each of these areas represents a triangularly wedge of sediment that increases in volume as the depth of channel incision increases in the upstream direction. An estimate of the volume of material eroded from the bed and banks of Aliso Creek through the project area was not available in past studies. A rough estimate based on cross sections provided by SLA (1999) indicates that on the order of 5,000 to 15,000 cubic yards of sand may have been eroded per year, on the average, from 1971 to 1998.

Channel incision is a process that once initiated tends to feed upon itself, will not reverse itself, and can often accelerate during the initial stages, until major changes in the stream morphology are realized. This is a result of the increase in capacity to convey floods as the channel incises. As a result, rather than the channel spilling its high flows onto the adjacent floodplain and dissipating much of the energy of the flow during flood events, larger and larger floods are confined to the main channel as incision continues. This causes an increase in shear stress and the ability of the stream to transport sediments. These factors in turn cause the flow to more readily erode the bed and banks. Eventually, the channel may establish a new equilibrium state at a lower elevation after it has widened, eroded a new inset floodplain, and possibly reduced its slope and contacted geologic controls that limit further degradation. This process is referred to as the Channel Evolution Model for incised channels and is presented in Schumm et al. (1984).

Review of historic cross sections (Simons, Li and Associates 1999) show that in the area just downstream of ACWHEP, the channel has incised nearly 20 feet and the channel width has doubled between 1971 and 1998. The channel widths in 1971 ranged from 55 to 70 feet and in 1998 from 110 to 140 feet. Based on observations during the field visit, the channel incision process is still in its early stages and will continue into the future. Similar changes in channel width have occurred in the upstream incision area near the Sulphur Creek confluence, though the channel incision since 1971 is less at about 10 to 12 feet.

Insight into the potential equilibrium condition of the Aliso Creek channel can be gained by looking at the evolution of the stream immediately above the ACWHEP structure. When the structure was installed in the early 1990s its crest was placed above the thalweg of Aliso Creek. Since that time, sediment has deposited in the pool and a new channel has formed in the deposition zone above the ACWHEP structure. The new channel has a slope of approximately 0.15 percent or 8 feet per mile. This new channel slope is considered to be in equilibrium with the current sediment supply. This assumption will require verification through sediment transport studies during later project phases. The new assumed equilibrium slope has been established for approximately a quarter of a mile upstream of the ACWHEP grade control. This is in contrast to the current channel slope between the CTP Bridge and ACWHEP of 0.35 percent or 18 feet per mile. To reach the equilibrium slope the channel between the CTP Bridge and ACWHEP would need to incise an additional 20 feet or more. Therefore the potential for continued degradation of the Aliso Creek channel exists. It is likely that as the channel continues to incise it will hit geologic controls or the bank heights will become such that their failure happens even more rapidly. At this point, incision would slow or stop and channel widening and bank erosion would accelerate. This is the third stage in the incised Channel Evolution Model (Schumm et al. 1984). In either case, the deviation from the apparent equilibrium slope indicates a high potential for continued channel instabilities in the Aliso Creek project area.

Aliso Creek channel upstream of ACWHEP

2.1.2 Influences on Stream Stability

The primary cause of channel instability on Aliso Creek in the project area is believed to be the development of the watershed. This development has occurred in large part from the 1960s to the present. Two factors associated with development and contributing to the incision of Aliso Creek are increased flows and reduced sediment supply. The increased flows are the result of development adding impervious areas to the watershed, reducing the infiltration capacity in other locations, and increasing the speed at which runoff is concentrated and conveyed through the watershed. The increased runoff is manifested in both larger peaks and greater volumes. These factors result in increasing the capacity of the stream to transport sediment. The second factor, reduction in sediment supply, is the result of covering the erodible surface of the watershed with nonerodible surfaces such as buildings and roads or much less erodible surfaces such as lawns.

The consequence of these two factors, the increase in sediment transport capacity and reduction in sediment supply, work in combination to create a sediment deficit. A sediment deficit refers to the supply of sediment being less than the inherent capacity of the stream to sediment. When this occurs, the stream erodes the bed and banks to satisfy its capacity to transport sediment. As a result of the alterations caused by development of the watershed, a significant sediment deficit has been created on Aliso Creek. The manifestation of impacts from the sediment deficit has been rapid and dramatic because the sandy material comprising the bed and banks are readily eroded.

Development in the Aliso Creek watershed increased from 8 percent in 1968 to 74 percent by 1998 (Simons, Li and Associates 1999). Nearly all the available land has been built out with the only significant undeveloped areas being in the Cleveland National Forest and the Aliso and Wood Canyon Wilderness Park. Therefore, most of the impacts of development on both sediment supply and flow magnitudes have been realized. Consequently, the factors that created the sediment deficit are not expected to significantly intensify and the current estimated equilibrium slope is appropriate for the conceptual design effort.

2.1.3 Strategies to Restore Stream Stability

The approach to restoring the stability of Aliso Creek relies on adjusting the channel to exhibit the 0.15% equilibrium slope. A reduction in the slope can be achieved by either increasing the channel length or decreasing the amount of fall. Initial investigations have indicated that increasing the channel length sufficiently to produce a channel gradient of less than half the current gradient would not be feasible. This approach would require a sinuosity of over 2.2

which would be infeasible considering the width of the valley floor and the historic channel form. The alternative approach, and the one adopted, is to reduce the effective fall in the channel by providing energy dissipation structures. *(Note: In future design iterations, the potential to increase the sinuosity by some degree to reduce the number of grade controls can be explored. The current scenario represents the highest cost approach and provides a good basis for the initial cost estimate.)*

The overall strategy is to provide a sufficient number of structures that result in reducing the effective gradient to 0.15 percent. In addition to reducing the gradient, the structures function to control the grade and limit the potential for any further degradation. The grade controls also provide a location where the channel has a high degree of lateral stability. Therefore, they also assist in reducing future channel migration and in preventing damage to the infrastructure at the valley margins.

An additional component of the stream stabilization effort involves reconnecting the channel to its floodplain. This will be accomplished by devloping a main channel that will start going overbank at a typical discharge on the order of the 2-year event. For purposes of the conceptual design, the 2-year flow of 1,600 cfs was used to size the channel. The reconnection to the floodplain helps reduce the sediment transport capacity, and thus the tendency for the channel to degrade, and promotes a healthy riparian corridor. With a reconnected floodplain, the overbank areas can support a more diverse community of riparian vegetation and one of larger aerial extent. The potential for wetlands to develop and be supported will greatly increase.

To provide the project with a higher level of sustainability, the grade controls will have buried extensions traversing the floodplain. This will reduce the likelihood that the channel will avulse, and if conditions caused the channel to avulse away from the grade control, incision of a new channel would still be limited by the extensions of the grade control.

Two approaches to the implementation of the grade controls are investigated. One approach is to use grade controls with large vertical differences on the order of 6 feet. This approach requires the fewest grade controls and the primary advantage may be in cost savings. The second approach is to use more numerous but lower height grade controls with drops on the order of 2 feet. Though construction costs for grade controls may be higher, this approach has a higher level of sustainability and higher environmental benefits. There are two primary factors that increase the sustainability of the lower grade control option. First of all, with the more numerous and closer spaced grade controls, if the equilibrium slope reduces further in the future, the amount of degradation between grade controls will be small since the reduced slope only

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propagates over a distance on the order of one third that associated with the large grade controls. Secondly, the larger grade controls create a much greater discontinuity in the floodplain that increases the potential energy available, and the likelihood, for creating a channel avulsion around the grade control.

