Malibu Creek Ecosystem Restoration Study

Los Angeles and Ventura Counties, California

Appendix J

Habitat Evaluation

U.S. Army Corps of Engineers
Los Angeles District

January 2017

This page was intentionally left blank for duplex printing.

Table of Contents

Section **Page**

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION AND PURPOSE

The purpose of the Habitat Evaluation (HE) is to provide a quantitative valuation of existing and future conditions in the Malibu Creek Ecosystem. This HE provides a relative assessment of the reaches both upstream and downstream of Rindge Dam, as defined by existing fish passage barriers and the USACE's hydrodynamic modeling of Malibu Creek.

The USACE's guidance for ecosystem restoration in the Civil Works Program is provided in Engineer Regulations (ER) 1105-2-210, Appendix E, and Section V. The regulations provide information on the purpose and importance of quantifying the environmental outputs of ecosystem restoration projects to assure that civil work investments in ecosystem restoration have the intended beneficial effects, are consistent with Administration policy, and will be conducted in the most cost effective manner.

This guidance requires that the ecosystem outputs of proposed restoration alternatives of a Feasibility Study undergo a detailed cost effectiveness and incremental cost analysis (ER 1105-2-210, Appendix E, Section V, parts E-33 to E-37) to allow explicit comparison of the additional cost and additional outputs associated with project alternatives. To perform this type of analysis, the environmental outputs must be based on some quantifiable unit (e.g., habitat units, functional capacity units, etc.). Once quantified, the most cost-effective restoration option or combination of options that best meet the restoration goals can be determined.

This document presents the quantitative analysis of habitat values within five reaches downstream and thirteen reaches containing ten barriers upstream of Rindge Dam. The analysis of the upstream reaches assumes dam removal occurs under one of the alternatives considered in this Integrated Report. This current 2014 HE updates information for the reaches in the mainstem up to the confluence with Cold Creek provided by Camp Dresser and McKee (CDM) (2008) and also assesses habitat values upstream from: 1) the Cold Creek Confluence with Malibu Creek and continues to Century Dam, 2) Las Virgenes Creek upstream to the I-101 crossing, and 3) reaches of Cold Creek to the upstream limit of fish passage (**Figure 1.1-1**).

1.1 Target Ecosystem Benefits and Limitations

Malibu Creek is the second largest watershed draining into the Santa Monica Bay at 109 square mi (mi^2). Over 75% of the watershed is undeveloped, with much of the land owned by California Department of Parks and Recreation. The unusual geomorphology of the creek results in a wide variety of habitat types supporting hundreds of native plants and animals, including numerous state and federally listed aquatic species such as Tidewater goby (*Eucyclogobius newberryi*), Arroyo chub (*Gila orcuttii*), Pacific lamprey (*Entosphenus tridentatus*), and southwestern pond turtles (*Actinemys marmorata*) (Swift et al. 1993). Important wildlife movement corridors support the continued survival of terrestrial animals, including mountain lions (*Puma concolor*), bobcats (*Lynx rufus*), badgers (*Taxidea taxus*) and mule deer (*Odocoileus hemonius*) (Penrod et al. 2006).

For the purpose of this study, federally endangered southern steelhead trout (*Oncorhynchus mykiss*) were selected as the "keystone" species and the potential impacts and benefits of the various project alternatives were assessed in light of how they would potentially affect this species. Steelhead were chosen because of their anadromous life history which requires that the fish have access to high quality habitat in both the ocean and the creek at various stages.

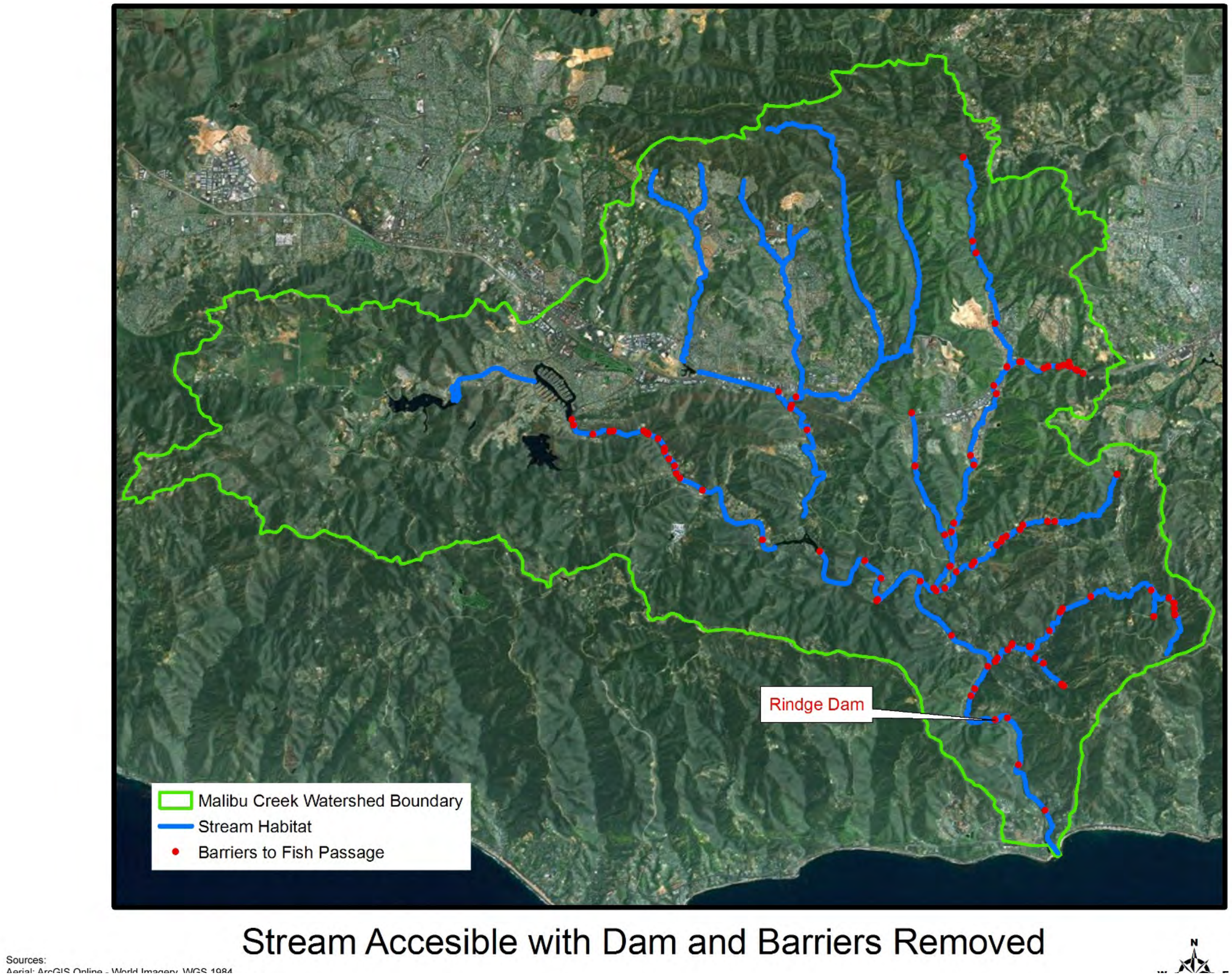


Figure 1.1-1 Malibu Creek Watershed

By increasing habitat that is able to support this species, many of the other species of concern benefit as well.

The population of steelhead in Malibu Creek has been the focus of numerous studies (Keegan 1990, Swift et al. 1993, Ambrose and Orme 2000, Abramson and Grimmer 2005, CalTrout 2006, Dagit and Abramson 2007, Dagit and Krug 2011) and were considered to be the southernmost population when the species was federally listed in 1997 (NMFS 2007). Malibu Creek has been identified as a Core 1 population, indicating its high priority for recovery based on factors such as intrinsic potential for recovery, regional significance both spatially and genetically, and the capacity of the watershed to respond to recovery actions (NMFS 2012). One of the limiting factors for this species in Malibu Creek has been identified as limited over-summering habitat (Spina 2003, Boughton and Goslin 2006), and summer stream temperature (Spina 2007, Thompson et al. 2012, NMFS 2012). The pattern of interrupted flows observed during the summer and fall months in reaches of the mainstem and upper tributaries has been regularly observed. Although not conclusively determined, high summer stream temperatures and associated low levels of dissolved oxygen combined with extensive eutrophication was associated with a die-off of steelhead in Malibu Creek (Dagit et al. 2009). This background information was considered when developing the habitat value scores noted below.

Currently steelhead have access to three linear miles of Malibu Creek below Rindge Dam. The removal of Rindge Dam has been identified as a high priority action critical to the recovery of the species (NMFS 2012). Removal of Rindge Dam alone would add ~ 5.5 linear miles of available steelhead habitat, resulting in a total of 8.5 linear miles of habitat available. Additionally, both local on-the-ground surveys (TAC members 2012) and the back of the envelope GIS approach (Boughton and Goslin 2006) concur that in addition to the existing use of all reaches downstream of the dam to date, removal of the dam and an additional nine upstream barriers could provide steelhead access to ~9.3 additional miles of high-medium quality habitat (Abramson and Grimmer 2005) resulting in a total of ~18 miles available to steelhead within the Malibu Creek watershed.

2.0 TECHNICAL COMMITTEE INVOLVEMENT

In 2004, a Technical Advisory Committee (TAC) was established to assist with the habitat evaluation required for this Study. USACE routinely performs habitat evaluations with the assistance of interested resource agency stakeholders (e.g., U.S. Fish & Wildlife Service, California Department of Fish and Wildlife (CDFW), National Marine Fisheries Service (NMFS), California Department of Parks and Recreation (CDPR) and the local sponsor(s)).

The habitat evaluation method used for this study was developed through a series of consensus-building meetings with the TAC. The TAC was made up of a team of experts representing federal, state, and local agencies with expertise in the principles of wildlife biology, fisheries, and restoration of estuarine and riverine systems, as well as knowledge of the Malibu Creek Ecosystem. The focus of the TAC at that time was to develop a modified Habitat Evaluation Procedure (HEP) to quantitatively assess the quality of existing habitat in several reaches of Malibu Creek, including Malibu Lagoon.

In 2008, the TAC developed a modified Habitat Evaluation (HE) to quantitatively assess several downstream reaches (**Figure 3.3-1**) of Malibu Creek under existing and future conditions of several dam removal alternatives. A list of the TAC members is provided in **Appendix J1**. Following a gap in progress on the Feasibility Study, the TAC was reconvened, and a series of four TAC meetings were held in June and July of 2008. The focus of these meetings was to revisit the HE and develop the quantitative habitat valuations for future conditions for the Alternative 1

No Action Alternative and several Project alternatives. The habitat evaluation greatly benefited from this approach, and the varied expertise of the members of the TAC was fully utilized in this analysis.

Unfortunately the TAC was not able to reach a consensus in 2008 on several key environmental issues related to this Study before funding halted the study. The TAC did provide detailed recommendations on how to improve the evaluation when the project was reinitiated.

In 2011, the TAC was reconvened to consider several upstream reaches defined by existing fish passage barriers (**Figure 3.3-2**). USACE completed a draft HE of the reaches upstream of Rindge Dam, which was reviewed and modified by the TAC in 2012-2014. The current HE assessment is based on the 2008 HE method, with modifications, as described in **Section 3.3**. The TAC subsequently requested that the comments provided for the 2008 draft be revisited and that the HE be consolidated into one document to cover both upstream and mainstem reaches, and provide for a consistent scoring system, as feasible.

One of the key differences between the 2008 HE and the 2014 HE is that the 2008 HE relied on the USACE's hydrologic, hydraulic and sediment transport modeling to estimate the quantity of sediment change in Malibu Creek reaches with and without removal of Rindge Dam as compared to the baseline, or initial bed elevation. Detailed information about model inputs and assumptions, methodology, and results are presented in **Appendix B**. Since sediment transport from Rindge Dam removal would not affect upstream reaches covered in this 2014 HE, modifications to the HE method were required to quantify the natural processes variables, as described below.

Continued input from the TAC also provided additional guidance for updating this HE, which included:

- revisiting the mapping of the riparian habitat units to clarify and document the process with the most up to date aerial images and data;
- streamlining the scoring of the HE to avoid duplicative counting of the value of listed species;
- clarification on the use of the **Appendix B** analysis to compute habitat units (HU) per reach;
- clarification of methodology and assumptions made in preparation of the HE;
- updated field data on steelhead presence/use of onsite pools (Dagit and Krug 2011, RCDSMM unpublished data); and
- updated field data on pools that dry out (RCDSMM unpublished data)
- updated field data on the presence/absence of specific invasive or special-status species of interest based on the knowledge of the TAC

3.0 HABITAT EVALUATION ANALYSIS

3.1 <u>Introduction</u>

A Habitat Evaluation Procedure (HEP) is a habitat-based evaluation procedure developed by the USFWS (1980) that is used to quantify biological resources of concern. Based on models known as habitat suitability indices for certain species or habitat types, variables are identified and assigned a score on a scale of 0 – 1.00 (lowest to highest value). An equation in which variables are weighted as to their importance is used to obtain a numerical score or Habitat Suitability Index (HSI). This score is then multiplied by the acres of habitat to determine Habitat Units (HUs) for the selected habitat.

A modified HEP tailors the HEP process to a particular application, a certain level of effort desired by the user, or the availability of existing species and habitat utilization data (Wakeley and O'Neil 1988). In this case, a modified HEP was considered first to quantify existing conditions of the Malibu Creek Ecosystem, and then to quantify predicted future conditions without restoration and under several restoration alternatives. This included using the confined riverine evaluation procedures contained in the California Rapid Assessment Method (CRAM). The TAC decided that this methodology was not feasible to predict future conditions (see below) and developed a completely different methodology in 2008 for Malibu Creek. The methodology is sufficiently modified from the original HEP process that it was decided to refer to the new methodology as a Habitat Evaluation (HE) to avoid confusion with the USFWS HEP process.

This Habitat Evaluation assessed the numerical gains/losses in habitat value to the project area located in Malibu Creek for purposes of assisting with the incremental cost analysis and to assist in the impact assessment for the various alternatives, including six action and one no action alternatives. The Habitat Evaluation used a methodology created and implemented by a Technical Advisory Committee (TAC), whose membership is listed in **Appendix J1**. Members included resource agency representatives, non-governmental organizations, and local sponsors with detailed, up-to-date knowledge about conditions within and adjacent to the project area. Their knowledge was used to select the appropriate indices and scoring criteria for quantifying gains/losses to habitat value.

The following alternatives are being considered for project implementation:

- Alternative 1 No Action Alternative
- Alternative 2a Dam Removal with Mechanical Transport
- Alternative 2b Dam Removal with Mechanical Transport and Upstream Barrier Removal
- Alternative 3a Dam Removal with Natural Transport
- Alternative 3b Dam Removal with Natural Transport and Upstream Barrier Removal
- Alternative 4a - Dam Removal with Hybrid Mechanical and Natural Transport
- Alternative 4b- Dam Removal with Hybrid Mechanical and Natural Transport and Upstream Barrier Removal

The following target years (TY) were selected for habitat value calculations in the HE:

- TY 0 - present day existing conditions;
- TY1 - one year following the start of construction, Alternative 2 is expected to take five to eight years for construction, Alternative 3 is expected to take at least twenty years, but may take up to 100 yrs for complete removal of the dam and accumulated sediments, and Alternative 4 is expected to take five yrs for construction,. For purposes of this HE Alternatives 2 & 4 are assumed to take 5 yrs for dam removal and Alternative 3 is assumed to take 50 yrs for dam removal;
- TY10 - ten years following the start of construction; riparian community would be expected to be installed and maturing following restoration of areas disturbed by construction at the barrier locations for Alternatives 2 & 4; the bulk of the dam is assumed to still be in place for Alternative 3;
- TY50 - fifty years following the start of construction; the end of the period of analysis for the Feasibility Study. Under Alternative 3, the dam is removed by TY50, however depending on storm flows accumulated sediments could still present a complete barrier.

As described above, the projected timelines for Alternative 2 and 4 were originally based on a work schedule that allowed for truck ingress and egress during an eight hour day. Limiting trucking hours could extend the construction period by up to three years, but would not affect the scores for any of the alternatives that use mechanical removal (Alternatives 2 and 4). This is because conditions at TY10 are not expected to be significantly different for these alternatives for both proposed and reduced trucking hours. The former requires five years for complete dam removal while the latter could require up to eight years.

3.2 Modified HE Method

3.2.1 Supporting Studies

The following studies were heavily relied upon for background information on existing environmental conditions in the Malibu Creek watershed.

Abramson M., and M. Grimmer. 2005. Fish Migration Barrier Severity and Steelhead Habitat Quality in the Malibu Creek Watershed. Produced for California State Coastal Conservancy and California Department of Parks and Recreation.