The increased number of grade controls also provides locations where the channel horizontal alignment is defined. This may partially mitigate the increased cost of the more numerous grade controls by reducing the expense associated with bank and utility protection.

In terms of lateral stability of the channel, two approaches are evaluated. The first relies on stabilizing the channel in place using stone toe protection and bioengineered upper bank protection. The second approach limits the amount of bank protection and instead provides a line of buried riprap protection adjacent to the utility corridor. This protection will limit the lateral migration of the channel from reaching the utilities, but will still allow the channel to exhibit some dynamic lateral behavior.

2.1.4 Discussion of Potential Influence of Stream Stabilization on Area Beaches

The channel stabilization and stream corridor restoration activities on Aliso Creek will significantly reduce bank erosion and channel degradation in the project area. Though the restoration activities greatly benefit the stream and riparian corridor, they will result in a reduction in sediment supply to Aliso Beach. It is important to consider the potential influence of the restoration effort on Aliso Creek and the other beaches along the south coast of Orange County. This section discusses the role of bank erosion and channel downcutting in the overall sediment budget for Aliso Creek and in the sediment budget for the beaches of southern Orange County.

The report, “Aliso Creek Environmental Restoration Study, Final Hydraulics and Sedimentation Documentation” (Simons, Li and Associates 1999) provides estimates of the sand transport for individual storm events. In the reaches through the project area the report indicates sand transport on the order of 6,000 cubic yards, 13,000 cubic yards and 21,000 cubic yards for the 2-, 10- and 100-year events, respectively. Average annual sediment yield would be expected to be greater than the yield for a 2-year event and possibly comparable to the 10-year event yield. This would place the average annual sand yield on the order of 13,000 cubic yards per year. The report “Sediment Budget Analysis Dana Point to Newport Bay, California” (USACE 1997) estimates the average annual contribution of sand sized sediment from Aliso Creek to the littoral zone at 12,000 cubic yards. The estimate was based on a reduction of the 18,600 cubic yards per year estimate developed in "Comprehensive Coastal Study of Crescent Bay, Laguna Beach, California" (USACE 1996).

Erosion from the bed and banks of Aliso Creek appears to represent a significant and possibly the majority of the sand contribution that Aliso Creek delivers to the beach. This contribution was estimated to be on the order of 5,000 to 15,000 cubic yards per year. To understand the significance of the sand contribution from Aliso Creek bed and bank erosion and the influence a reduction in this sediment source could have on the beach, a review of the coastal processes and sediment budget for the littoral zone is informative. The report "Coast of California Storm and Tidal Waves Study South Coast Region Orange County" (USACE 2002) and the various studies that were compiled to develop the report provide this information.

Aliso Beach lies in a 14 mile littoral cell that lies between Newport Bay and Dana Point Harbor. It is comprised of 23 pocket beaches that represent mini littoral cells that are separated by headlands and rocky points. These beaches are in dynamic equilibrium and have remained stable over the past 50 years. The long-term alongshore transport of sand is from northwest to southeast or Newport Harbor to Dana Point.

The sediment budget presented in USACE (1997) reports estimates of sediment sources to the 23 mini-cells in terms of seacliff erosion and watershed contributions. The total annual seacliff continuation is reported as 7,920 cubic yards per year while the watershed contribution is estimated at 18,180 cubic yards per year. Based on these estimates, the 12,000 cubic yard contribution from Aliso Creek is two thirds of the total watershed contribution and almost 50 percent of the total sand contribution to the system. The influence on the alongshore sand transport estimates of the Aliso Creek sand delivery can be seen in reviewing the estimates for alongshore sand transport for the 23 beaches. To the northwest, the alongshore sand transport between the mini-cells ranges from less than 100 cubic yards per year to just over 3,000 cubic yards per year. At Aliso Beach, the alongshore supply from the northwest is estimated at 3,069 cubic yards per year and the alongshore transport from Aliso Beach to Thousand Steps Coast to the south east is 14,417 cubic yards per year. This level of alongshore transport is estimated to continue to Dana Point where alongshore sand flux is estimated at 15,209 cubic yards per year.

Though there is a high level of uncertainty as to the exact values of the components comprising the beach sand budget, it is apparent that the contribution of sand from the accelerated erosion of the bed and banks of Aliso Creek is a significant factor in the budget. A reduction in this component by stabilizing the bed and banks of the creek will alter this budget. However it is unknown as to what if any impact this may have on Aliso Beach and the six pocket beaches to

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the southeast. It may be that the pocket beaches are relatively insensitive to the supply of sediment. Looking at the pocket beaches to the northwest, the budget indicates they receive only about 20 to 25 percent of the sand flux as compared to the beaches to the southeast of Aliso Creek, but these northwest beaches exist in a similar state as the beaches to the southeast. It is possible that most of the beaches of the southern Orange County coast are at or very near their natural holding capacity. The beaches may be at their critical slopes which results in them passing sediment delivered to them without significant storage. Under this condition it may be possible that the large contribution of sand from Aliso Creek may not be necessary to maintain the beaches. On the other hand, a large reduction in sand from Aliso Creek could result in passing below the threshold of sand supply such that the beaches to the southeast would respond by narrowing.

On a broader scale, the level of current sand supply from the erosion of the banks and degradation of the bed of Aliso Creek is not a natural condition. Changes in watershed conditions brought about by development have created the channel incision on Aliso Creek. The stream has responded to these changes by eroding its banks and degrading its bed. Not only are these two processes extremely detrimental to one of the few undeveloped reaches of coastal stream in the area, but it is also not sustainable. At some point, the channel incision and widening process will allow the stream to evolve into an equilibrium channel at a new base level. This sequence of events is explained in the channel evolution model for incised channels (Schumm et al. 1984). Through this process, in the next several decades to a century, a wider and flatter channel will develop that is in equilibrium with the flows and sediment supply from the developed watershed. When the equilibrium condition is reached, the sediment supply from Aliso Creek will be similar to the reduced supply that would result from the channel stabilization and restoration effort. Consequently, if adverse impacts on the beaches result from the stream stabilization project, similar adverse impacts would be realized in the future when the new equilibrium channel developed. Beach nourishment would be required if these impacts were to be avoided.

The previous discussion provided an overview of the sediment budget for Aliso Beach and the other south Orange County beaches along with the potential for the Aliso Creek restoration effort to alter that balance. There is currently insufficient information to evaluate whether there would be an impact to the beaches from reducing the amount of sediment supplied to the coast from erosion of Aliso Creek. To better evaluate if there would be impacts, additional analyses would be required. These may include:

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- An accurate determination of the volume of sediment removed from the bed and banks of Aliso Creek in the past several decades
- Determination of the portion of the eroded Aliso Creek material that is sand
- Evaluation of the sediment transport capacity for the restored channel
- Evaluation of the future watershed sediment supply
- Determination of the sensitivity of Aliso Beach and the beaches south to Dana Point to a reduced sediment supply
- Determination of the feasibility and cost of beach nourishment if necessary to avoid a reduction in beach widths.