This study documents results of a fish passage barrier survey in the Malibu Creek watershed. The study identified each of the barriers that were seen during the surveys that were potential impediments to steelhead migration using the criteria provided in the CA Salmonid Stream Restoration Manual Part IX Fish Passage Evaluation at Stream Crossings (Flosi and Reynolds 2003 revised as Flosi et al. 2012). In total, 35 barriers upstream of Rindge dam were identified that impede fish passage at moderate to high flows or are not passable altogether; 29 of which are manmade and 6 are natural (i.e. waterfalls and cascades). Data collected included: a barrier severity ranking, measurements of the barrier, jump height, depth of the pool downstream of the barrier, and a qualitative description of the barrier. The results of this study were the basis for identify existing conditions for upstream reaches for this HE, with supplementation by other data sources and confirmation via field visit. The study also provided baseline information for existing conditions in downstream reaches. The HE assumed that no major changes have occurred since survey completion (2005) and that no major changes are expected prior to the start of construction.

California Trout, Inc. (Caltrout) 2006. Santa Monica Mountains Steelhead Habitat Assessment Final Project Report. Submitted to California Department of Fish and Game and California State Coastal Conservancy- Santa Monica Bay Restoration Project. January 18.

This study identified and prioritized which streams within 23 watersheds should be selected for steelhead restoration actions; recommend what specific actions could be implemented within each focal watershed, where, and at what cost. The study conducted a habitat type and quality and fish passage inventory in 13 local watersheds. In the 10 focal watersheds where data and reports did not exist, field surveys were conducted to collect information about salmonid habitat conditions and the location and severity of migration barriers. The study was the basis for determining existing conditions of fish passage barriers in the upper reaches, with supplementation of field visits. The HE assumed that no major changes have occurred since survey completion and that no major changes are expected prior to the start of construction.

Dagit R., and M. Abramson. 2007. Malibu and Arroyo Sequit Creeks Southern Steelhead Monitoring. Prepared for California Department of Fish and Game. Resource Conservation District for the Santa Monica Mountains. Agoura Hills, CA.

This study documented the abundance and distribution of southern steelhead trout based on monthly snorkel surveys, as well as the status of the benthic community in Malibu and Arroyo Sequit Creeks. Data collected included habitat type, percent canopy cover, substrate, percent algae cover, shelter value and percent instream cover at each location where steelhead were observed. This provides a continuous record of instream conditions suitable to supporting steelhead, as well as documents the number of each size class observed and presence of any redds. The status of the benthic community was determined by applying the southern California Benthic Index of Biological Integrity. The study was used as the basis for determining existing conditions, including the presence of non-native benthic species. The HE assumed that since this report included the invasion by New Zealand Mud Snails, percent cover of native/invasives was basically stable; and that the spread of aquatic invasives is limited by natural and man-made barriers in the stream, as well as protocols for decontaminating gear to prevent spread by field crews.

Dagit, R., and J. Krug. 2011. Summary Report Santa Monica Bay Steelhead Monitoring 2009-2011. Final Report to CDFG Contract No. P0850021. Resource Conservation District for the Santa Monica Mountains. Agoura Hills, CA.

This study documented population size and location of steelhead within Malibu Creek from mouth to Rindge Dam, as well as documented the overall abundance and distribution of steelhead in creeks within the Santa Monica Bay. The study utilized monthly snorkel surveys that were conducted in all reaches accessible to steelhead. The study was the basis for determining existing conditions and use by steelhead for each of the proposed reaches. Data collected included habitat type, percent canopy cover, substrate, percent algae cover, shelter value and percent instream cover at each location where steelhead were observed. This provides a continuous record of instream conditions suitable to supporting steelhead, as well as documents the number of each size class observed and presence of any redds. Steelhead abundance and distribution varies yearly and is related to rainfall, especially in Malibu Creek, however the habitat available, including stable refugia pools, remained consistent over time, despite the additional sediment loading following the wildfire in 2007.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey and B. Collins. 2010. California Salmonid Stream Habitat Restoration Manual, Volume 2, 4th Edition. The Resources Agency, California Department of Fish and Game, Wildlife and Fisheries Division, Sacramento, CA.

This manual provides the tools necessary to properly map, evaluate and assess the severity of fish passage barriers at stream crossings, and also identifies potential restoration strategies and implementation measures. It builds and expands upon earlier editions which have been the standard reference documents for steelhead restoration projects since 1991.

Aerial Information Systems (AIS), Environmental Systems Research Institute (ESRI), California Department of Fish and Game, California Native Plant Society and National Park Service. 2007. Preliminary Spatial Vegetation Data of Santa Monica Mountains National Recreation Area and Environs. USGS-NPS Vegetation Mapping Program, Santa Monica Mountains National Recreation Area, Thousand Oaks, CA.

This study was based on aerial surveys (2005-2008) and associated ground truthing conducted by National Park Service (NPS) biologists. The study provided the basis for determining existing conditions documenting species and plant communities present, supplemented by field visits in 2012 to the upstream barriers. This data was also used to help define the extent and species assemblage of the riparian corridor downstream of Rindge Dam. The TAC assumed that the percent cover of native/invasives was basically stable; and, that invasive removal efforts are keeping pace with invasive spread due to ongoing weed removal efforts by Mountains Restoration Trust, State Parks, National Park Service, etc.

National Marine Fisheries Service. 2012. Southern California Steelhead Recovery Plan Summary. Southwest Regional Office, Long Beach, CA.

The Southern California Steelhead Recovery Plan describes the current status and identifies existing threats and potential recovery actions needed to recover this Distinct Population Segment. The Plan highlights both regional recovery actions as well as those specific to each watershed. Threats to steelhead recovery are ranked as very high to low. Malibu Creek is a Priority Core 1 watershed in the Santa Monica Mountains Biogeographic Population Group. Roads, recreational facilities, culverts and road crossings, dams and surface diversions, and non-native species are all identified as very high threats. The removal of Rindge and Malibu dams, and improved fish passage are listed as critical recovery actions.

3.2.2 Additional Field Work

USACE and CDM conducted field surveys for the project area in June 2008 to confirm existing conditions as compared to that documented in the above surveys. The goal was to assess fish barriers and adjacent habitat. An updated field review of all of the upstream barriers and adjacent areas was conducted in June 2012 and data collected between 2008 and 2014 was reviewed.

3.2.3 Hydrology, Hydraulics and Sediment Modeling

Hydrodynamic modeling was performed to determine future conditions in Malibu Creek under various restoration scenarios, including future without project conditions (Alternative 1 No Action Alternative). Modeled results of scour and sediment deposition were estimated for each reach downstream of Rindge Dam under each alternative scenario. This information was used to describe the general changes in hydrology, hydraulics and sedimentation that are anticipated, and how they would influence specific variables used to calculate Habit Unit scores. It should be noted that the accuracy of the model is approximately one-half of the accuracy of the input elevation data. Elevation data was based on two-foot contours, so model accuracy is approximately 1-ft.

This information was updated in 2013 to reflect the final array of alternatives being discussed. Detailed information about model inputs and assumptions, methodology, and results are presented in **Appendix B**.

3.2.4 Hydrology, Hydraulics and Sedimentation Modeling Assumptions

The following information is excerpted from the **Appendix B** to provide additional context when reviewing the HE results.

Flow in Malibu Creek is perennial, although some reaches flow subsurface in both the upper and lower reaches. There are numerous factors that are vital to determining the ecosystem assessment of the selected alternatives. These factors are used in the habitat evaluation process and allow better understanding and communication about the creek system. To assist in the evaluation of the alternatives from the ecosystem perspective, the width-to-depth ratios were determined for each of the initial alternatives. These results are shown in **Appendix B**. In addition, the average bankfull width-to-depth ratios and the entrenchment ratios were determined for each reach under each of the initial alternative scenarios. The results are presented **Appendix B**).

Flow data was obtained from the USGS gage (LA County stream gage F130-R) located just upstream of the Malibu Creek Road tunnel located 1.5 mi upstream from Rindge Dam. Flows below the gage are influenced by discharges from the Tapia Wastewater Treatment Plan between November 15 and April 15 each year, as well as by required summer low flow augmentation required to meet the requirements of their NPDES permits. If summer flows drop below 2.5 cubic feet per second (cfs), a release of 1.2 cfs is required.

Soils in the Malibu Creek watershed are susceptible to high erosion rates due to a combination of climate, topography, vegetation and soil structure. The sediment transport capacity refers to the amount and size of sediment that the creek has the ability, or energy, to transport. The key components that control the sediment transport capacity are the velocity and depth of the water moving through the channel. Velocity and depth are controlled by the channel slope and dimensions, discharge (volume and magnitude of flow), and roughness of the channel. Changes in any of these parameters will result in a change in the sediment transport capacity of the creek.

The specific characteristics of the sediment load are another key factor influencing channel form and process. The load is the total amount of sediment being transported. There are three types of sediment load in the creek: dissolved, suspended, and bed load. The dissolved load is made of the solutes that are generally derived from chemical weathering of bedrock and soils. Fine sands, clay, and silt are typically transported as suspended load. The suspended load is held aloft in the water column by turbulence. The bed load is made up of sands, gravels, cobbles, and boulders. Bed load is transported by rolling, sliding, and bouncing along the bed of the channel. While dissolved and suspended loads are important components of the total sediment load, in most river systems, the bed load is what influences the channel morphology and stability.

3.2.5 Use of Hydrologic, Hydraulic and Sediment Transport Modeling

Mainstem Reaches

Hydrodynamic modeling was performed by the USACE, to determine future conditions in Malibu Creek under various restoration scenarios, including the future without project conditions. Detailed information about model inputs and assumptions, methodology, and results are presented in **Appendix B**.

Modeling included assumptions on sediment rate (including reductions as control measures are implemented to meet Total Maximum Daily Loads (TMDLs)), stream inputs, and tidal variations. The models were run using the period of record inflows to estimate the future results shown in the tables. The models were also run with 50%, 20%, 10%, 5%, 2%, 1%, 0.5%, and 0.2% ACE events to show the downstream results for a range of hypothetical flood events.

Model outputs included scour and deposition trends at over 80 stations along Malibu Creek for several target years, including years 1, 5, 10, 20, 30, 40, and 50. Predicted amounts of sediment deposition and scour were used to determine future conditions with respect to habitat quality in each of the five Malibu Creek reaches.

The following target years were selected for habitat value calculations in the HE:

- TY 0 is present day existing conditions;
- TY1 is one year following start of construction associated with the project alternative;
- TY10 is when the riparian restoration efforts are expected to result in an establishing vegetation community for Alternatives 2 & 4; in middle of construction for Alternative 3;
- TY50 is the end of the period of analysis of this Study.

Output provided by the model included the quantity of sediment change as compared to the baseline, or initial bed elevation. For the purposes of the HE, it was important to review the changes in sedimentation from one target year to another. The computer program HEC-6T "Sedimentation in Stream Networks", version 5.13.20 of February 2003 was used to conduct the numerical sediment transport modeling in this study. Model runs were conducted and verified by USACE. Substantial erosion or deposition of materials within a reach would affect Aquatic and Riparian Habitat Values, therefore, calculations were performed on the sediment data to determine the depth of sediment deposition or scour at each station since the previous target year. Details on methodology and other outputs can be found in the **Appendix D**.

The model output for Years 1, 5, 10, and 50 are provided in **Appendix J2 (Table 2)** illustrating the change in bed elevation as compared to the initial bed elevation. Although not presented in this appendix, the model output also included data for Years 2, 3, 4, 20, 30, 40, 60, 70, and 75. For example, bed elevation at Station 550.6 (first entry) is 2.2 ft. The change between initial bed elevation and TY5 is 1.8 ft. This means that sediment is predicted to accumulate at this station resulting in a bed elevation 4.0 ft (2.2 + 1.8) after 5 yrs.

The depth of sediment deposition, or scour, <u>between</u> target years was also calculated for TY1, TY1-5, TY1-10, TY5-10, and TY10-50 as compared to the initial bed elevation and the results are provided in **Appendix J2** (**Table 2**) of this HE. This provides a picture of the dynamic deposition or scour for each time period as compared to the initial bed elevation. The data were further analyzed to calculate the projected bed elevation at each target year. A profile of the modeled bed elevation for all alternatives at TY1, TY5, TY10, and TY50 is presented in (**Plates 14-21** in **Appendix B**). These figures show how the bed elevation and resulting gradients are expected to change should the sediment remain or be removed from the system. Alternative 1 No Action Alternative is also presented on each figure. Initial modeling for Alternative 3 Dam Removal with Natural Transport was done assuming complete dam removal by TY1, which is not considered to be representative of the currently proposed Alternative 3. Nevertheless it shows trends in downstream patterns that are useful in evaluating this alternative.

Time periods exhibiting high levels of erosion or deposition were assumed to have lower levels of aquatic habitat and potentially lower levels of use by steelhead. In this regard, sediment movement helped the TAC to identify time periods during which aquatic vegetation and habitat available to steelhead could be negatively impacted, and the TAC adjusted the scoring accordingly. The scale of erosion or deposition also allowed for direct comparison between alternatives that was used by the TAC to ensure consistent scoring of all of the indices. Depending on the level of scour or sediment deposition, the Aquatic Habitat variable D (connectivity) could be affected.

3.2.6 Comparison of predicted cross section conditions with selected steelhead refugia pools

The TAC felt it would be helpful to compare the predicted sediment model patterns with observations of specific pools in Reach 3 Cross Creek Bridge to Big Bend area and Reach 4 Big Bend area to Rindge Dam made monthly during Resource Conservation District of the Santa Monica Mountains (RCDSMM) snorkel surveys (**Table 3.2-1** and **Figure 3.3-1**). Using the control point and cross section data from the USACE model, only two pools could be examined in Reach 3. The majority of stable pools providing critical summer refugia are located within Reach 4. The pools were named by the Heal the Bay and RCDSMM Stream Teams based on relevant observable characteristics and mapped using GPS points taken at the downstream end of the pools.

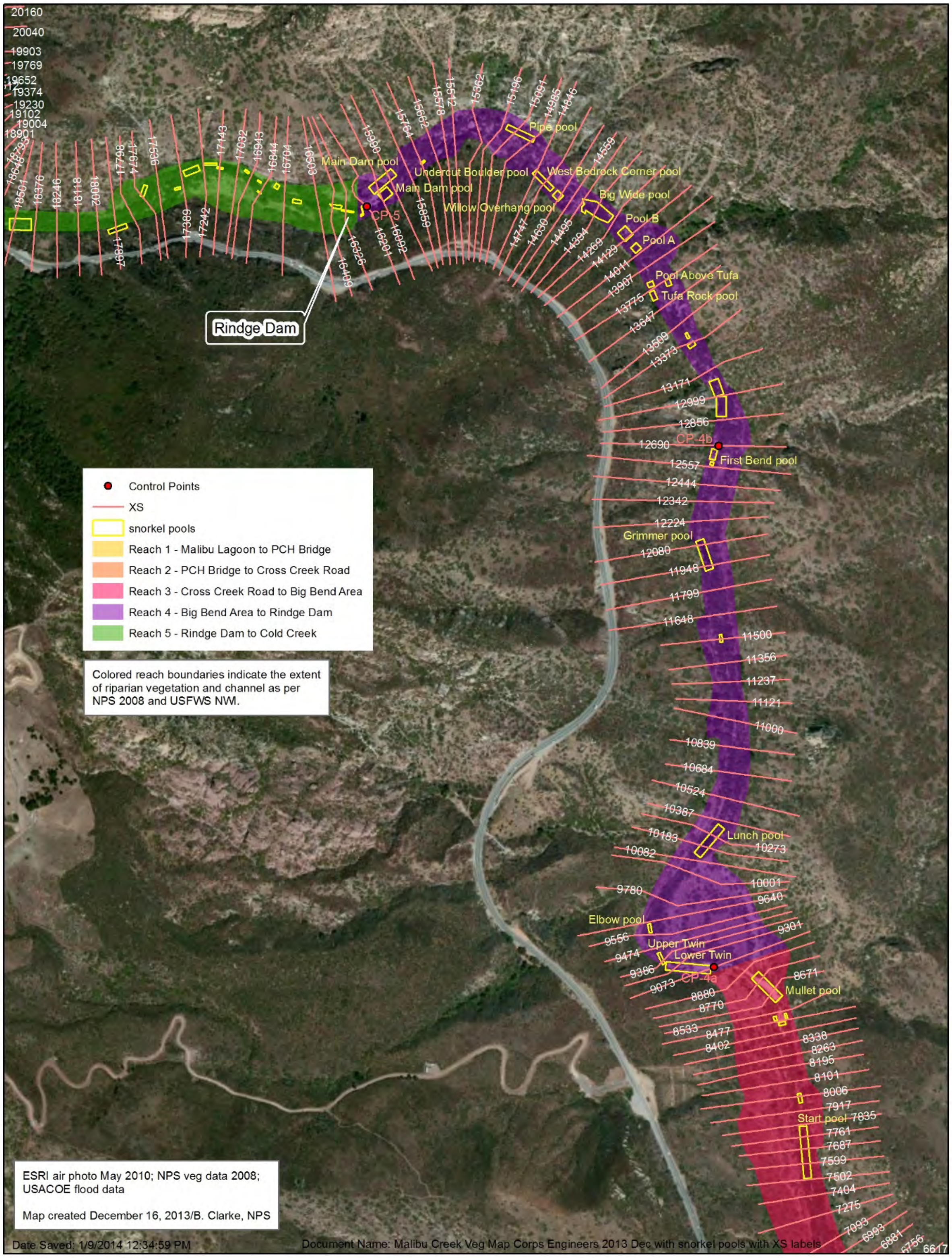
As can be seen in **Figure 3.2-1**, there are more cross sections identified than were used in the analysis of impacts to specific pools. The ‘missing stations’ (which are cross section locations in the models) are due to modeling limitations. The sediment transport models (HEC-6T) are very sensitive to the ‘closeness’ of the cross sections which causes some numerical instabilities and some cross sections had to be removed; whereas the hydraulic water surface models (HEC-RAS) need more cross sections in certain locations. Thus, the HEC-RAS model has more cross sections. The GIS cross sections (stations) are from the HEC-RAS models so there are some with no output from the HEC-6T models; so the closest station having similar topography was used in the analysis of potential impacts to specific pools.

The snorkel survey data provides a picture of how the pools have evolved between 2005 and 2013 (Dagit and Abramson 2007, Dagit and Krug 2010, RCDSMM unpublished data), especially in response to the 2007 wildfire. Caltrout (2006) examined the quality of pool habitat for adults (very good), pool habitat for juveniles (excellent), substrate for adults and spawning (good), and instream shelter for adults (good) for the extent of all three reaches. The pool locations were mapped in 2001-2002 by Heal the Bay and utilized for the Caltrout (2006) report. Due to lack of data, it was not possible to compare the USACE control points or cross sections with snorkel data for Reach 1 Malibu Lagoon, Reach 2 PCH Bridge to Cross Creek Bridge, or Reach 5 Rindge Dam to Cold Creek confluence.

Table 3.2-1 Changes in bed elevation in selected pools based on USACE Cross sections

POOL (cross section)	Alternative	Initial Bed Elevation (ft)	TY 1	TY 5	TY 10	TY 50	Final Bed Elevation (ft)
Start Pool	1	38	0.5	3.0	3.8	5.4	**43.4**
(7404.4)	2	38	1.5	2.5	3.2	3.8	**41.8**
	3	38	2.0	7.3	9.7	10.4	**48.4**
	4	38	1.6	2.8	3.4	4.2	**42.2**
Mullet Pool	1	53	0	-0.3	-1.6	-2.8	50.2
(8770.2)	2	53	-2.5	-4.0	-3.9	-1.5	51.5
	3	53	0.1	4.6	5.9	8.6	**61.6**
	4	53	-2.4	-3.0	-3.1	-1.1	51.9
Lower Twin	1	57	0.1	1.3	3.0	4.7	**61.7**
(9072.9)	2	57	2.5	2.2	2.5	4.0	**61.0**
	3	57	0.2	5.7	7.3	9.5	**66.5**
	4	57	3.3	3.5	3.6	4.6	**61.6**
Lunch	1	69	-0.1	-0.1	-0.8	-0.6	68.4
(10082.0)	2	69	-2.1	-2.3	-2.3	0.5	**69.5**
	3	69	-0.1	4.1	6.3	6.6	**75.6**
	4	69	-2.4	-0.8	-0.9	1.9	**70.9**
Grimmer	1	92	0.0	1.3	2.0	-4.0	88.0
(11948)	2	92	-4.2	-7.3	-6.9	-5.0	87.0
	3	92	1.6	10.2	14.1	7.0	**99.0**
	4	92	-4.4	-5.1	-4.3	-1.9	90.1
Big Wide	1	143	0.4	3.4	2.2	-2.8	140.2
(143940	2	143	-2.8	1.8	1.8	0.7	**143.7**
	3	143	6.8	3.2	-2.4	-0.3	142.7
	4	143	-2.8	1.0	1.4	0.9	**143.9**
Broken Pipe	1	160	-0.5	-2.9	-2.9	-2.9	157.1
(14985)	2	160	-2.9	-2.9	-2.9	-2.9	157.1
	3	160	3.6	10.2	-2.9	-2.9	157.1
	4	160	-2.9	-2.9	-2.9	-2.9	157.1
Big Boulder	1	185	-0.2	-2.9	-2.9	-2.9	182.1
(15764)	2	185	-2.9	-2.9	-2.9	-2.3	182.7
	3	185	13.3	8.0	-2.4	-1.4	180.6
	4	185	-2.9	-2.8	-2.8	-2.7	182.3
Dam Pool	1	185	-2.9	-2.9	-2.9	-2.9	182.1
(16092)	2	185	-2.9	-2.9	-2.9	-2.9	182.1
	3	185	32.1	20.1	7.3	-3.0	182.0
	4	185	-2.9	-2.9	-2.9	-2.9	182.1

Note: bold indicates increased bed elevation due to deposition



1

2 **Figure 3.2-1 Mainstem of Malibu Creek showing reaches and refugia pools.**

<u>Reach 3 Cross Creek Road Bridge to Big Bend area</u>

This is a fairly low gradient reach with the main channel threading through a wide area of the canyon with a well-established riparian corridor. At the downstream end by the Cross Creek Bridge, the channel is modified by some armoring associated with the private homes on both banks. This portion of the reach is wide and shallow, usually providing a run-riffle complex. At the upstream end the gradient increases slightly with a short stretch of step pools made of boulders that define the lower end of Start Pool (so named as it is where we begin snorkel surveys). Between Start and the upstream Mullet Pool lies a step pool cascade complex.

Based on the Hydrology and Hydraulics (**Table 2**, **Appendix J2**), the model indicates initial scouring followed by some deposition, with most falling in the upper portion of the reach for Alternatives 1, 2 and 4. For Alternative 3 Dam Removal with Natural Transport, little scour is anticipated and deposition could be as much as 15 ft, which would potentially eliminate all the step pools in the reach, as well as fill in the refugia pools such as Start and Mullet Pools.

Start Pool

This is a long, narrow low gradient mid-channel pool that at low flows becomes a run, with banks defined by tules, cattails, and willows. The average depth is around 60 cm, with maximum depths of up to 100 cm observed in small areas. There is fair to good instream habitat and shelter value for steelhead. This pool is defined by a step pool-cascade habitat at both its downstream and upstream ends. The pool tail crest provides some suitable spawning gravel. Although Start Pool does not go dry, the step pool complex upstream to Mullet Pool often dry down in the summer months minimizing connectivity. The reach downstream to the Cross Creek Bridge comprised of a riffle – run sequence similarly flows subsurface when flows are low.

When first mapped in Sept 2004, the length was 100 m, average width 10 m, average depth 40 cm, with a maximum depth of 100 cm. The substrate was a mix of gravel and boulders. This pool did not experience any observed changes due to the 2007 wildfire and has remained fairly stable over time. Due to its stability, this pool has been a water quality monitoring site, with a YSI 5500 data sonde intermittently placed during the summer of 2009 and 2010, and a TROLL 9900 data sonde permanently installed in fall 2012. Also, each summer between 2005 and 2013, a HOBO temperature logger was also deployed from June through October to monitor summer water temperatures.

The USACE sedimentation model cross section suggests that there could be increased deposition at this site under all alternatives. The potential for reducing spawning gravel and rearing habitat over 50 yrs will incrementally continue under Alternative 1 No Action Alternative, increase slightly for Alternative 2 Dam Removal with Mechanical Transport and Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport for 5-10 yrs, but increase significantly for Alternative 3 Dam Removal with Natural Transport for at least 50 yrs.

Mullet Pool

Mullet Pool is another mid-channel pool 89 m long, averaging 10 m wide with an average depth of 100 cm. Substrate is boulders with patches of suitable spawning gravel. It is defined on both the downstream and upstream end with step pools and riffles. Mullet Pool has experienced low to no flows causing it to dry down between July and November in 2004, 2008, 2009, 2010, 2011, 2012 and 2013.

The USACE sedimentation model cross section suggests that this pool would experience slight scour under Alternatives 1 No Action Alternative, Alternative 2 Dam Removal with Mechanical Transport and Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport. However, under Alternative 3 Dam Removal with Natural Transport, the pool would experience up to 8 ft of deposition in the first 50 yrs, and could remain affected with reduced spawning and rearing habitat for at least 50 yrs, depending on the rate of sediment movement by storms.

Reach 4 Big Bend Area to Rindge Dam

This stream reach is bounded by an alluvial deposition area where rock slopes cause bends in the channel at the lower end of the reach, moves upstream into a narrow portion of the canyon with steep walls confining the channel, and ends in a plunge pool at the base of Rindge Dam. The gradient increases from the downstream to upstream end of the reach, resulting in relatively stable, large boulder defined pools separated by boulder cascades and step pools. The riparian corridor is also constrained and transitions into chaparral and coastal sage scrub assemblages as the slope increases.

Based on the Hydrology and Hydraulics (**Table 2, Appendix J2**), the model indicates a pattern of overall scouring for Alternatives 1 No Action Alternative, Alternative 2 Dam Removal with Mechanical Transport and Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport. The model indicates significant deposition for Alternative 3 throughout the life of the project. The scour predicted below Rindge Dam for Alternatives 1, 2 and 4 is significant (up to -2.9 ft below current bed elevation) as the creek channel lowers over time with sediment removal. It is anticipated that this will eliminate the habitat in the existing pool below the dam for many years while the channel adjusts. For Alternatives 2 and 4, the realignment of the stream channel is anticipated to stabilize faster (within 10 yrs) than it would for Alterative 3 (20-100 yrs).

The impacts to this reach are of particular concern as there are several important refugia pools that provide important over summer habitat for steelhead, in addition to spawning and rearing habitat.

Lower Twin Pool

Constrained on the west by an exposed bedrock slope and on the east by alluvial deposits, this pool is approximately 80 m long, averages 16 m wide and has an average depth of 200 cm. Maximum depths of over 500 cm have been observed when the pool is full. Substrate is boulder dominated at the upstream end and defined by a cascade, but sandy on the downstream end where it tails out into gravel near an old pipe. Lower Twin Pool has dried up when it experienced low to no flows between July and November in 2004, 2009, 2012 and 2013.

The USACE sedimentation model cross section suggests that there could be increased deposition in this site. The potential for reducing spawning gravel and rearing habitat over 50 yrs will incrementally continue under Alternative 1 No Action, increase slightly for Alternative 2 Dam Removal with Mechanical Transport, and Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport (5-10 yrs), but increase more significantly for Alternative 3 Dam Removal with Natural Transport (5 – 100 yrs).

Lunch Pool

Lunch Pool is located where the creek bends to respond to an exposed bedrock slope on the east, and leads to a lower gradient bend in the stream channel where alluvial deposition occurs. The pool is approximately 65 m long, averages 20 m wide with an average depth of 150 cm and maximum depth in the areas scouring under large boulders as deep as 400 cm. The substrate is primarily sand. This pool has good to excellent steelhead shelter value and instream cover. This pool has never dried up and is another water quality monitoring location where data sondes were deployed in 2009 and 2010.

The USACE sedimentation model cross section suggests that slight scour would continue under Alternative 1 No Action Alternative, however all other alternatives would experience initial scour followed by some deposition beginning in TY5 which could result in the loss of spawning gravel and rearing habitat at the pool tail and potential loss of over summer refugia habitat in the upstream end of the pool. Alternative 2 increases bed elevation only slightly at TY50, with Alternative 4 having a similar depositional pattern. Alternative 3 Dam Removal with Natural Transport begins to cause deposition by TY5 and it increases slowly over time.

Grimmer Pool

This pool is confined by an exposed bedrock slope on the west bank, and narrow riparian buffer on the east bank. It is approximately 62 m long, with an averaged width of 13 m and an average depth of 150 cm, however the upstream end of the pool below the cascade can be over 400 cm deep. The downstream end of the pool tails out into a run, riffle and step pool complex. The substrate is sand dominated. This pool has excellent steelhead shelter value and instream cover.

The USACE sedimentation model cross sections suggest that this pool would experience substantial scour overall under Alternatives 1 No Action Alternative, and Alternative 2 Dam Removal with Mechanical Transport; with slight scour for Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport, although the timing and extent varies slightly between alternatives. Alternative 1 No Action Alternative shows a pattern of slow incremental deposition followed by scour over time. There is initially a loss of 4 ft compared to initial bed elevation in TY1 for Alternative 2 Dam Removal with Mechanical Transport and Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport, which increases by TY5, with some deposition predicted beginning in TY10 and stabilizing by TY50. For Alternative 3 Dam Removal with Natural Transport, deposition is predicted to start in TY1, increase substantially by TY10 and then lower by TY50 resulting in an overall increase of bed elevation and loss of important over-summer refugia habitat.

Big Wide Pool

This pool has experienced the most change following the 2007 wildfire. Prior to the fire, the pool was 92 m long and averaged 25 m wide, with an average depth of 300 cm and maximum depth of over 400 cm on the west bank by a bedrock slope. The east bank is bordered by a narrow riparian zone and a steep canyon wall. The upstream end of the pool is defined by a boulder cascade which is a summer low flow barrier. The downstream end of the pool had areas of suitable spawning gravel. Following the fire, the pool has accumulated slugs of sand which have resulted in an average depth of 150 cm, and maximum depths reduced to around 200 cm.

The USACE sedimentation model cross sections suggest that there would be mixed impacts to this pool. Under Alternative 1 No Action Alternative, initial deposition continues through TY10, but then bed elevation reduces substantially by TY50. A similar pattern is observed for Alternative 3 Dam Removal with Natural Transport, which experiences a 6 foot increase in bed elevation due to deposition in TY1, which eventually scours out until by TY50 the bed elevation is close to starting levels. Both Alternatives 1 and 3 could result in a long-term incremental loss of spawning and rearing habitat, as well as reduced over summer refugia in this pool. Alternative 2 Dam Removal with Mechanical Transport and Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport both experience initial scour followed by incremental deposition starting in TY5. Overall, the pattern in this pool suggests that it will remain fairly stable under all alternatives.

Broken Pipe Pool

The creek divides into two threads in this area, resulting in pools forming on both the west and east side, with a well vegetated depositional bar separating them. The Broken Pipe Pool is on the east side, defined by a bedrock slope. This pool is approximately 50 m long, and averages 10 m wide. The average depth is 80 cm, but there is a deep undercut on the downstream end by a large boulder, which provides a maximum depth of 200 cm. The substrate is gravel dominated, with very good steelhead shelter value and instream cover.

The USACE sedimentation model cross sections suggest that by TY50, bed elevation conditions in this pool will be substantially scoured as compared to the initial bed elevation, but the predicted interim impacts differ between alternatives. For Alternatives 1 No Action Alternative, Alternative 2 Dam Removal with Mechanical Transport and Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport, scour by TY5 has stabilized and the pool remains constant. For Alternative 3 Dam Removal with Natural Transport, deposition of approximately 6 ft of sediment is predicted for TY1, decreasing by half by TY5, and then slowly scouring out so that by TY50 it is similar to the bed elevation of the other alternatives. The deposition of sediment between TY1-TY10 could reduce spawning and rearing habitat as well as over summer refugia habitat in this pool.

Big Boulder Pool

This mid-channel pool is dominated by a bedrock slope on the west bank, and a jumble of house size boulders on the east. The channel turns slightly around these obstacles. The pool is approximately 30 m long, with an average width of 12 m. Prior to the 2007 wildfire, the average depth was 300 cm, but currently is about 150 cm with a few deeper undercuts that get up to 300 cm deep. The substrate is a mix of sand, patches of gravel and boulder. The shelter value and instream cover for steelhead is excellent.

As was the case with Broken Pipe Pool, the USACE sedimentation model cross sections suggests that the Big Boulder Pool will experience substantial scour by TY50 as compared to the initial bed elevation, but the interim impacts also differ. For Alternatives 1 No Action Alternative, and Alternative 2 Dam Removal with Mechanical Transport and Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport, scour begins in TY1 but by TY5 has stabilized and the pool remains constant. For Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport, scour is essentially complete by TY1 with a relatively constant pool elevation thereafter. For Alternative 3 Dam Removal with Natural Transport, deposition of approximately 13 ft of sediment is predicted for TY1, decreasing by TY5, and then slowly scouring out so that by TY50 it is similar to the bed elevation of the other alternatives. The deposition of sediment between TY1-TY10 could reduce spawning and rearing habitat as well as over summer refugia habitat in this pool.

Dam Pool

Located below Rindge Dam, the plunge pool is constrained by bedrock slope on the west bank, and large boulders on the east bank. The main body of the pool is about 25 m long and between 15-20 m wide, but it narrows as it flows downstream due to sand deposition on the west bank. The total length of the pool is approximately 90 m to where it tails out in a gravel bed leading to a riffle - step pool complex. The scour below the dam creates a maximum depth of 250 cm, but the average depth is 100 cm. The substrate is dominated by sand with patches of gravel. The shelter value and instream cover for steelhead is good to excellent.