2.2 Alternatives

Three alternatives were formulated that would achieve the goal of stream stability by restoring an equilibrium slope and reconnecting the floodplain. The first two alternatives rely on large (6-foot) grade control structures to stabilize the channel gradient. Large grade control structures are generally more cost effective than smaller structures because the number of structure can be reduced. Alternative 1 locates the structures downstream of ACWHEP. Alternative 2 spaces the structures more evenly between the CTP and the Sulphur Creek confluence. In Alternative 3 small (2-foot) drop structures are used to stabilize the slope.

Each alternative includes two options to protect the utility lines. Option A uses stone protection to lock the channel in place to prevent it from migrating toward the utility corridor and causing erosion. Option B allows the channel to migrate and provides erosion protection at the utility corridor.

Appendix A includes the plan and profile sheets for each of these alternatives.

2.2.1 Alternative 1 – 6-foot Grade Control Structures to ACWHEP

This alternative uses grade control structures to provide overall stream stability. Eight (8) 6-foot high grade control structures will be located along Aliso Creek from the CTP to the ACWHEP structure. The location of the grade control structures will allow an equilibrium slope to be constructed between each grade control structure. The equilibrium slope of 0.15% will provide a channel geometry that will allow for conveyance of the water and sediment in the creek without

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the persistent erosion that is currently experienced along the creek. In this alternative the existing ACWHEP structure would remain in place. Two (2) additional 6-foot grade control structures will be located downstream of the Aliso and Sulphur Creeks confluence. Construction of the equilibrium slope upstream of these grade control structures will restore the eroded section of the creek downstream of AWMA Road Bridge and prevent any undermining of that bridge.

Construction of the grade control structures and equilibrium slope will involve significant fill in the channel downstream of ACWHEP. This infilling will cause the floodplain to be reconnected with the main channel which will allow more frequent inundation of that adjacent floodplain downstream of ACWHEP. Upstream of ACWHEP to the AWMA Road Bridge reconnection to the floodplain will be achieved through grading (soil removal) of the floodplain banks.

2.2.1.1 Grade Control Structures

Each of the proposed grade control structures in this alternative has a total height of 6 feet. The grade control structures consist of a 15-foot deep soil cement structure that spans the creek from AWMA Road to the maintenance road, a 120-foot long by 3-foot thick grouted stone slope at 5%, a 60-foot long by 5-foot deep stilling basin at the end of the slope, and articulated concrete revetment along both sides of the bank. The structure will drop 6 feet over a channel length of 120 feet and be built at a 5% slope. The stilling basin at the end of the slope will dissipate energy and reduce the velocities. The plans included in Appendix A show the layout of this structure.

Future design efforts should include further investigation of more aesthetic treatments for the grade control structures. Ordinary grouted rock allows a significant amount of concrete to show, such as at ACWHEP (see photograph in Section 2.2). An alternative is to use a low grout line in which the rocks are not completely covered with grout and following the placement the concrete is cleaned off the visible portions of the rock. This type of treatment has a higher aesthetic value and a higher construction cost. The following sketch shows a conceptual appearance of the grade control structure with the low grout line.

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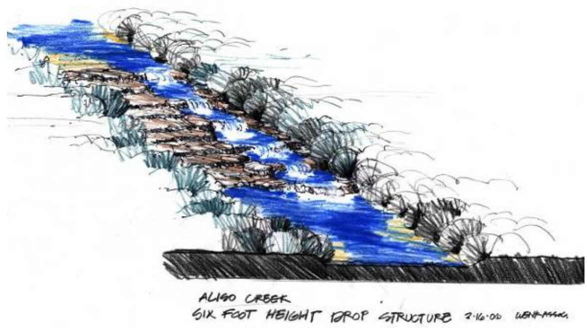

Channel section with 6-foot grade control structure

2.2.1.2 <u>Utility Protection</u>

Two variations within this alternative will provide for protection of the utilities located within the maintenance road east of the main channel. Alternative 1A locks the low flow channel in place through placement of rock at the toe of the channel and soil wraps above the rock. The stone toe / soil wrap protection would be placed along the low flow channel from the CTP to AWMA Road Bridge, a total channel length of nearly 3.2 miles. The stone would be placed to a height of 2 feet and a depth of 5 feet below the constructed grade. The soil wraps would provide an additional 3 feet of channel height above the stone. By locking the channel in place it would prevent the channel from migrating laterally and cause erosion damage to the adjacent utility corridor.

Alternative 1B protects the utility and maintenance road through placement of buried rock along the length of the maintenance road on the east side of the creek from the CTP to Alicia Parkway. The low flow channel is allowed to migrate laterally but would encounter hard bank protection if it gets close to the utility corridor. Placement of the buried riprap would require significant earthwork efforts and other options such as placing a windrow of rock for launching was briefly examined. The amount of rock required for launching would be considerable and would still require a fair amount of earthwork especially to bury the rock for aesthetic and environmental purposes. This option of rock placement should be examined further in future designs. The total length of the buried riprap wall is approximately 3 miles. This alternative allows more natural geomorphic processes and floodplain interaction.

In future design phases alternatives to buried riprap, such as biotechnical streambank stabilization, will be investigated and considered.

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2.2.1.3 Fish Passage

The fish for which fish passage will be designed is the steelhead or rainbow/cutthroat trout. These fish can swim up slopes at a maximum of 8%; however, hydraulic diversity/shadows such as from boulders are required at steep slopes. The proposed grade control structure has a slope of 5%. Future design efforts would need to incorporate features along that structure that provide hydraulic diversity (such as resting pools) and boulders along the face of the structure to allow for fish passage. No fish passage considerations were given to warm water fisheries.

2.2.1.4 Alternative Cost

The total cost of Alternative 1A is $26,050,200. The total cost of Alternative 1B is $25,748,400. Appendix B includes a detailed breakdown of the cost estimate.

The cost estimate does not include the cost to pursue permitting of this project. A portion of the project lies within the coastal zone therefore a permit from California Coastal Commission will be needed. Extensive fill in the channel will require that an individual, rather than nationwide, 404 permit be obtained from the U.S. Army Corps of Engineers. Permits will also be required from California Department of Fish and Game and the Regional Water Quality Control Board.

2.2.2 Alternative 2 – 6-foot Grade Control Structures to Sulphur Creek

This alternative uses grade control structures to provide overall stream stability. Eleven (11) 6-foot high grade control structures will be located along Aliso Creek from the CTP to the confluence with Sulphur Creek. The location of the grade control structures will allow an equilibrium slope to be constructed between each grade control structure. The equilibrium slope of 0.15 percent will provide a channel gradient that will allow for conveyance of the water and sediment in the creek without the persistent erosion that is currently experienced along the creek. In this alternative the existing ACWHEP structure would be removed. Construction of the proposed channel slope will remediate the erosion along the entire channel, particularly downstream of ACWHEP and downstream of AWMA Road Bridge.

Construction of the grade control structures and equilibrium slope will involve significant fill in the channel. This infilling will cause the floodplain to be reconnected with the main channel which will allow more frequent inundation of that adjacent floodplain from the CTP to AWMA Road bridge.

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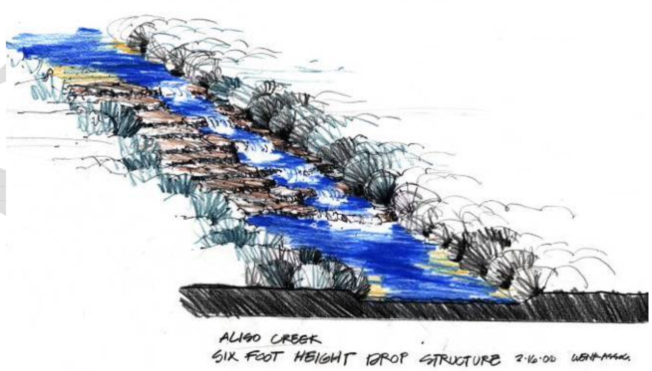
2.2.2.1 Grade Control Structures

The grade control structures are similar to those associated with Alternative 1 but in different locations. Each of the proposed grade control structures in this alternative has a total height of 6 feet. The grade control structures consist of a 15-foot deep soil cement structure that spans the creek from AWMA Road to the maintenance road, a 120-foot long by 3-foot thick grouted stone slope at 5%, a 60-foot long by 5-foot deep stilling basin at the end of the slope, and articulated concrete revetment along both sides of the bank. The structure will drop 6 feet over a channel length of 120 feet and be built at a 5% slope. The stilling basin at the end of the slope will dissipate energy and reduce the velocities. The plans included in Appendix A show the layout of this structure.

Future design efforts should include further investigation of more aesthetic treatments for the grade control structures. Ordinary grouted rock allows a significant amount of concrete to show, such as at ACWHEP (see photograph in Section 2.2). An alternative is to use a low grout line in which the rocks are not completely covered with grout and following the placement the concrete is cleaned off the visible portions of the rock. This type of treatment has a higher aesthetic value and a higher construction cost. The following sketch shows a conceptual appearance of the grade control structure with the low grout line.



Channel section with 6-foot grade control structure

2.2.2.2 Utility Protection

Two variations within this alternative will provide for protection of the utilities located within the maintenance road east of the main channel. Alternative 2A locks the low flow channel in place through placement of rock at the toe of the channel and soil wraps above the rock. The stone toe / soil wrap protection would be placed along the low flow channel from the CTP to AWMA Road Bridge, a total channel length of 3.2 miles. The stone would be placed to a height of 2 feet and a depth of 5 feet below the constructed grade. The soil wraps would provide an additional 3 feet of channel height above the stone.

Alternative 2B protects the utility and maintenance road through placement of buried rock along the length of the maintenance road on the east side of the creek from the CTP to Alicia Parkway. Placement of the buried riprap would require significant earthwork efforts and other options such as placing a windrow of rock for launching was briefly examined. The amount of rock required for launching would be considerable and would still require a fair amount of earthwork especially to bury the rock for aesthetic and environmental purposes. This option of rock placement should be examined further in future designs. The total length of the buried riprap wall is approximately 3 miles. This channel improvement allows the low flow channel to migrate naturally until it reaches the buried rock at which point further lateral migration would be impeded.

In future design phases alternatives to buried riprap, such as biotechnical streambank stabilization, will be investigated and considered.

2.2.2.3 Fish Passage

The fish for which fish passage will be designed is the steelhead or rainbow/cutthroat trout. These fish can swim up slopes at a maximum of 8%; however, hydraulic diversity/shadows such as from boulders are required at steep slopes. The proposed grade control structure has a slope of 5%. Future design efforts would need to incorporate features along that structure that provide hydraulic diversity (such as resting pools) and boulders along the face of the structure to allow for fish passage. No fish passage considerations were given to warm water fisheries.

2.2.2.4 Alternative Cost

The total cost of Alternative 2A is $27,291,142. The total cost of Alternative 2B is $29,039,947. Appendix B includes a detailed breakdown of the cost estimate.

The cost estimate does not include the cost to pursue permitting of this project. A portion of the project lies within the coastal zone therefore a permit from California Coastal Commission will be needed. Extensive fill in the channel will require that an individual, rather than nationwide, 404 permit be obtained from the U.S. Army Corps of Engineers. Permits will also be required from California Department of Fish and Game and the Regional Water Quality Control Board.

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2.2.3 Alternative 3 – 2-foot Grade Control Structures to ACWHEP

This alternative uses grade control structures to provide overall stream stability. Twenty-four (24) 2-foot high grade control structures will be located along Aliso Creek from the CTP to the ACWHEP structure. The location of the grade control structures will allow an equilibrium slope to be constructed between each grade control structure. The equilibrium slope of 0.15 percent will provide a channel geometry that will allow for conveyance of the water and sediment in the creek without the persistent erosion that is currently experienced along the creek. In this alternative the existing ACWHEP structure would remain in place. Two (2) additional 6-foot grade control structures will be located downstream of the Aliso and Sulphur Creeks confluence. Construction of the equilibrium slope upstream of these grade control structures will restore the eroded section of the creek downstream of AWMA Road Bridge and prevent future undermining of that bridge.

Construction of the grade control structures and equilibrium slope will involve significant fill in the channel downstream of ACWHEP. This infilling will cause the floodplain to be reconnected with the main channel which will allow more frequent inundation of that adjacent floodplain downstream of ACWHEP. Upstream of ACWHEP to the AWMA Road Bridge reconnection to the floodplain will be achieved through grading (soil removal) of the floodplain banks.

2.2.3.1 Grade Control Structures

The grade control structures downstream of ACWHEP will be 2-foot high and the 2 grade control structures upstream of ACWHEP near the Sulphur Creek confluence will be 6-foot high. The 2- foot grade control structures consist of a 10-foot deep soil cement structure that spans the creek from AWMA Road to the maintenance road, a 30-foot long by 3-foot deep stilling basin downstream of the soil cement, and stone protection along both sides of the bank. The two 6-foot grade control structures consist of a 15-foot deep soil cement structure that spans the creek from AWMA Road to the maintenance road, a 120-foot long by 3-foot thick grouted stone slope at 5%, a 60-foot long by 5-foot deep stilling basin at the end of the slope, and articulated concrete revetment along both sides of the bank. The structure will drop 6 feet over a channel length of 120 feet and be built at a 5% slope. The stilling basin at the end of the slope will dissipate energy and reduce the velocities. The plans included in Appendix A show the layout of this structure.

Future design efforts should include further investigation of more aesthetic treatments for the grade control structures. Ordinary grouted rock allows a significant amount of concrete to show,

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such as at ACWHEP (see photograph in Section 2.2). An alternative is to use a low grout line in which the rocks are not completely covered with grout and following the placement the concrete is cleaned off the visible portions of the rock. This type of treatment has a higher aesthetic value and a higher construction cost. The following sketch shows a conceptual appearance of the grade control structure with the low grout line.

Channel section with 2-foot grade control structure

2.2.3.2 Utility Protection

Two variations within this alternative will provide for protection of the utilities located within the maintenance road east of the main channel. Alternative 3A locks the low flow channel in place through placement of rock at the toe of the channel and soil wraps above the rock. The stone toe / soil wrap protection would be placed along the low flow channel from the CTP to AWMA Road Bridge, a total channel length of nearly 3.2 miles. The stone would be placed to a height of 2 feet and a depth of 5 feet below the constructed grade. The soil wraps would provide an additional 3 feet of channel height above the stone.