As was the case with the two pools located just downstream of the Dam Pool, the USACE sedimentation model cross sections suggests that the Dam Pool will experience scour by TY50 as compared to the initial bed elevation, but the interim impacts differ. For Alternatives 1 No Action Alternative, Alternative 2 Dam Removal with Mechanical Transport and Alternative 4 Hybrid Dam Removal with Mechanical and Natural Transport, scour is essentially complete by TY1 with a relatively constant pool elevation thereafter. For Alternative 3 Dam Removal with Natural Transport, deposition of approximately 32 ft of sediment is predicted for TY1, decreasing by TY5, and then slowly scouring out so that by TY50 it is similar to the bed elevation of the other alternatives. The deposition of sediment between TY1-TY10 could reduce spawning and rearing habitat as well as over summer refugia habitat in this pool.

3.2.7 Assumptions and Limitations of the HE

The assumptions used to develop this habitat evaluation are described below for each variable. The TAC relied upon accessible published studies and extensive local knowledge to develop the quantitative scoring system used, however they recognized that this still has limitations. The time and expense of additional studies needed to improve precision and the ability to facilitate project performance monitoring evaluation and potentially, was not available which could potentially affect adaptive management decisions in the future.

Due to the extended time frame for developing this document (2002-2014), data used for the hydrological, hydraulic and sediment modeling did not include the impacts associated with the 2007 wildfire, which burned much of the project area. The models provide reasonable comparison between the different alternatives under the scenarios examined to enable evaluation of potential impacts associated with each alternative, but do not necessarily reflect all possible conditions. The effects of wildfires on flows and sedimentation in Malibu Creek was studied by USGS between 2007 and 2012, but the results of that study are not yet available. Discussion of wildlife impacts on specific pools are discussed in **Section 3.2.6**.

Additionally, the changes in extent and composition of native and non-native vegetation, as well as habitat conditions reflect the best professional judgment of the TAC, who relied upon both aerial and on-the-ground examination by local resource agencies of sites to make the determination of conditions.

One of the main anthropogenic influences on hydrology in Malibu Creek is the discharge from the Tapia Wastewater Treatment Plant (TWTP), located just downstream from the confluence with Cold Creek. TWTP average daily discharge releases vary between 6-11 cfs during the winter season between November 16 and April 14. In years past, Tapia was intermittently required to release recycled water in the last months of fall to augment Malibu Creek flows in accordance with their NPDES permit.

Section V. C. of the current TWTP *NPDES permit No. CA0056014 R4 2010-0165 says:*

> *"The existence of minimal streamflow conditions that require flow augmentation in Malibu Creek to sustain endangered species as determined by the Executive Officer. The Discharger shall augment flow in the Malibu Creek, such that 2.5 cfs of maximum total flow is measured at the Los Angeles County gauging station F-130-R to sustain the steelhead trout habitat. Discharge to augment flow shall not be dependent on whether receiving water station RSW-MC004D (formerly known as station R-4) is dry or wet. The discharge shall not cause a breach of the Malibu Lagoon. During the prohibition period, the Discharger must obtain written permission from the Executive Officer to discharge into Malibu Creek for the purpose of this provision."*

In 2013, after two years of very low rainfall, creek flows required augmentation much earlier. Tapia releases began in May, and continued until mid-November providing 0.10 cfs in 2012 and 0.62 cfs in 2013. Recycled water releases are fed through a hydrant to maintain a constant flow to Serial Outfall 001 which is located at the TWTP.

Another limitation of this study are the potential changes to precipitation patterns resulting from climate changes in the Los Angeles region, as well as the potential for overall temperature increases. Modeling conducted by a consortium at UCLA (Hall et al. 2013) suggest that the coastal region including the Santa Monica Bay will have an increase of 3-5°F average temperature, with warmer winters and much warmer summer/fall temperatures by 2050. One of the measures that directly concern the steelhead trout is the number of days exceeding 95°F during the summer and fall, when water temperatures can rise above the critical thermal limit and cause fish mortality. Although we recognize that the short term impacts to existing refugia pools associated with the removal of Rindge Dam could be exacerbated by increased air and water temperatures, it was beyond the scope of this document to examine those potential impacts.

3.3 <u>Revised Methodology</u>

Typically the USACE relies upon a Habitat Evaluation Procedure (HEP) that incorporates metrics from the California Rapid Assessment Method for Wetlands and Riparian Areas (CRAM, Collins et al. 2006). CRAM was developed as a cost-effective and scientifically defensible method for monitoring the conditions of wetlands throughout California. One application of the method is to assess the progress of restoration or mitigation through comparison to ambient conditions, reference conditions, and expected endpoints. USACE has committed to using CRAM within its environmental restorations program, and a fair amount of work was conducted to develop a combined HEP/CRAM methodology for use in this Study.

The HEP/CRAM methodology included several metrics for which a very detailed assessment of a carefully selected area, known as an Assessment Area, was required. For instance, to evaluate biotic structure, HEP/CRAM required a quantification of the number of plant layers present, the number of co-dominant species present, and the percentage of layers dominated by non-native species. The TAC decided that it was not possible to accurately predict these detailed metrics for future conditions. It was the consensus of the 2008 TAC that a more simplified approach to habitat valuation was needed, similar to that developed for this Study.

Similar to the Matilija Environmental Working Group, the TAC reached consensus on variables that represent important components of environmental restoration of the Malibu Creek ecosystem.

One fundamental understanding of the TAC was that a key element of any restoration program for Malibu Creek should address aquatic habitat and aquatic connectivity with steelhead as an indicator species, while considering multiple species habitat needs, as well as considering other important features of a healthy ecosystem, including riparian habitat quality, wildlife linkages, hydrology, and sediment regime.

Malibu Creek is one of the last remaining habitats that support the federally endangered southern steelhead trout, and a considerable amount of information exists on aquatic habitat quality in the Malibu Creek ecosystem (Ambrose and Orme 2000, Abramson and Grimmer 2005, Caltrout 2006, Dagit and Abramson 2007, Dagit and Krug 2011). In addition, steelhead were historically found in upstream reaches of Malibu Creek and its tributaries, including Cold Creek (Dagit et al. 2005), despite the presence of Tunnel Falls, a natural barrier approximately 4,900 ft upstream of Rindge Dam that is only passable at high flows. Therefore in 2012, the TAC added 10 upstream reaches defined by existing fish passage barriers to the HE.

Three primary ecosystem components were considered to be equally important for the evaluation of habitat in support of this Study: aquatic habitat value, riparian habitat value, and natural processes, each component made up of two or more quantifiable variables. Following standard HEP design, each variable was given a numerical rating or value between 0 and 1.00 and then used to calculate an overall score to identify the quality of habitat, which was then multiplied by the amount (acreage) of that habitat to obtain the Habitat Units (HUs) for each habitat type.

The HE method used in the current 2014 assessment for upstream reaches is slightly modified from that used in 2008 for downstream reaches. These modifications are described for each of the three ecosystem components in the following sections. The TAC also modified the 2008 method used for downstream reaches using new information not available to the 2008 TAC.

3.3.1 Defining the Reaches

<u>Mainstem Reaches</u>

This subarea is Malibu Creek from the Pacific Ocean to the confluence with Cold Creek. This area includes the footprint of the dam, the area upstream of the dam from which accumulated sediments would be removed, and the area downstream of the dam that would be indirectly affected by dam removal.

For hydrodynamic modeling, used to determine future conditions in Malibu Creek under various restoration scenarios, Malibu Creek was divided into five reaches (**Figure 3.3-1** and summarized in **Table 3.3-1**). Detailed information for reach designation is presented in **Appendix B**. The reaches were defined based on channel characteristics and elevation changes. Due to modeling constraints, the lagoon was separated from the creek and the upstream limit was determined by visual inspection of aerial photographs and a noted break in channel profile. Reach 2 PCH Bridge to Cross Creek Bridge was established based on the downstream limit of sediment transport based on the modeling. Reach 3 from Cross Creek Bridge to Big Bend area is a depositional floodplain area with a natural change in channel direction. In Reach 4, Big Bend area extending to Rindge Dam, the elevation changes and the canyon narrows, clearly distinguishing it from the characteristics of a broader floodplain and less constrained channel downstream to the Cross Creek Bridge. Reach 5 Rindge Dam to Cold Creek also reflected a natural change in channel characteristics.

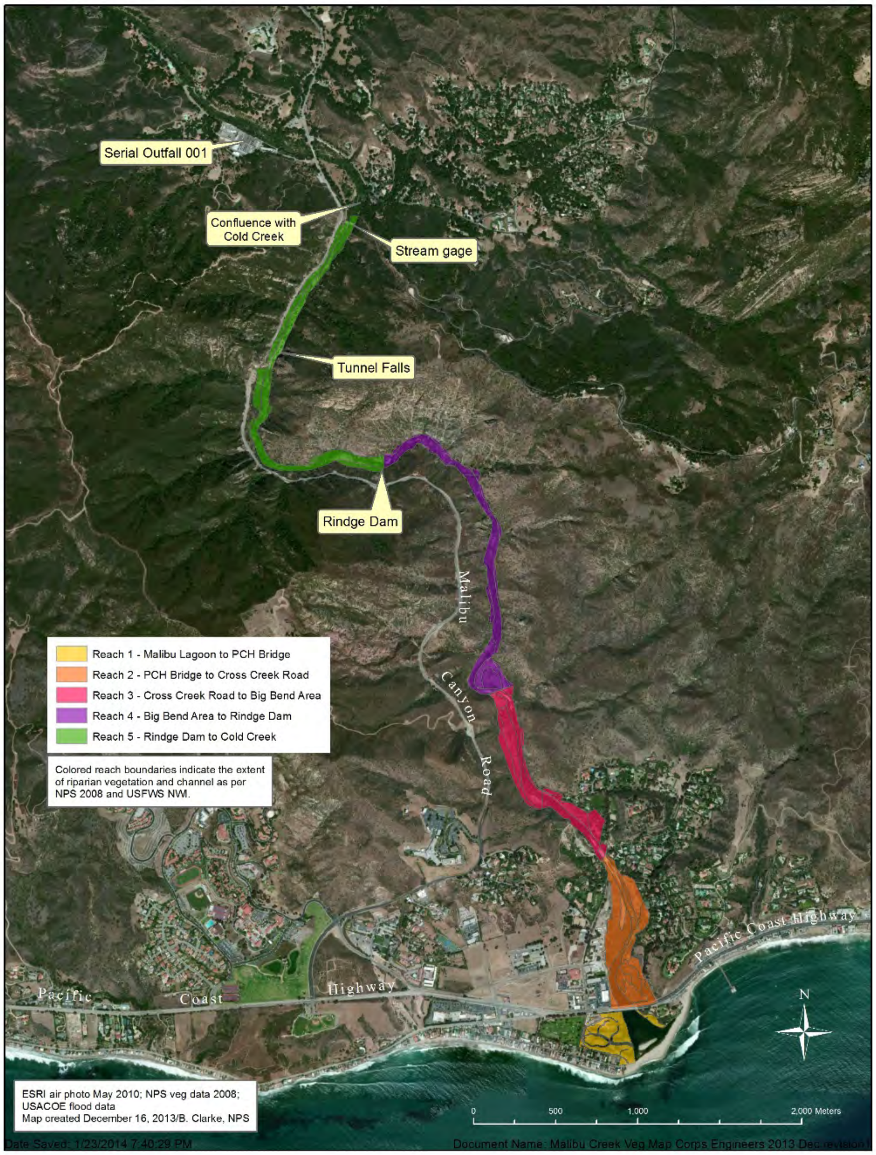


Figure 3.3-1 Mainstem Reaches- Malibu Creek Ecosystem Restoration Feasibility Study

Table 3.3-1 Summary of Mainstem Reaches

Mainstem Reach	**Stream Length (ft)**	**Total Riparian Acres**
Reach 1 - Malibu Lagoon Mouth to Pacific Coast Highway (PCH) Bridge		15.7
Reach 2 - PCH Bridge to Cross Creek Bridge	3168	42.7
Reach 3 - Cross Creek Bridge to Big Bend Area	7920	40
Reach 4 - Big Bend Area to Rindge Dam	3696	35.2
Reach 5 - Rindge Dam to Cold Creek Confluence	7920	28
TOTAL	**22,704**	**161.6**

The mainstem reaches were extensively modeled using standard USACE Hydrology and Hydraulics models to evaluate flows and the erosion and deposition of stream sediments resulting from changes, such as the removal of Rindge Dam. This information was absent for the second subarea (upstream reaches). The scoring of some variables for the mainstem subarea is therefore slightly different than for the same variables for the upstream reaches for this reason (e.g. Aquatic Habitat Value variables B and C).

Data on Aquatic Habitat Value variable B included erosion and deposition estimates for the mainstem subarea that allows consideration of changes to substrate affecting spawning activity. This information is not available for the upstream subarea resulting in a slightly different set of criteria.

Data on Aquatic Habitat Value variable C were limited by survey data to broad generalizations for the mainstem subarea; stream flow data available in the upstream reaches allows for a more specific set of criteria.

Upstream Reaches

The additional upper watershed habitat that could potentially be available following the removal of Rindge Dam was evaluated based on review of ten man-made barriers that include thirteen upstream reaches of Malibu Creek and its tributaries, as shown in **Figure 3.3-2** and summarized in **Table 3.3-2**. Man-made barriers are considered to be limiting factors for steelhead and other aquatic species and removal of these barriers would increase the tributary areas accessible to them. Of these ten barriers, all but one, CC8 – Stunt Road culvert, are proposed for removal as part of Alternatives 2b, 3b, and 4b. Barrier CC8 is proposed to be left in place for two reasons: the Cost Effective/Incremental Cost Analysis (CEICA) in **Appendix E** suggests there is little gain of habitat value compared to the cost for removal of this barrier, and 2) the barrier appears to checking the upper limit of New Zealand mud snail invasion up Cold Creek. Removal of all remaining nine barriers under consideration would make the Malibu Creek watershed open to the following areas to steelhead trout: to Century Dam on Malibu Creek, to Highway 101 on Las Virgenes Creek, to Stunt Road on Cold Creek and approximately 2/3 the length of Liberty Canyon Creek.

Reaches were determined based on a list of priority barriers located on Las Virgenes Creek and Cold Creek identified by the TAC and Abramson and Grimmer (2005). An additional reach on the mainstem of Malibu Creek from the Cold Creek Confluence up to Century Dam was included to provide a comprehensive evaluation of habitat that could be made accessible to fish following the removal of Rindge Dam. Neither Century Dam, nor Malibou Dam are proposed for removal or modification at this time.

Habitat units (HUs) were calculated for each reach under existing conditions and predicted future conditions (with and without removal or modification of the fish barrier). HUs primarily represent the benefit gained by opening up each reach for steelhead.

An additional three tributary streams to Cold Creek and Las Virgenes Creek were also examined and could be opened to steelhead if the appropriate upstream barriers were removed. The three tributaries are: Dark Canyon Creek, Stokes Creek, and Liberty Canyon Creek. Due to a variety of limitations, they were not included in the proposed barrier removal project at this time. As discussed below, only the habitat associated with Liberty Canyon was included in the HU analysis as only it has “good” or better habitat for steelhead.

Dark Canyon Creek runs into Cold Creek just upstream of barrier CC2 (Malibu Meadows Bridge). Removal of barriers CC1 (Piuma Culvert) and CC2 would restore access to this creek. However, the creek was previously assessed as poor habitat for steelhead (Abramson and Grimmer, 2005) and also has impassable barriers. Therefore, it was not included in this evaluation.

Stokes Creek runs into Las Virgenes Creek just upstream of barrier LV1 (Crags Road Culvert). Removal of barrier LV1 would restore access to this creek. However, the creek was previously assessed as poor habitat for steelhead (Abramson and Grimmer, 2005) and also has impassable barriers. Therefore, it was not included in this evaluation.

Liberty Canyon Creek also runs into Las Virgenes Creek upstream of barrier LV1 (Crags Road Culvert). Removal of barrier LV1 would restore access to this creek. Additionally, the creek was previously assessed as good habitat for steelhead (Abramson and Grimmer, 2005) and also has no impassable barriers within the good habitat (upstream habitat above a passable barrier was considered to be poor habitat for steelhead). Therefore, the length of this stream that is considered to be good habitat (5,267 ft) was included in this evaluation by adding to the length of Las Virgenes Creek made accessible by removal of barrier LV1.