Alternative 3B protects the utility and maintenance road through placement of buried rock along the length of the maintenance road on the east side of the creek from the CTP to Alicia Parkway. Placement of the buried riprap would require significant earthwork efforts and other options such as placing a windrow of rock for launching was briefly examined. The amount of rock required for launching would be considerable and would still require a fair amount of earthwork especially to bury the rock for aesthetic and environmental purposes. This option of rock placement should be examined further in future designs. The total length of the buried riprap wall is approximately 3 miles. This channel improvement allows the low flow channel to migrate naturally until it reaches the buried rock at which point further lateral migration would be impeded.

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In future design phases alternatives to buried riprap, such as biotechnical streambank stabilization, will be investigated and considered.

2.2.3.3 Fish Passage

The fish for which fish passage will be designed is the steelhead or rainbow/cutthroat trout. Future design efforts would need to incorporate features along the grade control structure that allow for fish passage. Because of the relatively low height of the grade control structures, pools at the base of the drop may be the only requirement for the fish to jump over the structures. No fish passage considerations were given to warm water fisheries.

2.2.3.4 Alternative Cost

The total cost of Alternative 3A is $27,319,300. The total cost of Alternative 3B is $27,069,000. Appendix B includes a detailed breakdown of the cost estimate.

The cost estimate does not include the cost to pursue permitting of this project. A portion of the project lies within the coastal zone therefore a permit from California Coastal Commission will be needed. Extensive fill in the channel will require that an individual, rather than nationwide, 404 permit be obtained from the U.S. Army Corps of Engineers. Permits will also be required from California Department of Fish and Game and the Regional Water Quality Control Board.

2.3 Alternative Discussion and Recommendation

The basic difference between Alternative 1 and Alternative 2 is whether the ACWHEP structure is maintained and the location and number of 6-foot grade control structures needed to maintain the equilibrium slope. Alternative 2 is more cost efficient than Alternative 1. The savings on construction cost is approximately $650,000.

The basic difference between Alternative 1 and Alternative 3 is the use of 6-foot grade control structures or 2-foot structures to maintain an equilibrium slope. Alternative 1 is more cost effective than Alternative 3 with a savings of approximately $1,270,000. However there are other issues to consider when choosing between the 6-foot and 2-foot structures.

1. 2-foot structures are more sustainable because they provide for a continuous reconnection of the floodplain without a significant potential for reactivation of channel incision processes if one of the structures were flanked. With the six foot structures, if one structure is flanked, channel incision will proceed rapidly.

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2. The larger vertical difference over the 6 foot structures requires that all of the 100-year flood (or other design flow) to be routed thought the grade control structure and not out in the floodplain. In contrast, the 2-foot structures can allow flood flows to continue in the overbank past the structures.

3. Because of the closer spacing of the 2-foot grade control structures, they are less sensitive to changes in equilibrium slope. The amount of aggradation or degradation that would result from a change in equilibrium slope from the estimated 0.15 percent will be approximately three times greater for the 6 foot grade control structures since the distance between structures is three times that of the lower structures.

4. The 2-foot grade control structures will provide points of lateral channel stability at closer increments and may result in less need for bank protection to prevent the channel from migrating into the utility corridor.

5. It will be easier to incorporate fish passage at the 2-foot structures.

Because of the superior functionality of the 2-foot grade control structures over the 6-foot grade control structures, Alternative 3 is the recommended stream stability alternative.

2.4 Future Channel Design Considerations

For the conceptual level of design included in this report, several design considerations were not explored. Future design efforts should consider the following:

The proposed project will involve filling in many places in the current channel and floodplain and cutting in others; therefore, the actual channel will not be intact in much of the project reach. In the next level of design, the proposed channel alignment should be addressed in detail. Considerations would include the appropriate sinuosity (which could result in a reduction in the number of drops) and the proximity to the utility lines in combination with locations of the grade control structures. The grade controls should be placed so they help prevent channel migration into the utility corridor.

Some additional refinement of the grade control and channel geometry should be made. Grade controls should be placed at geomorphically correct planform locations. They should be in straight or crossings in the alignment and should not direct flows into bends. In addition, investigation of shaping the drop structure sill to allow some migration of the channel laterally at the sill for Option B. Sizing of the main channel should be given further consideration with the

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equilibrium channel that has formed upstream of the ACWHEP structures used as a reference channel.

Consideration of salvaging native vegetation such as willows and shrubs that are currently growing adjacent to the channel should be considered. Where compatible with designed floodplain elevations, the vegetation should be left in place. Where the vegetation will be eliminated by fill or excavation, transplanting the vegetation should be considered. Opportunities to incorporate desirable stands of existing vegetation should be investigated when developing the final alignment. Opportunities are limited by the amount of regrading that will occur in the floodplain.

Due to the amount of disturbed area resulting from channel excavation and filling and the removal of vegetation, the project will be susceptible to erosion in the first several years prior to the reestablishment of vegetation. Therefore, interim erosion control such as netting and mulching should be employed. It may also be desirable to perform temporary irrigation to increase the rate at which vegetation is established.

A scheme that passes flows around the project during construction in a lined ditch to perform dewatering with the ditch being able to serve as a delivery system for temporary irrigation of the project area after construction should be considered.

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3.0 Water Quality Alternatives

3.1 Water Quality Assessment

Beneficial Uses of Aliso Creek have been identified by the Regional Board to include the following:

Agricultural Supply (AGR) – Includes use of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering or support of vegetation for range grazing.

Contact Water Recreation (REC1) – A potential beneficial use that includes use of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible.

Non-contact Water Recreation (REC-2) – Includes the use of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible.

Warm Freshwater Habitat (WARM) – Includes uses of water that support warm water ecosystems.

Wildlife Habitat (WILD) – Includes uses of water that support terrestrial ecosystems.

Beneficial Uses at the mouth of Aliso Creek at the Pacific Ocean have been identified by the Regional Water Quality Control Board to include the following:

Contact Water Recreation (REC1) – A potential beneficial use that includes use of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible.

Non-contact Water Recreation (REC-2) – Includes the use of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible.

Wildlife Habitat (WILD) – Includes uses of water that support terrestrial ecosystems.

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Rare, Threatened, or Endangered Species (RARE) – Includes uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plan or animal species established under state or federal law as rare, threatened or endangered.

Marine Habitat (MAR) – Includes use of water that supports marine ecosystems.

The 303(d) list, published by the State Water Resources Control Board, identifies the following impairments to Aliso Creek that lead to negative impacts to the beneficial uses: (1) Bacteria Indicators, (2) Phosphorus – located at the lower 4 miles of Aliso Creek, and (3) Toxicity

3.1.1 Orange County Health Care Agency

Over the past 40 years, the Orange County Health Care Agency has been testing the coastal waters in Orange County for bacteria that indicate possible presence of human disease-causing organisms. Samples are collected weekly at approximately 150 ocean, bay, and drainage locations throughout coastal Orange County. Within the Aliso Creek Watershed, there are sample locations at the mouth of Aliso Creek and on Aliso Beach.

The exceedances of the regulatory standards for bacteria indicators at the Aliso Creek Watershed sample locations have led to postings of the beach at the mouth of Aliso Creek. The signage at a posted beach identifies the potential hazards to human health that can result from contact with the water at that location. During the 2004 calendar year along the 2 mile stretch of beach known as the Aliso County Beach and South Laguna Beach, postings were initiated on 6 occasions for a total of 8 days. In 2003, 11 postings were initiated over a total of 21 days.

3.1.2 Current Study Design Criteria

The water quality elements in the alternatives of this study focus on reduction of bacteria. Bacteria is included on the Regional Board 303(d) impairment list as a medium priority pollutant for TMDL development. High bacteria levels are responsible for the beach postings at Aliso Beach.

A review of monthly flow data from 1982-1987 at the Laguna gage indicates that in the dry season (May – September) a flow of 10 cfs is exceeded 17 days annually. Throughout the entire year this flow is exceeded 68 days annually. Water quality in the dry season tends to be of higher concern due to increased recreational use. Ten (10) cfs is equivalent to 6.5 MGD.

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3.2 End-of-Pipe Treatment Alternatives

The goal of the end-of-pipe treatment is to prevent or limit the beach postings seen at the beach near the Aliso Creek outlet. Because the recreational use of the beach occurs during the dry weather season, the project is focused on dry weather flows.

In order to assess the likelihood of reduction of beach postings if the Aliso Creek surface water is treated for bacteria, the 2005 data collected by the Orange County Health Care Agency was reviewed. Near the outlet of the creek samples are taken 2 times per week at the following stations: Treasure Island Pier, Treasure Island Sign, Aliso-North, Aliso-Middle, Aliso Beach (midpoint between Middle and South stations), and Aliso-South. At each of these locations the bacteria levels (fecal coliform, enterococcus, and total coliform) is compared against the following standard:

Table 1. AB 411 Bacteria Standard

Indicator	Single Sample (MPN)	30-day Geometric Mean (MPN)
Total coliform	10,000	1,000
Fecal coliform	400	200
Enterococcus	104	35

Based on this sampling and the above standards, several postings were made in 2005. For the posting occurrences, there is a 100% correlation between an exceedance in the creek and an exceedance in the surf zone. Therefore, there is a high degree of probability that removing bacteria from the creek will reduce the bacteria in the surf zone which will reduce or eliminate the beach postings.

While end-of-pipe bacteria treatment involves new technology, there are two local beach projects using this type of project: Salt Creek Beach in Dana Point and Moonlight Beach in Encinitas.

Salt Creek Beach is located approximately 2.6 miles south of Aliso Beach. In 2004 there were 13 postings for a total of 108 days over the 3 mile reach in the Salt Creek area. During this same time period there were 4 postings for a total of 6 days over the 2 mile reach in the Aliso Creek area. The treatment technology selected at Salt Creek is ozone. The Salt Creek Ozone Treatment Facility came online in the fall of 2005. Monitoring data at this point show excellent results with no postings at the Salt Creek Beach during the operation of the facility.

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A similar project at Moonlight Beach in the City of Encinitas which uses ultraviolet radiation to remove the bacteria has met with similar positive results and dramatic reductions in beach postings. It should be noted that while the bacteria kill rate of the water treated at the Moonlight Beach plant is in excess of 99%, the bacteria at the beach have not been reduced to the same levels. Studies are underway to investigate the cause of the increase in bacteria levels in the treatment plant effluent between the treatment plant outlet and the ocean. A likely contributor appears to be bacteria inputs as the creek water flows over the beach. The source of beach inputs are the wrack line and seagulls on the beach. These same conditions exist at the Aliso Beach. Since the Moonlight Beach facility has come online, beach postings have been reduced by 90%.

The correlation of the Aliso Creek bacteria exceedances with exceedances at the beach and the success of the Salt Creek Project and Moonlight Beach Project indicate that a bacteria treatment facility on Aliso Creek near its mouth at Aliso Beach is a viable solution to reducing or eliminating the beach postings.

The following end-of-pipe solutions were investigated to address the water quality:

- Alternative WQ#1 – Treat for TSS and Divert to Outfall
- Alternative WQ#2 – Treat for TSS and Bacteria and Return to Creek
- Alternative WQ#3 – Treat for TSS and Bacteria and Reuse

In each of these alternatives water is diverted out of Aliso Creek. Diversion occurs by damming up the flow and pumping it out of the creek. It is anticipated that this diversion would be temporary and capable of being removed during storm events, such as with the inflatable dams used for other low flow diversions in Orange County. The following figure shows a conceptual layout of the creek diversion and treatment facility.

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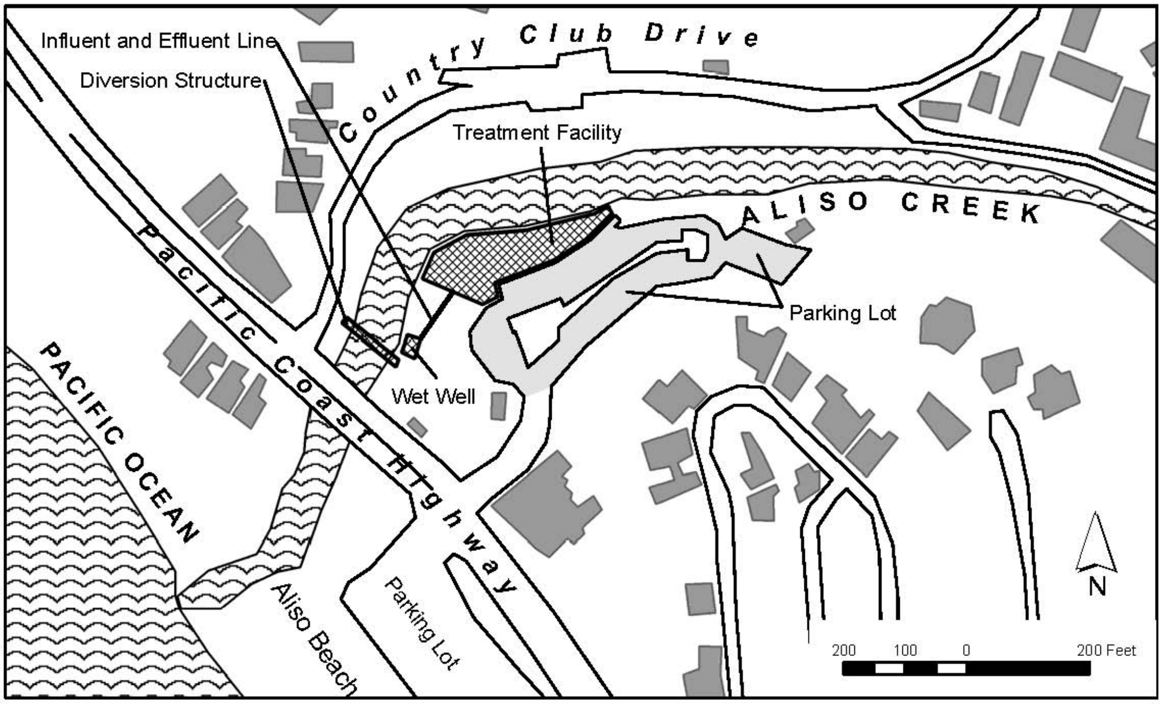

Figure 2. Conceptual Layout of Water Quality Treatment Facility

3.2.1 Alternative WQ-1 – Treat for TSS and Divert to Outfall

This alternative is based on diversion of the water from Aliso Creek just upstream of Pacific Coast Highway, treatment of the water to requirements of the NPDES Outfall Permit, and release into the South Orange County Wastewater Authority (SOCWA)/Aliso Creek Outfall.