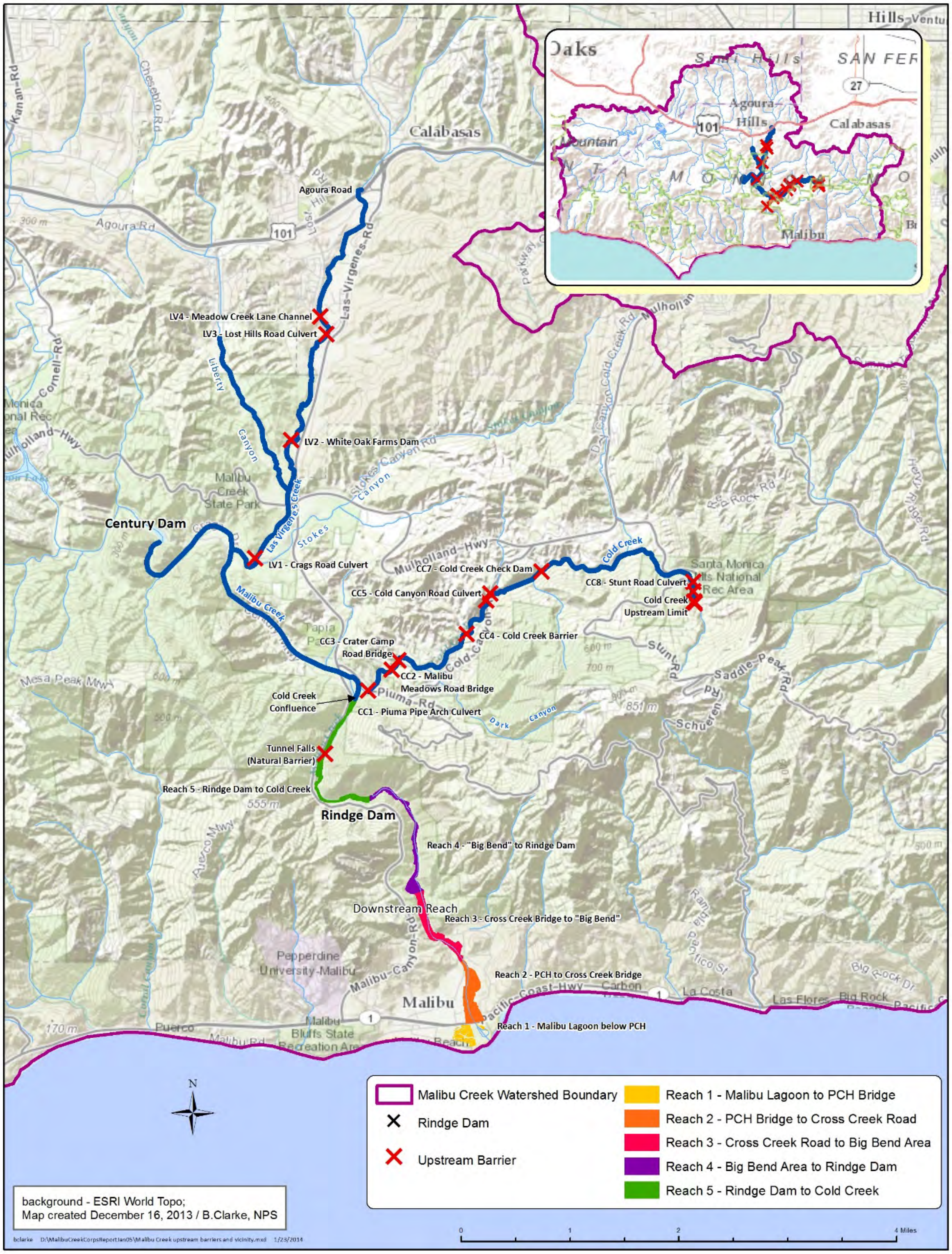


Figure 3.3-2 Upstream Reaches – Malibu Creek Ecosystem Restoration Feasibility Study

Other tributaries in the Malibu Creek watershed are outside the project area, including: Malibu Creek above Century Dam, Las Virgenes Creek above Agoura Road, and Cold Creek above the Stunt Road Culvert. Project construction would not restore access to these tributaries.

Table 3.3-2 Upstream Reaches Evaluated

Reach	Downstream – Upstream Barrier ID	Creek or Tributary	Reach Length (ft)
Cold Creek Confluence to Century Dam	Cold Creek Confluence (no barrier) – Century Dam	Malibu Creek	18,630
Las Virgenes Creek Confluence to Crags Road Culvert Crossing	LV Confluence – LV1	Las Virgenes	1,687
Crags Road Culvert Crossing to White Oak Farms Dam	LV1 – LV2	Las Virgenes	11,979
White Oak Farms Dam to Lost Hills Road Culvert	LV2 – LV3	Las Virgenes	6,353
Lost Hills Road Culvert to Meadow Creek Lane Channel	LV3 – LV4	Las Virgenes	1,017
Meadow Creek Lane Channel to I-101 Freeway bridge	LV4 – I-101 Freeway	Cold Creek	8,474
Cold Creek Confluence to Piuma Pipe Arch Culvert	CC Confluence – CC1	Cold Creek	693
Piuma Pipe Arch Culvert to Malibu Meadows Road Bridge	CC1 – CC2	Cold Creek	1,824
Malibu Meadows Road Bridge to Crater Camp Road Bridge	CC2 – CC3	Cold Creek	562
Crater Camp Road Bridge to Cold Creek Barrier	CC3 – CC4	Cold Creek	4,332
Cold Creek Barrier to Cold Canyon Road Culvert	CC4 – CC5	Cold Creek	2,211
Cold Canyon Road Culvert to Stunt Road Culvert	CC5 – CC8	Cold Creek	12,011
Stunt Road Culvert to 12 foot waterfall	CC8 – upstream limit	Cold Creek	1,138
Additional stream accessible to steelhead (ft)			69,773

Notes:
1. LV1-LV2 includes Liberty Canyon Creek, a tributary to Las Virgenes Creek, that would be opened by removal of LV1
2. CC6 is a natural barrier (large waterfall) located within CC5-CC8 reach.
3. CC7 is an artificial barrier that has been removed via outside mitigation funds.

The Aquatic Habitat Value variable measures connectivity between reaches. For mainstem reaches this was done by observed drying out of stretches of Malibu Creek as there are no man-made or natural barriers that would serve this purpose. For upstream reaches there are man-made and/or natural barriers that would still isolate reaches under varying conditions. Thus this variable was scored differently for the two subareas.

Riparian Habitat Value variables for the two subareas are essentially the same, however they were evaluated differently. The mainstem subarea was evaluated using historical survey data and TAC expertise. The upstream reaches were evaluated using aerial photographs and interpretation by contractor and TAC expertise.

Natural Processes variables were identical for the two subareas.

3.3.2 Aquatic Habitat Value

<u>Mainstem Reaches</u>

In 2008, three variables, (A, B, and C) were chosen to represent aspects of aquatic habitat that are important for the recovery of the steelhead population. A fourth variable (D) was added in 2012 to allow evaluation of mainstem reaches that dry out on a regular basis, thus affecting connectivity on a reach basis, similar to natural barriers in some of the upstream reaches.

Steelhead connectivity measures connectivity to the ocean from the reach being evaluated. This variable is used to measure connectivity for purposes of steelhead only and to answer the question, "Can adult steelhead make it to the reach by swimming upstream from the ocean?"

Aquatic connectivity measures connectivity to the reach immediately downstream from the reach being evaluated. Aquatic connectivity measures connectivity for other, local species to expand into adjacent reaches that were previously isolated by the presence of pools that dry out occasionally.

The Aquatic Habitat Value Score was calculated using the following equation:

Aquatic Habitat Value Score = (A+B+C+D)/4

Where:

- A = Habitat Value: the structural composition of the in-stream habitat important for steelhead and other native fish. A measure of structural patch richness, Habitat Value is higher when there is a complexity of physical structure (boulders, rock ledges, woody debris, etc.) that provides in-stream shelter to fish, as well as a variety of substrates and topographic features (pools, riffles, etc.) important for spawning and other life stages. Along with the professional judgment of members of the TAC, a considerable amount of information exists on habitat quality in Malibu Creek (Abramson and Grimmer 2005, Caltrout 2006, Dagit and Krug 2011) for quantification of this variable. This variable was evaluated based on the best professional judgment of project staff and TAC members, utilizing their own familiarity, and considerable data collected including Weighted Pool Habitat Quality (wPHQ) ratings from Abramson and Grimmer (2005) as provided in **Appendix J4**. It was the final consensus of the TAC that the Habitat Value variable should carry the same weight as the other variables.

- B = Steelhead Use: closely related to the value of aquatic habitat present, but also considers invasive predators, impaired water quality, impaired benthic community, and other limiting factors for steelhead (NOAA 2007, NMFS 2012), excluding accessibility, which is addressed in Variable C. Steelhead Use considers the number of life stages present, as appropriate for the habitat type found in the reach. This variable measures whether or not various life stages of steelhead are present now in each reach, and whether or not, based on TAC best professional judgment, the reach would support various life stages if accessible. This determination includes the factors listed above.

    - In early iterations of the HEP design, only one interim value between 0 and 1.00 was available to reflect a situation where steelhead were present but not all life stages were supported (assigned a score of 0.50). Upon further consideration, the TAC decided that interim values of 0.25 and 0.75 should be added to better represent steelhead use as it exists currently and in the future based on predicted sediment transport under the various restoration alternatives.

- C = Steelhead Connectivity (between the reach and ocean): reflects the importance of fish barriers on Malibu Creek as a limiting factor for steelhead. Initially, Aquatic Connectivity was not included in the HEP design. However, in the process of evaluating aquatic habitat value with respect to steelhead, the TAC concluded that it was necessary to factor in the accessibility of steelhead to the reach in question. The most severe barrier, Rindge Dam, prohibits steelhead use in reaches above it, even though habitat exists there. The TAC recommended that if Aquatic Connectivity = 0, then Steelhead Use (Variable B) was also to be set = 0.

- D = Aquatic Connectivity to the adjacent downstream reach: gives higher scores to reaches that are more connected to adjacent habitat by not drying out in summer.

Variables for mainstem reaches were quantified as described below.

Variable A, Habitat Value:
1.00 Excellent- functioning as in historical condition and able to support robust populations of native fish.
0.75 Good- able to support pertinent life stages of native fish; in good condition but slightly impaired in relation to historical condition.
0.50 Fair- meets all minimum requirements of pertinent life stages of native fish, but substantially impaired in relation to historical condition.
0.25 Poor- marginal value to pertinent life stages of native fish.
0.00 Very Poor- unable to support required life stages (i.e. migration, spawning, and rearing of young).

Variable B, Steelhead Use:
1.00 Use of habitat by all appropriate life stages*.
0.75 Adults and juveniles present, spawning discontinued due to lack of suitable substrate**.
0.50 Adults only.
0.25 Adult use possible, conditions poor.
0.00 No steelhead present in reach.

*For the lagoon, appropriate life stages include adults and smolts; spawning is not expected. Therefore, possible scores in the lagoon include 1.00, 0.50, and 0.
**This allows evaluation of sedimentation effects on downstream reaches, which is not possible for the upstream subarea.

Variable C, Steelhead Connectivity between the reach to the ocean:
1.00 Always passable.
0.75 Passable at low flows.
0.50 Passable at moderate flows.
0.25 Passable at high flows.
0.00 Not passable.

Note: In Reach 5, Tunnel Falls is a natural low flow barrier located upstream of Rindge dam with a jump height of 2.62 meters and pool depth of 2.13 m which makes it passable at flows greater than 50 cfs.

Variable D, Aquatic Connectivity to the adjacent downstream reach (period of record 2005-2013):

1.00 Reach never dries out.
0.75 Reach dries out once in monitoring record.
0.50 Reach dries out twice in monitoring record.
0.25 Reach dries out three or more times in monitoring record.
0.00 Reach dries out for substantial periods of time or there is a permanent barrier.

Upstream Reaches

In 2012, a second Aquatic Connectivity score was added, as described below. As discussed earlier, Variables B, C, and D are defined and scored differently than for the mainstem reaches, so this score is kept separate for the upstream reaches. With this modification, Aquatic Habitat Value includes four variables (A, B, C, and D) to represent aspects of aquatic habitat that are important for the recovery of the steelhead population.

The Aquatic Habitat Value Score was calculated using the following equation:

Aquatic Habitat Value Score = (A+B+C+D)/4

Where:

- A = Habitat Value: the structural composition of the in-stream habitat (pools, substrate, shelter) important for steelhead and other native fish (based on Weighted Pool Habitat Quality (wPHQ) ratings from Abramson and Grimmer (2005) as provided in **Appendix J4**.

- B = Steelhead Use: closely related to the value of aquatic habitat present, but also considers invasive predators, impaired water quality, impaired benthic community, and other limiting factors for steelhead. Variable B considers the number of life stages present, as appropriate for the habitat type found in the reach.

- C = Steelhead Connectivity between the reach and the ocean: the accessibility of the reach from the ocean for steelhead. Even with the removal of Rindge Dam, natural barriers downstream of a specific reach may restrict steelhead use in that reach. Adult steelhead, however, would only attempt to pass Tunnel Falls (a natural barrier approximately 4,900 ft upstream of Rindge Dam that is only passable at high flows) when winter flows were sufficient to open the mouth of Malibu Creek. However, flows required to make Tunnel Falls passable are 50-100 cfs, which is scored as a 0.50 using criteria established by the TAC. This score was used for all reaches above Tunnel Falls as a conservative estimator for the value of upstream barrier removal to minimize overestimation of the benefits of removal of upstream barriers. This provides a stronger confidence in the resulting calculation of numerical benefits from barrier removal.

- D = Aquatic Connectivity to the adjacent downstream reach: gives higher scores to reaches that are more connected to adjacent habitat. Existing and future without project alternatives conditions are based on Abramson and Grimmer (2005) ranking of barrier severity (see **Appendix J4**). Future with project condition is assumed to result in all of the barriers downstream of the reach under evaluation being made passable at most flows.

Variables for the upstream reaches were quantified as described below.

Variable A, Habitat Value:

1.00 Excellent- functioning as in historical condition and able to support robust populations of native fish.

0.75 Good- able to support pertinent life stages of native fish; in good condition but slightly impaired in relation to historical condition.

0.50 Fair- meets all minimum requirements of pertinent life stages of native fish, but substantially impaired in relation to historical condition.

0.25 Poor- marginal value to pertinent life stages of native fish.

0.00 Very Poor- unable to support required life stages (i.e. migration, spawning, and rearing of young).

Variable B, Steelhead Use:

1.00Use of habitat by all appropriate life stages.

0.75Adults and juveniles present.

0.50Adults only.

0.25Adult use possible but poor conditions

0.00No steelhead present in reach.

Variable C, Steelhead Connectivity between the reach to the ocean:

1.00Downstream barriers are passable at most flows (less than 5 cfs).

0.75At least one downstream barrier is only passable at low flows (5 – 50 cfs).

0.50 At least one downstream barrier is only passable at moderate flows (greater than 50 cfs).

0.25At least one downstream barrier is only passable at high flows (greater than 100 cfs).

0.00At least one downstream barrier is not passable.

Note: In Reach 5, Tunnel Falls is a natural low flow barrier located upstream of Rindge dam with a jump height of 2.62 meters and pool depth of 2.13 m which makes it passable at flows greater than 50 cfs.

Variable D, Aquatic Connectivity to the adjacent downstream reach:

1.00Downstream barrier is passable at most flows (less than 5 cfs).

0.75Downstream barrier is passable at low flows (5 – 50 cfs).

0.50Downstream barrier is passable at moderate flows (greater than 50 cfs).

0.25Downstream barrier is passable at high flows (greater than 100 cfs).

0.00Downstream barrier is not passable.

3.3.3 Riparian Habitat Value

Mainstem Reaches

In 2008, four variables, (A, B, C, and D) were selected to represent aspects of riparian habitat in the Malibu Creek ecosystem. In 2012, the Listed Species variable (C) was deleted, as information on the potential for threatened or endangered aquatic species other than steelhead (such as Pacific lamprey, *Lampetra tridentate*) to occur in the system with or without the project is lacking. The TAC also wanted to avoid "double-counting" the value of listed/special-status species in the Habitat Unit calculations. Also in 2012, the TAC decided that the Adjacent Land Use Character variable (D) would not be included in assessment of Riparian Habitat Value, as removal or modification of the dam would not alter land use on adjacent habitat within the state park. Scoring for the mainstem reaches was primarily based on detailed knowledge of the reaches by TAC members and the results of the following studies (Abramson and Grimmer 2005, Caltrout 2006, AIS ET AL. 2007, Dagit and Krug 2011). The Riparian Habitat Value Score was calculated using the following equation:

Riparian Habitat Value Score = (A + B)/2

Where:

- A = Percentage (%) of Native Vegetation is considered an important measure of riparian habitat quality. Determination of native vegetation cover was based on updated, detailed knowledge of local conditions from the TAC.

- B = Percentage (%) of Non-native Vegetation, which was weighted the same as % Native Vegetation, reflects the important role that non-native vegetation plays in riparian habitat quality, and the need to include non-native vegetation removal and control measures in restoration efforts. This variable was scored to reflect a decrease in value with increase in non-native vegetation. Determination of non-native vegetation cover was based on updated, detailed knowledge of local conditions from the TAC.

When scoring this variable, the TAC relied upon the NPS (2008) vegetation mapping, arundo removal project timelines, and on-the ground surveys following the 2007 wildfire. The TAC also assumed that native vegetation was more conducive to supporting a variety of wildlife species, especially those that rely upon native cover to move safely across the landscape. Loss of native vegetation was considered to negatively affect wildlife habitat and movement potential. Additionally, the hardening and erosion/stability of banks is associated with the decrease in native vegetation and serves as a reasonable proxy for evaluating impacts to habitat quality associated with those problems. Much of the mainstem of Malibu Creek, especially between Cross Creek Rd. Bridge and Rindge Dam experiences limited anthropogenic channel impacts, although the overall sediment and erosion patterns, especially that following a wildfire can be significant. The reaches between the Cross Creek Road Bridge and Malibu Lagoon have experienced extensive bank armoring and modification, with associated loss of native vegetation.