3.2.1.1 Project Details

The SOCWA / Aliso Creek wastewater Ocean Outfall is located southwest from the mouth of Aliso Creek and outfalls 1 ½ miles offshore. This alternative includes diversion of the low flow Aliso Creek waters, which is typically of the lowest quality and impacts the beach during the high use summer months, to the existing SOCWA / Aliso outfall. The existing bacteria levels in the creek water are compatible with the permitted limits of the outfall. However, it is likely that the total suspended solids (TSS) will exceed the permit limits. Therefore, the diverted stormwater must first be treated in a new stormwater treatment plant before being conveyed into the ocean outfall. This treatment plant will be located in the County parking lot upstream of Pacific Coast Highway. A diversion structure will be required within the stream to divert the low flow into a wet well before it is pumped through the treatment plant.

The following cost estimate is based on engineering judgment, which is deemed adequate for concept level planning.

Table 2. Cost Estimate Alternative WQ-1

Element	Capital Cost	Annual Operation and Maintenance Cost
6.5 MGD wastewater treatment facility	$9,750,000	$600,000 (excluding sludge disposal)
Diversion infrastructure (pump, wet well, pipes)	$2,000,000	$38,000 (assumes no SOCWA fees)
TOTAL	$11,750,000	$638,000

3.2.1.2 Alternative Variations

A variation of this alternative that was considered was conveying the water to the existing CTP located 1 ¼ miles upstream of the diversion location and allowing the stormwater to be treated as part of the sanitary system operations before it is conveyed into the outfall. Due to this high TSS and low BOD the stormwater runoff cannot be mixed with the sanitary sewage for treatment without pretreatment. In addition the capacity of this plant is 6.7 MGD. The expected flow that will be diverted (6.5 MGD) will exceed the capacity of the current plant. Therefore no further consideration was given to this variation of the alternative.

A second variation of this alternative that was considered was conveying the water directly to the outfall without any pretreatment. This would save nearly all of the capital and O&M costs. However, the SOCWA / Aliso Outfall is regulated through an NPDES permit that includes a limitation on TSS. The TSS present in the low flow exceeds this limit. It is assumed that obtaining a variance on the outfall permit would be a difficult and likely unsuccessful endeavor. Therefore this alternative was not pursued.

3.2.1.3 Alternative Challenges

The following permitting challenges should be considered before pursuing this alternative. It is recommended that a review of the alternatives that specifically evaluates the details of the permitting process be made.

The existing SOCWA /Aliso Outfall line has a capacity of 50 MGD. The current flow rate on this line is approximately 21 MGD. The estimate of flow that would be diverted from Aliso

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Creek is 6.5 MGD. Diversion of Aliso Creek water into the outfall line would significantly reduce the available capacity of the outfall line. This capacity reduction may prevent SOCWA from granting the discretionary permit needed to divert the water into the outfall. If the discretionary permit could not be obtained, this alternative would not be feasible.

Prior to 2001 the low flow was being diverted into an outfall line without pretreatment. The permit for this operation was denied in 2001 by the California Coastal Commission. This denial was apparently based on the use of a manmade structure (i.e. the diversion berm) within the coastal reach of the creek. Since that time other diversions have been permitted and it is likely that the issues raised in 2001 could be overcome at this time. However a diversion structure will be required in the creek and permitting will be a significant hurdle for this alternative. The coastal zone for which the California Coastal Commission has jurisdiction extends beyond the CTP.

3.2.1.4 Alternative Benefits

The water quality benefit of this alternative would be the expected improvement of water quality at the beach by lowering the bacteria limits. This improvement should result in reduction or elimination of beach postings near the Aliso Creek outlet directly resulting from Aliso Creek contamination when the treatment plant is operating correctly and the creek water is within the plant capacity limits. This alternative does not provide any improvements in the water quality of Aliso Creek beyond the outlet area.

3.2.2 Alternative WQ-2 - Treat for TSS and Bacteria and Return to creek

This alternative includes diversion of the water from Aliso Creek just upstream of Pacific Coast Highway, treatment of the water to remove the TSS and bacteria, and release of the treated water back into the channel.

3.2.2.1 Project Details

This alternative includes diversion of the low flow to a stormwater treatment plant located in the County parking lot upstream of Pacific Coast Highway. The stormwater treatment plant would use either ozone or ultraviolet radiation to eliminate the bacteria. Pretreatment of the stormwater via media filtration would be required for effective disinfection. A diversion structure would be required within the stream to divert the low flow into a wet well before it is pumped through the treatment plant. The treated water would then be returned to the creek just downstream of the diversion location.

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The following cost estimate is based on engineering judgment, which is deemed adequate for concept level planning.

Table 3. Cost Estimate Alternative WQ-2

Element	Capital Cost	Annual Operation and Maintenance Cost
6.5 MGD wastewater treatment facility	$10,150,000	$780,000 (excluding sludge disposal costs)
Diversion infrastructure (pump, wet well, pipes)	$2,000,000	$38,000
TOTAL	$12,150,000	$818,000

Future design efforts on this alternative should consider co-location of this facility at the CTP to reduce O&M costs from staff resource needs and address issues related to loss of use at the County parking lot.

3.2.2.2 Alternative Challenges

The following permitting challenges should be considered before pursuing this alternative. It is recommended that a review of the alternatives that specifically evaluate the details of the permitting process be made.

It is certain that this alternative would improve the quality of Aliso Creek water before it reaches the beach. However, natural inputs could occur between the facility outfall and the location where the ocean is sampled. Based on the current regulatory standard for assessing health risk due to bacteria levels, postings could persist due to the natural inputs. However, it is expected that postings would be significantly reduced. Additional design efforts should consider the feasibility of returning the treated water closer to the surf zone.

Prior to 2001 the low flow was being diverted into an outfall line. The permit for this operation was denied in 2001 by the California Coastal Commission. This denial was apparently based on the use of a manmade structure (i.e. the diversion berm) within the coastal reach of the creek. Since that time other diversions have been permitted and it is likely that the issues raised in 2001 could be overcome at this time. However a diversion structure will be required in the creek and permitting will be a significant hurdle for this alternative. The coastal zone for which the California Coastal Commission has jurisdiction extends beyond the CTP.

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The treatment facility that will be built for this alternative is proposed for construction at the County parking lot located east of Pacific Coast Highway. This parking lot currently serves the public during their use of the nearby recreational facilities, i.e. the beach. Reallocating the parking space to a treatment facility will involve a permitting challenge because of the impact to the access to the beach.

3.2.2.3 Alternative Benefits

The water quality benefit of this alternative would be the expected improvement of water quality at the beach by lowering the bacteria limits. This improvement should result in the elimination or reduction of beach postings near the Aliso Creek outlet directly resulting from Aliso Creek contamination when the treatment plant is operating correctly and the creek water is within the plant capacity limits. This alternative does not provide any improvements in the water quality of Aliso Creek beyond the outlet area.

3.2.3 Alternative WQ-3 - Treat for TSS and Bacteria and Reuse

This alternative is based on diversion of the water from Aliso Creek just upstream of Pacific Coast Highway, treatment of the water to reuse water standards, and sale of that water to users in the watershed for irrigation.