Variables for the mainstem reaches were quantified as described below:

Variable A, Percentage of Native Vegetation:

1.0080 to 100 % native cover
0.7560 to 80% native cover
0.5040 to 60% native cover
0.2520 to 40% native cover
0.105 to 20% native cover
0.000- 5% native cover

Variable B, % Non-native Vegetation:

1.000 to 5% cover
0.755 to 20% cover
0.5020 to 40% cover
0.2540 to 60% cover
0.1060-80% cover
0.0080 to 100% cover

Upstream Reaches

As was done for the mainstem reaches, the Listed Species variable (C) and Adjacent Land Use Character variable (D) were deleted for the upstream reaches assessment. Therefore, the Riparian Habitat Value for the upstream reaches was quantified based on two variables, one for the percentage of native vegetation in the reach (Variable A), and the other for the percentage of non-native vegetation (Variable B).

Unlike for the mainstem reaches, updated knowledge from the TAC was not available for the upstream reaches. Native vegetation cover was therefore based on visual observation of aerial photography using Google Earth images dated April 2011. Non-native vegetation cover was based on data for *Arundo donax* (used as a surrogate for non-native vegetation because it is highly invasive and often forms monotypic stands that preclude riparian canopy species) collected by Abramson and Grimmer (2005). National Park Service (NPS) data from 2002 and 2003 on invasive vegetation were reviewed for use in this study, but were ultimately deemed inappropriate as the surveys were conducted from accessible roads and trails, and were not a representative survey. The Riparian Habitat Value Score was calculated using the following equation:

Riparian Habitat Value Score = (A + B)/2

Where:

- A = Percentage (%) of Native Vegetation, based on visual observation of aerial photography (using Google Earth, April 2011).
- B = Percentage (%) of Non-native Vegetation, using the percentage of *Arundo donax* within each reach (based on Abramson and Grimmer (2005); see **Appendix J5**).

Variables for the upstream reaches were quantified as described below.

Variable A, Percentage of Native Vegetation:

1.0080 to 100 % cover
0.7560 to 80% cover
0.5040 to 60% cover
0.2520 to 40% cover
0.105 to 20% cover
0.000 to 5% cover

Variable B, Percentage of Non-Native Vegetation:

1.000 to 5% cover
0.75 5 to 20% cover
0.50 20 to 40% cover
0.25 40 to 60% cover
0.10 60 to 80% cover
0.0080 to 100% cover

3.3.4 Natural Processes

The same two variables (A and B) were used in both the 2008 mainstem and 2013 upstream HE's to quantify the level of alteration of natural processes that affect the Malibu Creek ecosystem. The Natural Processes score was calculated as an average of these two variables:

Natural Processes = (A+B)/2

Where:

- A = Natural Hydrologic Regime: the amount of hydrologic disturbances (dams, levees, water diversions, watershed urbanization, etc.) within and adjacent to the reach. None of the reaches are considered completely natural due to the impact from manmade structures that affect hydrology throughout the watershed.

- B = Natural Sediment Regime: the alterations in the river corridor or adjacent watershed which affect the amount of natural sediment entering the riparian ecosystem. A completely natural sediment regime would only transport sediment from the watershed with no introduced sediments from man-made impoundments or runoff from anthropogenic sources such as farms, residences, industrial, commercial, or recreational developments that add sediment to the stream. None of the reaches are considered to have a completely natural sediment regime due to the impact from such alterations existing throughout the upper watershed and along the main stem of the creek downstream of Cross Creek Road Bridge.

Variables were quantified as described below. Review of the sediment model outputs (**Tables 1-2, Appendix J2**) were used to determine predicted rate and levels of deposition and scour which could potentially change the characteristics of the natural sediment regime within a given reach. Although potential natural low flow passage barriers are present both above and below Rindge Dam, these barriers were all passable at flows associated with migration up and downstream when the lagoon is open and connected to the ocean (Abramson and Grimmer 2005, CalTrout 2006).

Variable A, Natural Hydrologic Regime:

1.00 Natural hydrologic regime-no dams, levees, water diversions, or urbanization within or adjacent to the reach.
0.75 Minimal alteration-small dam, levee (~less than 10 ft), or water diversion present and adjacent watershed contains large areas of natural vegetation.
0.50 Moderate alteration-a large dam, levee (~greater than 10 ft), or water diversion is present within or at end of reach and large areas of natural vegetation communities present in adjacent watershed.
0.25 Substantial alteration- a large dam (~greater than 100 ft) or water diversion is present within or at end of reach and/or adjacent watershed significantly urbanized; limited natural vegetation present.
0.00 Extreme alteration-reach consists of concrete channel and adjacent watershed completely urbanized; limited or no natural vegetation present.

Variable B, Natural Sediment Regime:

1.00 Natural sediment regime- no alterations to the river corridor or adjacent watershed.
0.75 Minimal alteration- minimal alterations such as localized areas of riprap or other bank stabilization structures with large areas of natural vegetation present in adjacent watershed.
0.50 Moderate alteration- small portions of reach are altered by manmade structures and large areas of natural vegetation communities present in adjacent watershed.
0.25 Substantial alteration- large portions of reach are altered by manmade structures (e.g., dam that restricts sediment) and/or significant urbanization of adjacent watershed.
0.00 Not natural at all- reach consists of concrete channel.

3.4 Total Score and Habitat Units

The Total Habitat Value Score is the average of the three ecosystem components described above:

Total Habitat Value Score = (Aquatic Habitat Value + Riparian Habitat Value + Natural Processes)/3

Habitat Units were calculated for each reach as follows:

Habitat Units = Total Habitat Value Score * Acreage

Acreage (mainstem reaches): The acreage for each reach was determined by careful examination of a May 2010 aerial image (Google Earth) by DPR, USACE and RCDSMM staff, overlaid with the 2008 NPS vegetation polygons, the most up-to-date USFWS National Wetlands Inventory boundaries and the 10-yr projected flood map (CDM 2008). Once all of these layers were combined into the best estimate of riparian vegetation extent, the GIS program was used to calculate the area of habitat in acres within each reach.

Acreage (upstream reaches) = amount of stream length within the reach x 300 foot buffer on both sides. As dam removal would not affect sediment transport in the upstream reaches, 300 ft of riparian buffer was chosen by the TAC as a standard width for the upstream reaches, as it appeared to capture all relevant features.

Habitat Units were then averaged over the 50-yr project life to yield Average Annual Habitat Units (AAHU). The gain or loss of AAHU value relative to the Alternative 1 No Action alternative is what was used in the incremental cost analysis. AAHU values were calculated using an annualized model prepared by the USACE's Institute for Water Resources (IWR).

The IWR has developed IWR Planning Suite Decision Support Software to assist with the formulation and comparison of alternative plans. While the IWR Planning Suite was initially developed to assist with environmental restoration and watershed planning studies, the program can be useful in planning studies addressing a wide variety of problems. IWR Planning Suite can assist with plan formulation by combining solutions to planning problems and calculating the additive effects of each combination, or "plan." IWR Planning Suite can also conduct cost effectiveness and incremental cost analyses, identifying the plans which are the best financial investments, and displaying the effects of each on a range of decision variables. Additional information can be found online at: http://www.pmcl.com/iwrplan/

Annualizing ecosystem costs and outputs is required by the USACE planning guidance. The annualizer utility, a function of the IWR Planning Suite Decision Support Software, allows users to interpolate benefits over the period of analysis, in this case the life of the project. The utility estimates average annual benefits. For purposes of average annual habitat units, the National Ecosystem Restoration (NER) module of the annualizer is used. This module was designed to evaluate average annual habitat values (as opposed to costs). Habitat unit values calculated for TY0, TY1, TY10, and TY50 were entered into the calculator. Project life was set to 50 yrs, no maximum score was set, and linear interpolation selected. This is a conservative approach. Most restoration projects see a large initial increase, followed by a gradual approach to full functionality. However, this would be extremely difficult to model and so a more conservative approach was selected. Habitat Units were averaged over the 50-yr project life to yield Average Annual Habitat Units (AAHU) using the annualizer function. The gain or loss of AAHU value relative to the Alternative 1 No Action Alternative is what is used in the incremental cost analysis.

4.0 EXISTING CONDITIONS – MAINSTEM REACH

HE valuations for existing conditions in all reaches are presented in the tables below. The first column lists the variables associated with each of the three primary ecosystem components (Aquatic Habitat Value, Riparian Habitat Value, and Natural Process Value), and the second column presents the scores assigned to each variable at Target Year (TY) 0, or existing conditions. Comments and assumptions are provided to explain the score for each variable.

Equations used to calculate the scores for the three primary ecosystem components are shown in the row following the last variable associated with that component. The Total Score, presented in the third row from the bottom on each table, is an average of the three ecosystem component scores.

The acreage for each reach was determined by a systematic GIS mapping effort. First, the National Wetlands Inventory (NWI) shapefile (2008) was overlaid on an aerial base map photo (Google Earth 2010). The boundaries of this shapefile and associated attributes were used by the USFWS as the basis for identifying the acreage and percentage of Total Area of each habitat type used in the *Draft Fish and Wildlife Coordination Act Report: Malibu Canyon Ecosystem Restoration Feasibility Study* (USFWS 2013). A quick comparison to the layers posted on the socalwetlands.com website was used to confirm that these boundaries were the most up to date version available.

Next the 2008 vegetation layer groundtruthed and analyzed by the National Park Service, Santa Monica Mountains National Recreation Area (NPS) was overlaid on top of the NWI boundaries. This provided additional information on the vegetation type within the NWI as well as adjacent to the creek channel. All of the polygons representing riparian assemblages were selected, as well as polygons that were adjacent to the creek channel or within the floodplain designated as disturbed or mixed riparian species. Additional polygons identified as non-riparian species assemblages, either within the creek channel or floodplain were also examined and the polygons reshaped to capture any additional acres that met the NWI definition for Riverine or Palustrine systems.

Finally, the 10-yr projected flood map was added, showing both the defined limits for each reach, and the extent of potential flooding. A team from USACE, CDPR, NPS and RCDSMM then examined these boundaries from both a plan view, and using the GIS/Google Earth 3D tool to identify topographic features. Exercising best professional judgment based on ongoing fisheries sampling in the mainstem, the team adjusted the polygon boundaries to capture the extent of riparian/wetland acreage.

Even the best mapping tools have limitations, but by utilizing a suite of data layers generated by reputable sources, the extent of riparian/wetland acreage calculated represents the integration of the best available data.

4.1 Existing Conditions Reach 1 Malibu Lagoon

Malibu Lagoon is a seasonal coastal lagoon that represents only a small remnant of its historic area. It is connected to the ocean during the wet season but closed by a beach berm during a good portion of the year. The Pacific Coast Highway (PCH) Bridge bisects the Lagoon and constricts its surface area. For this HE analysis, the Lagoon was considered to be the area between the mouth and PCH Bridge, even though there are tidal influences and functions associated with the Lagoon somewhat upstream of the PCH Bridge. The lagoon consists of 16 ac of estuarine habitat.

Restoration of the lower part of Malibu Lagoon was recently completed by the Malibu Lagoon Restoration and Enhancement Plan, developed through a partnership between the California Coastal Conservancy, California State Parks, Heal the Bay, Santa Monica Bay Restoration Foundation, Resource Conservation District of the Santa Monica Mountains, and other resource and conservation organizations. Phase 1 of the Malibu Lagoon Restoration and Enhancement Plan, included restoration of two acres of paved parking, was completed in April 2008 (Moffat and Nichols 2005). Phase 2 of the lagoon restoration involved habitat enhancement for the tidewater goby and steelhead trout via increasing open water areas and tidal influence, extensive removal of non-native vegetation and revegetation with native species. Restoration also addressed storm drainage inputs, increased circulation, and other measures to restore the ecological structure and function of the Lagoon. Work was completed on this phase by March 2013.

For purposes of this HE, existing conditions in Malibu Lagoon assumed that the restoration activities were completed, and the two acres of former paved parking were included in the habitat acreage, for a total of 16 ac. Existing conditions also assume that non-native vegetation was removed and the Lagoon has been restored to a physical condition that is considered moderately impaired from its historic condition. This is because although the restoration significantly improved tidal circulation and upland and wetland habitat values, the lagoon is still substantially reduced in size, has remaining challenges associated with water quality and adjacent development.

Both adult and juvenile steelhead are anticipated to use the lagoon. Although multiple snorkel surveys have definitively documented steelhead upstream of the lagoon (Dagit and Abramson 2007, Dagit and Krug 2011), lagoon conditions are such that snorkeling is not a safe or effective means of locating smolts within the lagoon. Regardless, the literature strongly supports the presence of smolts in the lagoon, at least for some period each year, as discussed below.

Smoltification is a complex suite of physiologic (gill structure, metabolism, behavior) changes that can begin miles upstream, often take at least several days to complete and does not always proceed in a sequential manner, but instead responds to a variety of cues (McCormick and Saunders 1987, Folmar and Dickhoff 1980). Environmental variables such as temperature and photoperiod are associated with increased salinity tolerance in juveniles over 100 mm FL (Conte and Wagner 1965). Juvenile *O. mykiss* leaving a creek system benefit from the opportunity to undergo physiologic transformation from fresh to salt water metabolism in the more protected brackish waters of coastal estuaries. This transition zone provides enhanced feeding and growth to sizes associated with higher marine survival (Bond et al. 2008).

Estuaries are more than just a linkage between the ocean and the creek. The multiple ecological factors present in these transition zones support the needs of different life stages of salmonids, and the enhanced growth possible in these habitats supports the persistence of the southern steelhead population by increasing marine survival. While we are still learning about the relationships between estuarine habitat types, and the bathymetric and tidal processes forming and maintaining these habitats, it appears that access to estuarine habitat plays an important role in overall juvenile survival, allowing more of these individuals to reach maturity (Bottom et al. 2001, Beck et al. 2001).

The Habitat Units calculated for the Malibu Lagoon under existing conditions is shown in **Table 4.1-1**. A discussion of how the values for each variable were calculated is found below.

Table 4.1-1 Habitat Units for Reach 1 - Malibu Lagoon (Existing Conditions)

	TY0
Aquatic Habitat Value	
A. Habitat Value	0.75
B. Steelhead Use	1.00
C. Steelhead Connectivity	0.50
D. Aquatic Connectivity	0.50
Score = (A+B+C+D)/4	0.69
Riparian Habitat Value	
A. %Native Vegetation Cover	0.75
B. % Non-native Vegetation Cover	1.00
Score=(A+B)/2	0.88
Natural Process Value	
A. Natural Hydrologic Regime	0.50
B. Natural Sediment Regime	0.25
Score=(A+B)/2	0.38
Total Score	0.65
Acreage	16
Habitat Units (H.U.)	10

4.1.1 Aquatic Habitat Value

The Lagoon is considered to be moderately impaired from historic condition, but in good condition following an extensive restoration effort. Restoration activities and plantings however have not had time to mature to full functionality. Habitat value is therefore assigned a score of 0.75.

The Lagoon is impaired for steelhead due to the presence of exotic predators, including crayfish, carp, largemouth bass, and catfish (Dagit and Swift 2005, Dagit and Abramson 2007, Dagit 2013).

The Lagoon has poor water quality, a limited benthic community, and high temperatures. These impairments are expected to improve over time with the Lagoon restoration. Adult steelhead are known to occur in the Lagoon (Ambrose and Orme 2000, Dagit and Ambramson 2007, Dagit and Krug 2011). While there is currently no evidence of use of the Lagoon by smolts based on seining surveys conducted in 2005 and 2012 (Dagit and Swift 2005, Dagit 2013) these surveys are not intended to catch smolts, nor is the gear used capable of catching smolts. TAC member's best professional judgment is that the lagoon is used by smolts prior to their entry into the ocean. This is common in other estuarine systems that allow the smolts to become acclimated to sea water and to feed and grow in a relatively safe and productive system. Therefore, the Lagoon is currently considered to be used by both adults and smolts. Steelhead use is therefore assigned a value of 1.00

The Malibu Lagoon restoration project was designed to increase tidal flows into the back channels to address cumulative sediment deposition that has occurred in this area over time resulting in anoxic conditions and decreased fish and benthic macroinvertebrate diversity. The lagoon restoration took into account sediment movement from the Malibu Creek watershed based on the predicted sediment regime into the future and considered that Rindge Dam would no longer exist. As the restoration is limited to the side channels of the lagoon, and not the main channel, where sediment is expected to move through en route to the ocean, sediment movement associated with the removal of Rindge dam is not anticipated to adversely affect the restored area.

A sand berm inhibits access to the lagoon from the ocean part of the year. While an unpassable barrier when present, the berm is not present year round and is considered to be passable for all flows when absent. The TAC assigned a value of 0.50 for the two Connectivity variables (Steelhead and Aquatic).

4.1.2 Riparian Habitat Value

The Malibu Lagoon Restoration project restored native vegetation to 60-80% cover. Plant cover placed during restoration has not fully matured. %Native Vegetation Cover is assigned a value of 0.75.

Malibu Lagoon Restoration project has removed all non-native vegetation to 0-5% cover. %Non-native Vegetation is assigned a value of 1.00.

4.1.3 Natural Process Value

Hydrology is moderately altered due to the presence of Rindge Dam and urban inputs. Although Rindge Dam is considered to be a large dam, it is not within or at the end of the reach. The adjacent watershed is significantly urbanized. Natural Hydraulic Regime is assigned a value of 0.50.

Sediment regime is substantially altered due to the presence of adjacent structures (PCH Bridge, associated bank protection). Significant urbanization of the surrounding watershed has occurred. Natural Sediment Regime is assigned a value of 0.25.

4.2 Existing Conditions Reach 2 – PCH Bridge to Cross Creek Bridge

This reach is approximately 3,168 ft long and includes 43 ac of riparian habitat as show in **Table 4.2-1**.

Table 4.2-1 Habitat Units for Reach 2 - PCH Bridge to Cross Creek Bridge (Existing Conditions)

	TY0
Aquatic Habitat Value	
A. Habitat Value	0.75
B. Steelhead Use	1.00
C. Steelhead Connectivity	0.75
D. Aquatic Connectivity	1.00
Score = (A+B+C+D)/4	0.88
Riparian Habitat Value	
A. %Native Vegetation Cover	0.75
B. % Non-native Vegetation Cover	0.25
Score=(A+B)/2	0.50
Natural Process Value	
A. Natural Hydrologic Regime	0.50
B. Natural Sediment Regime	0.25
Score=(A+B)/2	0.38
Total Score	0.58
Acreage	43
Habitat Units (H.U.)	25

4.2.1 Aquatic Habitat Value

Aquatic habitat is considered to be slightly impaired when compared to historical conditions, but is considered to be in good condition overall. Habitat value is therefore assigned a score of 0.75.

Surveys of pool habitat quality and fish barriers in this reach indicate this reach has excellent habitat quality overall and no barriers to fish passage (Abramson and Grimmer 2005, Dagit and Krug 2011). **Figure 3.2-1** show an overview of pools within this and other reaches below Rindge Dam. Extensive habitat assessment conducted by CalTrout (2006) documented excellent pool/habitat type, good substrate, and good instream shelter for adult steelhead and excellent pool/habitat type for juveniles from Malibu Lagoon to Rindge Dam. Overall, habitat quality for adult steelhead from Malibu Lagoon to Rindge Dam is considered good. All steelhead life stages utilize this reach under existing conditions. Steelhead use is assigned a value of 1.00.

Surveys of pool habitat quality and fish barriers in this reach indicate this reach has excellent habitat quality overall and no barriers to fish passage (Abramson and Grimmer 2005). A sand berm inhibits access to the lagoon from the ocean part of the year. While an unpassable barrier when present, the berm is not present year round and is considered to be passable for all flows when absent. Steelhead Connectivity is assigned a value of 0.75.
The downstream reach is the lagoon that never dries out. Aquatic Connectivity is assigned a value of 1.00.

4.2.2 Riparian Habitat Value

Based on surveys conducted by the National Park Service (2008), the riparian vegetation from the PCH Bridge to Rindge Dam is a mix of native and non-native vegetation. This reach has 60-80% native riparian vegetation. %Native Vegetation Cover is assigned a value of 0.75.

The presence of non-native, invasive giant reed (*Arundo donax)* was noted. In addition, invasive New Zealand Mud Snails (*Potamopyrgus antipodarum*) have been identified in all lower reaches of Malibu Creek (Dagit and Abramson 2007). This reach has 50-90% non-native vegetation. %Non-native Vegetation is assigned a value of 0.25.

4.2.3 Natural Process Value

Hydrology is moderately altered due to the presence of Rindge Dam and urban inputs. Although Rindge Dam is considered to be a large dam, it is not within or at the end of the reach. The adjacent watershed is significantly urbanized and portions of the west bank are armored. Natural Hydraulic Regime is assigned a value of 0.50.

Sediment regime is substantially altered due to the presence of adjacent structures (PCH Bridge, bank protection). Significant urbanization of the surrounding watershed has occurred. Natural Sediment Regime is assigned a value of 0.25.

4.3 Existing Conditions Reach 3 – Cross Creek Bridge to Big Bend Area

This reach is approximately 7,920 ft long and includes 40 acres of riparian habitat as show in **Table 4.3-1**.

Table 4.3-1 Habitat Units for Reach 3 – Cross Creek Bridge to Big Bend Area (Existing Conditions)

	TY0
Aquatic Habitat Value	
A. Habitat Value	0.75
B. Steelhead Use	1.00
C. Steelhead Connectivity	0.75
D. Aquatic Connectivity	0.25
Score = (A+B+C+D)/4	0.69
Riparian Habitat Value	
A. %Native Vegetation Cover	0.75
B. % Non-native Vegetation Cover	0.25
Score=(A+B)/2	0.50
Natural Process Value	
A. Natural Hydrologic Regime	0.50
B. Natural Sediment Regime	0.25
Score=(A+B)/2	0.38
Total Score	0.52
Acreage	40
Habitat Units (H.U.)	21

4.3.1 Aquatic Habitat Value

The riparian area contains a mix of native and non-native vegetation, including *Arundo donax*. Habitat quality in this reach is considered good (Caltrout 2006), however the benthic community is impaired, based on results in the poor range from sampling in 2005 for the Benthic Index of Biological Integrity (Dagit and Abramson 2007). Habitat value is therefore assigned a score of 0.75.

Based on the findings of recent snorkel surveys in pools located within this reach, adults, juveniles, and intermediate (1 year or older) steelhead are utilizing this reach (Dagit and Abramson 2007, Dagit and Krug 2011). Steelhead use is assigned a value of 1.00.

Steelhead Connectivity is assigned a value of.0.75 as it is passable at low flows.

Mullet Pool (**Figure 3.2-1**) goes dry in the summer on an annual basis for short time periods during the period of record (2005-2013). This pool is located within this reach. Aquatic Connectivity is assigned a value of 0.25.

4.3.2 Riparian Habitat Value

The riparian area contains a mix of native and non-native vegetation, including *Arundo Donax* (AIS ET AL. 2007). Habitat quality in this reach is considered good (Caltrout 2006), however the benthic community is impaired, based on results in the poor range from sampling in 2005 for the Benthic Index of Biological Integrity (Dagit and Abramson 2007). %Native Vegetation Cover is assigned a value of 0.75.

The riparian area contains a mix of native and non-native vegetation, including *Arundo donax*. This reach has 50-90% non-native vegetation. %Non-native Vegetation is assigned a value of 0.25.

4.3.3 Natural Process Value

Hydrology is moderately altered due to the presence of Rindge Dam and urban inputs. Although Rindge Dam is considered to be a large dam, it is not within or at the end of the reach. The adjacent watershed is significantly urbanized at the downstream end, but the upstream end is relatively undisturbed within the state park. Natural Hydraulic Regime is assigned a value of 0.50.

Sediment regime is substantially altered due to the presence of adjacent structures (Cross Creek Bridge, associated bank protection). Moderate urbanization of the surrounding watershed has occurred. Natural Sediment Regime is assigned a value of 0.25.

4.4 Existing Conditions Reach 4 – Big Bend Area to Rindge Dam

This reach of Malibu Creek is approximately 3,696 ft long and includes 35 acres of riparian as show in **Table 4.4-1**.

Table 4.4-1 Habitat Units for Reach 4 – Big Bend Area to Rindge Dam (Existing Conditions)

	TY0
Aquatic Habitat Value	
A. Habitat Value	0.75
B. Steelhead Use	1.00
C. Steelhead Connectivity	0.50
D. Aquatic Connectivity	0.25
Score = (A+B+C+D)/4	0.63
Riparian Habitat Value	
A. %Native Vegetation Cover	0.75
B. % Non-native Vegetation Cover	0.25
Score=(A+B)/2	0.50
Natural Process Value	
A. Natural Hydrologic Regime	0.50
B. Natural Sediment Regime	0.50
Score=(A+B)/2	0.50
Total Score	0.54
Acreage	35
Habitat Units (H.U.)	19

4.4.1 Aquatic Habitat Value

Habitat quality in this reach is considered good (Caltrout 2006) although slightly impaired compared to historical conditions. Habitat value is therefore assigned a score of 0.75.

Recent snorkel surveys in pools located within this reach identified the presence of adults, juveniles, and intermediate steelhead (Dagit and Krug 2011). Creation of redds and spawning, have been noted throughout this reach (Dagit and Abramson 2007, Dagit and Krug 2011). Steelhead use is assigned a value of 1.00.

Abramson and Grimmer (2005) identified one fish passage barrier within this reach, in addition to Rindge Dam itself: a natural cascade barrier passable at moderately high flows. Steelhead Connectivity is assigned a value of 0.50.

Lower and Upper Twin Pools go dry for short time periods during the period of record (2005-2013). These pools are located within this reach. In addition, Mullet Pool located downstream also goes dry in summer on an annual basis. This pool is located in the reach below this reach. Aquatic Connectivity is assigned a value of 0.25.

4.4.2 Riparian Habitat Value

Mix of native and non-native vegetation, including *Arundo donax*. This reach has 60-80% native riparian vegetation. %Native Vegetation Cover is assigned a value of 0.75.

Mix of native and non-native vegetation, including *Arundo donax*. This reach has 50-90% non-native vegetation. %Non-native Vegetation is assigned a value of 0.25.

4.4.3 Natural Process Value

Located within Malibu Creek State Park, adjacent land use is 60-80% unaltered and protected from future development. The adjacent watershed contains large quantities of natural vegetation. However, Rindge Dam is located at the end of the reach resulting in a moderate alteration to the natural hydraulic regime. Natural Hydraulic Regime is assigned a value of 0.50.

Moderate is used in the sense that the dam no longer holds water or sediment. Natural Sediment Regime is assigned a value of 0.50.

4.5 Existing Conditions Reach 5 – Rindge Dam to Cold Creek Confluence

This reach is located within the Malibu Creek State Park and is approximately 7,920 ft long with 28 ac of riparian habitat as show in **Table 4.5-1**.

Table 4.5-1 Habitat Units for Reach 5 – Rindge Dam to Cold Creek Confluence (Existing Conditions)

	TY0
Aquatic Habitat Value	
A. Habitat Value	0.75
B. Steelhead Use	0.00
C. Steelhead Connectivity	0.00
D. Aquatic Connectivity	0.00
Score = (A+B+C+D)/4	0.19
Riparian Habitat Value	
A. %Native Vegetation Cover	0.75
B. % Non-native Vegetation Cover	0.25
Score=(A+B)/2	0.50
Natural Process Value	
A. Natural Hydrologic Regime	0.50
B. Natural Sediment Regime	0.25
Score=(A+B)/2	0.38
Total Score	0.35
Acreage	28
Habitat Units (H.U.)	10

4.5.1 Aquatic Habitat Value

Aquatic habitat is good, but is considered to be slightly impaired compared to historical conditions. Habitat value is therefore assigned a score of 0.75.

Rindge Dam presents a complete barrier to fish in this reach. No steelhead are present in the reach. Steelhead use is assigned a value of 0.

Rindge Dam presents a complete barrier to fish in this reach. Steelhead Connectivity is assigned a value of 0.

Above Rindge, natural barriers are present, including “Tunnel Falls” which consists of a natural waterfall with a 2.62 meter jump that is only passable at high flows 50-100 cfs (Abramson and Grimmer 2005). Rindge Dam prevents any connectivity with downstream reaches. Aquatic Connectivity is assigned a value of 0.

4.5.2 Riparian Habitat Value

This reach has 60-80% native riparian vegetation. %Native Vegetation Cover is assigned a value of 0.75.

This reach has 60-80%Nonnative riparian vegetation. %Non-native Vegetation is assigned a value of 0.25.

4.5.3 Natural Process Value

Rindge Dam is located at the lower end of the reach resulting in a moderate alteration to the natural hydraulic regime. Natural Hydraulic Regime is assigned a value of 0.50.

Sediment regime is substantially altered due to the presence of Rindge Dam at the lower end of the reach. Natural Sediment Regime is assigned a value of 0.25.

5.0 ALTERNATIVES EVALUATED

In addition to the Future Without Project (Alternative 1 No Action), for which evaluation is required, three other project alternatives were evaluated, as described below. These alternatives were selected using a screening process and input from the TAC. Target years at which the habitat valuations are made are assumed to begin upon the start of construction of the alternative, with the exception of Alternative 1 No Action, where no construction would occur.

It should be noted that in the discussion below, values are provided for the potential scour or deposition levels for specific reaches affected by specific project alternatives, based on the USACE modeling results, which are discussed in detail in **Appendix J2**. These values have been compared to the results of Alternative 1 No Action Alternative to clearly communicate the anticipated effect of any given alternative on any given reach. The data are provided in **Appendix J2** (**Tables 1 and 2**).

5.1 Alternative 1 – No Action Alternative

Alternative 1 No Action Alternative assumes the existing hydrology and sediment regime continues through TY50. In addition, no restoration of vegetation is assumed.

Rindge Dam is effectively "full". As discussed in **Appendix B**, sediment flows into the reservoir area, over the dam, and continues downstream. However under optimal hydrologic conditions (a number of years with smaller magnitude events), some deposition could still occur within the reservoir to approach a theoretical depositional slope. Based on the hydrologic record, this optimal hydrologic condition is not likely to occur. As a result, without removal of the dam, the reach immediately downstream would continue to scour at a relatively slow rate. Reaches further downstream where the slope flattens out, would experience an increase of deposition such that on average about seven feet of deposition could be expected in the lower reaches by TY50. The effects of predicted scour and sedimentation on habitat values and the assumptions made in determining these effects are presented in the habitat value calculations for each reach below.

Under Alternative 1 No Action Alternative, the model generally predicts little change in the way of deposition or scour in the Malibu Creek Ecosystem, with the exception of Reach 4 from Big Bend to Rindge Dam and Reach 5 Rindge Dam to Cold Creek. Predicted scour of nearly 3 ft in several portions of the reach is assumed to adversely affect aquatic habitat at TY1 and TY10. Larger scour may occur in the reach above the dam that will have less effect owing to the riparian vegetation and the lack of connectivity to lower reaches. By TY50, the model predicts that these changes in bed elevation would be slight since Rindge Dam will no longer be trapping sediment.

HE valuations for Alternative 1 No Action Alternative conditions in all reaches are presented in **Table 5.1-1** through **Table 5.1-5**. The first column lists the variables associated with each of the three primary ecosystem components (Aquatic Habitat Value, Riparian Habitat Value, and Natural Process Value). The next three columns present the scores assigned to each variable at Target Year (TY) 1, 10 and 50. Comments and assumptions are provided to explain the score for each variable.

5.1.1 Alternative 1: Reach 1 - Malibu Lagoon

Table 5.1-1 Habitat Units for Alternative 1: Reach 1 - Malibu Lagoon

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.50	0.75	0.75
B. Steelhead Use	1.00	1.00	1.00
C. Steelhead Connectivity	0.50	0.50	0.50
D. Aquatic Connectivity	0.50	0.50	0.50
Score = (A+B+C+D)/4	0.63	0.69	0.69
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	1.00	1.00
B. % Non-native Vegetation Cover	1.00	1.00	1.00
Score=(A+B)/2	0.88	1.00	1.00
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.63	0.69	0.69
Acreage	16	16	16
Habitat Units (H.U.)	10	11	11

<u>Aquatic Habitat Value</u>

Vegetation planted as part of the lagoon restoration effort will mature, ongoing maintenance will ensure that non-native plants are removed. Ongoing monitoring and management will ensure that conditions are able to support robust populations of native fish despite ongoing recreational uses of the lagoon and the pressure of adjacent development. Deposition of material is predicted for TY1 and TY 5. The lagoon, following restoration, is expected to be moderately impaired from its historic condition. This is because although the restoration is anticipated to significantly improve tidal circulation and upland and wetland habitat values via restoration efforts, the lagoon is still substantially reduced in size, has significant challenges associated with water quality and adjacent development. Habitat value is therefore assigned a score of 0.50 for TY1 and 0.75 for TY10 and TY50.

Adults and smolts are expected to continue to be present, however no spawning occurs in the lagoon. Steelhead use is assigned a value of 1.00.

The sand berm will continue to form for all future conditions. Therefore this score will remain the same as for existing conditions. Steelhead Connectivity is assigned a value of 0.50.

The sand berm will continue to form for all future conditions. Therefore this score will remain the same as for existing conditions. Aquatic Connectivity is assigned a value of 0.50.

Riparian Habitat Value

Vegetation planted as part of the lagoon restoration effort will mature, ongoing maintenance will ensure that non-native plants are removed. TY1 will be unchanged from existing conditions, however TY10 and TY50 are expected to improve to 80-100% cover. %Native Vegetation Cover is assigned a value of 0.75 for TY1 and 1.00 for TY10 and TY50.