3.2.3.1 Project Details

This alternative includes diversion of the low flow, which is typically of the lowest quality and impacts the beach during the high use summer months, to a stormwater treatment plant located in the County parking lot upstream of Pacific Coast Highway. The stormwater treatment plant would use either ozone or ultraviolet radiation to eliminate the bacteria. Pretreatment of the stormwater via media filtration would be required for effective disinfection. A diversion structure would be required within the stream to divert the low flow into a wet well before it is pumped through the treatment plant. The treated water would then be reused as irrigation water for new development in the area.

The following cost estimate is based on engineering judgment, which is deemed adequate for concept level planning. For cost estimating purposes it is assumed that 20 acres of future development will use the treated water at a rate of 0.3 acre-feet/acre/week. This will create a demand of 1 acre-foot/day. Based on the 10 cfs low flow assumption, 20 acre-feet/day of water would be available. It is assumed that the water can be sold for $300 / acre-foot

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Table 4. Cost Estimate WQ-3

Element	Capital Cost	Annual Operation and Maintenance Cost
6.5 MGD wastewater treatment facility	$10,150,000	$780,000 (excluding sludge disposal costs)
Diversion infrastructure (pump, wet well, pipes)	$2,000,000	$38,000
Reclaimed water distribution lines	$2,500,000	$48,000
Sale of reclaimed water		($109,500)
TOTAL	$14,650,000	$756,500

3.2.3.2 Project Challenges

The following challenges should be considered before pursuing this alternative. It is recommended that a review of the alternatives that specifically evaluates the details of the permitting process and alternative assumptions be made.

The assumption for the future demand of reuse water has not been investigated and is critical to the feasibility of this alternative. Currently the CTP includes facilities to reclaim water from the wastewater treatment facilities. The facilities are not being used to the maximum capacity; therefore it is unlikely that additional demand for reuse water will be generated. If the demand does not exist this alternative is no longer viable because the disposal of the water will need to be addressed through one of the other end-of-pipe solutions. In addition this alternative is feasible only if all the low flow water can be sold as reuse water. If the demand does not exist another alternative would need to be used to dispose of the diverted flow.

Consumptive reuse of water within a designated receiving water is likely to generate permitting issues. Permitting would be a significant hurdle for this alternative.

Prior to 2001 the low flow was being diverted into an outfall line. The permit for this operation was denied in 2001 by the California Coastal Commission. This denial was apparently based on the use of a manmade structure (i.e. the diversion berm) within the coastal reach of the creek. Since that time other diversions have been permitted and it is likely that the issues raised in 2001 could be overcome at this time. However a diversion structure will be required in the creek and permitting will be a significant hurdle for this alternative. The coastal zone for which the California Coastal Commission has jurisdiction extends beyond the CTP.

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3.2.3.3 Alternative Benefits

The water quality benefit of this alternative would be the expected improvement of water quality at the beach by lowering the bacteria limits. This improvement should result in the reduction or elimination of beach postings near the Aliso Creek outlet directly resulting from Aliso Creek contamination when the treatment plant is operating correctly and the creek water is within the plant capacity limits. This alternative does not provide any improvements in the water quality of Aliso Creek beyond the outlet area.

3.2.4 End-of-Pipe Treatment Summary

The following table summarizes the costs for the end-of-pipe treatment alternatives.

Table 5. End-of-Pipe Treatment Alternative Costs

Alternative	Capital Cost	O&M
WQ#1 - Divert to Outfall	$10,750,000	$638,000
WQ#2 - Return to Creek	$12,150,000	$818,000
WQ #3 - Reuse	$14,650,000	$756,500

Alternative WQ#2 is the recommended alternative. The capital cost associated with this alternative is the 2nd least costly alternative and the annual O&M is the most costly of the 3 alternatives. However the permitting challenges associated with Alternative WQ#1 (i.e. capacity of the outfall) make this alternative less feasible. Alternative WQ#3 is not recommended due to the higher capital cost investment, the uncertainties associated with the demand for reuse water, and the permitting challenges associated with using stream diversions for consumptive use.

It should be noted that it is near certain that Alternative WQ#2 would improve the quality of Aliso Creek water before it reaches the beach. However, as discussed above, natural inputs could occur between the facility outfall and the location where the ocean is sampled to determine postings at the beach. Based on the current regulatory standard for assessing health risk due to bacteria levels, postings could persist due to the natural inputs. However, it is expected that postings would be significantly reduced.

During the design of the recommended treatment facility, opportunities for designing the system with a modular approach should be investigated. This will allow for portions of the system to be permanently taken offline if and when results from actions taken within the watershed to reduce

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the amount of excess runoff are seen. At that point there should be less urban runoff flowing through Aliso Creek onto the beach.

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4.0 Riparian and Floodplain Restoration

Consistent with the stream stabilization is the reconnection of the stream channel to its flood plain. Floodplain connection will not only allow for sustainability of stream stabilization to be enhanced by reconnection to the flood plain, there will be habitat and water quality improvements as well. Flood plain wetlands will form and be promoted by site contouring and selected planting. Invasive species, such as arundo, will be actively eliminated from the riparian and floodplain.

4.1 Habitat Development

As a result of site contouring, inundation by periodic high creek flows, aggressive invasive species control, and selective native plant introductions both riparian and floodplain habitat will develop over time. This community development will be dynamic and will evolve with the annual changes in stream flow characteristics. This mix of plant communities will provide needed and enhanced habitat for wildlife species within the park area. Specifically the riparian area will also help provide food and structure for resident warm water fisheries found within the creek and future cold water fisheries.

4.2 Habitat costs

The following cost estimate is based on engineering judgment, which is deemed adequate for concept level planning. The cost estimate included in Appendix B provides further details on the cost breakdown.

Table 8. Cost Estimate Riparian/Floodplain Habitat Development

Location	Size	Cost
Riparian Habitat	34,000 linear ft	$170,000
Floodplain Habitat	70 acres	$1,750,000
Invasive Removal (arundo)	70 acres	$1,050,000
Design, contingency, inspection		$2,178,600
TOTAL		**$5,148,600**
Annual O&M		**$35,000**

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5.0 Recommended Alternative

The recommended alternative includes stream stability, floodplain revegetation, and end-of-pipe water quality treatment elements. The layout, project benefits, summary cost estimate, and creek renderings are shown on Exhibits 1, 2 and 3 in Appendix C for all 3 alternatives. The recommended alternative is referred to as the Aliso Creek SUPER Project.

The stream stability solution that is recommended is Alternative 3B as described in Section 2.2 and 2.3. This alternative is the most costly of the stream stability solutions; however it includes several benefits over the other alternatives. It is a more sustainable system and the aesthetic appeal of the smaller grade control structures is greater than with the larger grade control structures in Alternative 1 and 2. Floodplain grading and native plant revegetation appropriate for this alternative was selected. Table 9 shows the total cost of this alternative.

Table 9. Basic Recommended Alternative.

Project Element	**Capital Cost**	**Annual O&M**
Stream Stabilization	$27,069,000	$6,000
Floodplain restoration and invasive control	$5,148,600	$35,000
Treatment Facility	$11,750,000	$638,000
Total Cost	**$43,967,600**	**$41,000**

6.0 References

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