Malibu Lagoon Restoration Project removed non-native vegetation to 0-5% cover; assumed maintenance at this level to TY50. %Non-native Vegetation is assigned a value of 1.00 for all future intervals.

Natural Process Value

The hydrologic and sediment regimes are dominated by adjacent man-made structures (PCH Bridge and associated riprap) and be nearby development (city of Malibu). These are considered to be moderate alterations resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

However, these man-made structures combined with the seasonal closing of the lagoon mouth has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.1.2 Alternative 1: Reach 2 - PCH Bridge to Cross Creek BridgeAquatic Habitat Value

Aquatic habitat would be slightly impaired at TY1, similar to existing conditions. Sedimentation lowers value at TY10 and TY50, but more naturalized sediment regime would improve habitat quality by TY50. Habitat value is therefore assigned a score of 0.75 for TY1, 0.50 for TY10, and 0.75 for TY50.

Steelhead use is expected to remain unchanged for TY1. By TY10, deposition of sediments is expected to impact spawning as deposited materials are expected to be finer than that preferred and may no longer be suitable for spawning habitat. This is an area of the stream that widens out, reducing water velocities that carried the finer sediments to this point. This area is also estuarine, salinity changes will contribute to the flocculation and deposition of finer sediment fractions in this area. Steelhead use is assigned a value of 1.00 for TY1 and 0.75 for TY10 and TY50.

Steelhead Connectivity is assigned a value of 1.00 for all future time intervals as it is assumed constant.

Aquatic Connectivity is assigned a value of 1.00 for all future time intervals as it is assumed constant.

Table 5.1-2 Habitat Units for Alternative 1: Reach 2 PCH Bridge to Cross Creek Bridge

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.75	0.50	0.75
B. Steelhead Use	1.00	0.75	0.75
C. Steelhead Connectivity	1.00	1.00	1.00
D. Aquatic Connectivity	1.00	1.00	1.00
Score = (A+B+C+D)/4	0.94	0.81	0.88
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	0.75	0.75
B. % Non-native Vegetation Cover	0.25	0.25	0.25
Score=(A+B)/2	0.50	0.50	0.50
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.60	0.56	0.58
Acreage	43	43	43
Habitat Units (H.U.)	26	24	25

Riparian Habitat Value

%Native Vegetation Cover is assigned a value of 0.75 for all future time intervals because no change is expected to vegetation cover.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

Natural Process Value

The hydrologic and sediment regimes are dominated by adjacent man-made structures (PCH Bridge and associated riprap, Cross Creek Bridge) and by nearby development (city of Malibu). These are considered to be moderate alterations resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

However, these man-made structures combined with the seasonal closing of the lagoon mouth has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.1.3 Alternative 1: Reach 3 - Cross Creek Bridge to Big Bend Area

Table 5.1-3 Habitat Units for Alternative 1: Reach 3 – Cross Creek Bridge to Big Bend Area

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.75	0.75	0.75
B. Steelhead Use	1.00	0.75	0.75
C. Steelhead Connectivity	0.75	0.75	0.75
D. Aquatic Connectivity	0.25	0.25	0.25
Score = (A+B+C+D)/4	0.69	0.63	0.63
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	0.75	0.75
B. % Non-native Vegetation Cover	0.25	0.25	0.25
Score=(A+B)/2	0.50	0.50	0.50
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.52	0.50	0.50
Acreage	40	40	40
Habitat Units (H.U.)	21	20	20

<u>Aquatic Habitat Value</u>

The lower portion (nearest Cross Creek Bridge) of this reach would receive greater than 5 ft of deposition at TY10 and TY50. Since this represents less than one quarter of the reach, aquatic habitat overall would not be affected through TY50. Habitat value is therefore assigned a score of 0.75 for all future time intervals.

The lower portion (nearest Cross Creek Bridge) of this reach would receive greater than 5 ft of deposition at TY10 and TY50. This could cause interrupted flow during the summer low flow season, reduce suitability of refugia pools in this reach and isolate juvenile rearing areas. Although this represents less than one quarter of the reach, steelhead use could be affected through TY50. Steelhead use is assigned a value of 1.00 for TY1 and 0.75 for all future intervals.

Steelhead Connectivity is assigned a value of 0.75 for all future time intervals as it passable at low flows.

Mullet Pool goes dry in the summer on an annual basis for the period of record. Aquatic Connectivity is assigned a value of 0.25 for all future time intervals.

Riparian Habitat Value

%Native Vegetation Cover is assigned a value of 0.75 for all future time intervals because no change is expected to vegetation cover.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

Natural Process Value

The hydrologic and sediment regimes are influenced by Rindge Dam. This is considered to be moderate alteration for this reach resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

However, this has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.1.4 Alternative 1: Reach 4 - Big Bend Area to Rindge Dam

Table 5.1-4 Habitat Units for Alternative 1: Reach 4 – Big Bend Area to Rindge Dam

	TY1	**TY10**	**TY50**
Aquatic Habitat Value			
A. Habitat Value	0.75	0.50	0.75
B. Steelhead Use	1.00	0.50	1.00
C. Steelhead Connectivity	0.50	0.50	0.50
D. Aquatic Connectivity	0.25	0.25	0.25
Score = (A+B+C+D)/4	0.63	0.44	0.63
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	0.75	0.75
B. % Non-native Vegetation Cover	0.25	0.25	0.25
Score=(A+B)/2	0.50	0.50	0.50
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.50	0.44	0.50
Acreage	35	35	35
Habitat Units (H.U.)	18	15	18

<u>Aquatic Habitat Value</u>

Sediment model predicts significant scour, which would degrade aquatic habitat starting in TY 5. Degradation is still assumed to be present at TY10. Conditions at TY1 are unchanged from existing conditions. Model indicates stabilization in sediment regime by TY10. Habitat value is therefore assigned a score of 0.75 for TY1, 0.50 for TY10, and 0.75 for TY50.
Steelhead Conditions at TY1 are unchanged from existing conditions. At TY10, spawning would be eliminated. Only adult steelhead would be present as breeding/rearing would cease. By TY50, a more natural sediment regime would result where both aquatic habitat quality and steelhead use scores improve to the existing conditions score. Steelhead use is assigned a value of 1.00 for TY1, 0.50 for TY10, and 1.00 for TY50.

This reach would be passable for steelhead at moderate flows; assumed constant to TY50. Steelhead Connectivity is assigned a value of 0.50 for all future time intervals.

Lower and Upper Twin Pools have gone dry for short time periods during the period of record (2005-2013). These pools are located within this reach. In addition, Mullet Pool goes dry on an annual basis for short time periods for the period of record. This pool is located in the reach below this reach. Aquatic Connectivity is assigned a 0.25 for all future time intervals.

<u>Riparian Habitat Value</u>

%Native Vegetation Cover is assigned a value of 0.75 for all future time intervals because no change is expected to vegetation cover.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

<u>Natural Process Value</u>

The hydrologic and sediment regimes are dominated by Rindge Dam. This is considered to be moderate alteration for this reach resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

However, this has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.1.5 Alternative 1: Reach 5 – Rindge Dam to Cold Creek Confluence

<u>Aquatic Habitat Value</u>

Sediment model predicts significant deposition/scour, which would degrade aquatic habitat starting in TY 5. Degradation is still assumed to be present at TY10. Conditions at TY1 are unchanged from existing conditions. Model indicates stabilization in sediment regime by TY10. Habitat value is therefore assigned a score of 0.75 for TY1, 0.50 for TY10, and 0.75 for TY50.
Rindge Dam remains as a complete barrier; no steelhead would be in the reach. Steelhead use is assigned a value of 0 for all future time intervals.

Rindge Dam presents a complete barrier to fish in this reach. Steelhead Connectivity is assigned a value of 0.

Above Rindge, natural barriers are present, including “Tunnel Falls” which consists of a natural waterfall (2.62 meters) that is only passable at high flows (50-100 cfs). Rindge Dam prevents any connectivity with downstream reaches. Aquatic Connectivity is assigned a value of 0.

Table 5.1-5 Habitat Units for Alternative 1: Reach 5 – Rindge Dam to Cold Creek Confluence

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.75	0.50	0.75
B. Steelhead Use	0.00	0.00	0.00
C. Steelhead Connectivity	0.00	0.00	0.00
D. Aquatic Connectivity	0.00	0.00	0.00
Score = (A+B+C+D)/4	0.19	0.13	0.19
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	0.75	0.75
B. % Non-native Vegetation Cover	0.25	0.25	.0.25
Score=(A+B)/2	0.50	0.50	0.50
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.35	0.33	0.35
Acreage	28	28	28
Habitat Units (H.U.)	10	9	10

<u>Riparian Habitat Value</u>

%Native Vegetation Cover is assigned a value of 0.75 for all future time intervals because no change is expected to vegetation cover.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

<u>Natural Process Value</u>

The hydrologic and sediment regimes are dominated by Rindge Dam. This is considered to be moderate alteration for this reach resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

The presence of Rindge Dam has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.2 Alternative 2 Dam Removal with Mechanical Transport Habitat Value Calculations

The Alternative 2 Dam Removal with Mechanical Transport entails the removal of the entire concrete arch and spillway of Rindge Dam as well as approximately 93 ft (or nearly all) of the sediment behind the dam by mechanical means down to the existing bedrock. Restoration of native vegetation and removal of non-native vegetation in the riparian area would occur in Reach 5 from this alternative. Removal of the dam and impounded sediment would take place in stages over five - eight years with no construction during the winter rain season. TY 5 represents the end of construction for this alternative for purposes of this HE.

According to the USACE' hydrodynamic model, significant scour would occur in the upstream Reach 5 from Rindge Dam to Cold Creek as well as in Reach 4 immediately downstream of Rindge Dam. Deposition would occur in the lower portion of Reach 3 Cross Creek Bridge to Big Bend reach, and in all lower reaches. In Reach 1 Malibu Lagoon, up to approximately 1 foot of sediment would be deposited due to the project. Deposition amounts in all reaches are less under this alternative than those predicted under Alternative 3 Dam Removal with Natural Transport and Alternative 4 Dam Removal with Hybrid Mechanical and Natural Transport. By TY50, the sediment regime would have stabilized such that less than 1 foot of additional deposition or scour would occur from TY10 to TY50 in most portions of each reach. The effects of predicted sedimentation and scour on habitat values and the assumptions made in determining these effects are presented in the habitat value calculations for each reach below.
HE valuations for the Alternative 2 Dam Removal with Mechanical Transport for all reaches are presented in **Table 5.2-1** through **Table 5.2-5**. The first column lists the variables associated with each of the three primary ecosystem components (Aquatic Habitat Value, Riparian Habitat Value, and Natural Process Value). The next three columns present the scores assigned to each variable at Target Year (TY) 1, 10 and 50. Comments and assumptions are provided to explain the score for each variable.

5.2.1 Alternative 2: Reach 1 – Malibu Lagoon

Table 5.2-1 Habitat Units for Alternative 2: Reach 1 – Malibu Lagoon

	TY1	**TY10**	**TY50**
Aquatic Habitat Value			
A. Habitat Value	0.50	0.50	0.75
B. Steelhead Use	1.00	1.00	1.00
C. Steelhead Connectivity	0.50	0.50	0.50
D. Aquatic Connectivity	0.50	0.50	0.50
Score = (A+B+C+D)/4	0.63	0.63	0.69
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	1.00	1.00
B. % Non-native Vegetation Cover	1.00	1.00	1.00
Score=(A+B)/2	0.88	1.00	1.00
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.63	0.67	0.69
Acreage	16	16	16
Habitat Units (H.U.)	10	11	11

Aquatic Habitat Value

Vegetation planted as part of the lagoon restoration effort will mature, ongoing maintenance will ensure that non-native plants are removed. Ongoing monitoring and maintenance will ensure that conditions are able to support robust populations of native fish despite ongoing recreational uses of the lagoon and the pressure of adjacent development. This alternative is predicted to result in slightly less than one foot of sediment deposition in one station in the Lagoon at TY1. At TY 5, slightly more than two feet of additional deposition would occur with negligible deposition by TY10, and a natural sediment regime would return by TY50. Aquatic habitat, as well as native vegetation, would be the same as existing conditions at TY1, but adversely affected at TY10, and a more natural condition at TY50. The lagoon, following restoration, is expected to be moderately impaired from its historic condition. This is because although the restoration is anticipated to significantly improve tidal circulation and upland and wetland habitat values via restoration efforts, the lagoon is still substantially reduced in size, has significant challenges associated with water quality and adjacent development. Habitat value is therefore assigned a score of 0.5 for TY1 and TY10, and 0.75 for TY50.

Adults and smolts are expected to continue to be present, however no spawning is expected to occur in the lagoon. Therefore, Steelhead use is assigned a value of 1.00.
The sand berm will continue to form for all future conditions. Therefore this score will remain the same as for existing conditions. Steelhead Connectivity is assigned a value of 0.50 for all future time intervals.

The sand berm will continue to form for all future conditions. Therefore this score will remain the same as for existing conditions. Aquatic Connectivity is assigned a value of 0.50 for all future time intervals.

Riparian Habitat Value

Vegetation planted as part of the lagoon restoration effort will mature, ongoing maintenance will ensure that non-native plants are removed. TY1 will be unchanged from existing conditions, however TY10 and TY50 are expected to improve to 80-100% cover. %Native Vegetation Cover is assigned a value of 0.75 for TY1 and 1.00 for TY10 and TY50.

The Malibu Lagoon Restoration Project removed non-native vegetation to 0-5% cover; assumed maintenance at this level to TY50. %Non-native Vegetation is assigned a value of 1.00 for all future intervals.

Natural Process Value

Removal of Rindge Dam would not appreciably alter the hydrologic and sediment regimes, which are dominated by adjacent man-made structures (PCH Bridge and associated riprap) and be nearby development (city of Malibu). These are considered to be moderate alterations resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

However, these man-made structures combined with the seasonal closing of the lagoon mouth has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.2.2 Alternative 2: Reach 2 - PCH Bridge to Cross Creek Bridge

Table 5.2-2 Habitat Units for Alternative 2: Reach 2 – PCH Bridge to Cross Creek Bridge

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.75	0.50	0.75
B. Steelhead Use	1.00	0.75	1.00
C. Steelhead Connectivity	1.00	1.00	1.00
D. Aquatic Connectivity	1.00	1.00	1.00
Score = (A+B+C+D)/4	0.94	0.81	0.94
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	0.75	0.75
B. % Non-native Vegetation Cover	0.25	0.25	0.25
Score=(A+B)/2	0.50	0.50	0.50
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.60	0.56	0.60
Acreage	43	43	43
Habitat Units (H.U.)	26	24	26

Aquatic Habitat Value

Under this alternative, deposition of over 3 ft is expected at TY10 throughout the reach, up to a maximum of over 7 ft. Aquatic habitat is slightly impaired at TY1, similar to existing conditions. This deposition is considered to adversely affect the aquatic habitat score at TY10 burying substrate and vegetation. Sedimentation lowers value at TY10 and TY50, but more naturalized sediment regime would improve habitat quality by TY50. Evidence of increased erosion in the upper part of the reach is seen in the bed elevation graphs for TY 5 and TY10 leading to a flattening of the reach allowing finer particles to settle. Habitat value is therefore assigned a score of 0.75 for TY1, 0.50 for TY10, and 0.75 for TY50.

Steelhead use is expected to remain unchanged for TY1. Deposition of sediments is expected to impact spawning as deposited materials are expected to be finer than that experienced in upstream reaches. The sediment may no longer be suitable for spawning habitat. This is an area of the stream that widens out reducing water velocities that carried the finer sediments to this point. This area is also partly estuarine, and salinity changes could contribute to the flocculation and deposition of finer sediment fractions in this area. Steelhead use is assigned a value of 1.00 for TY1 and 0.75 for TY10 and 1.00 for TY50.

Steelhead Connectivity is assigned a value of 1.00 for all future time intervals as it is assumed constant.

Aquatic Connectivity is assigned a value of 1.00 for all future time intervals as it is assumed constant.

Riparian Habitat Value

%Native Vegetation Cover is assigned a value of 0.75 for all future time intervals because no change is expected to vegetation cover.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

Natural Process Value

The hydrologic and sediment regimes are dominated by adjacent man-made structures (PCH Bridge and associated riprap, Cross Creek Bridge) and by nearby development (city of Malibu). These are considered to be moderate alterations resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

However, these man-made structures combined with the seasonal closing of the lagoon mouth has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.2.3 Alternative 2: Reach 3 Cross Creek Bridge to Big Bend Area

Table 5.2-3 Habitat Units for Alternative 2: Reach 3 – Cross Creek Bridge to Big Bend Area

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.75	0.75	0.75
B. Steelhead Use	1.00	0.75	1.00
C. Steelhead Connectivity	0.75	0.75	1.00
D. Aquatic Connectivity	0.25	0.50	0.50
Score = (A+B+C+D)/4	0.69	0.69	0.81
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	0.75	0.75
B. % Non-native Vegetation Cover	0.25	0.25	0.25
Score=(A+B)/2	0.50	0.50	0.50
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.52	0.52	0.56
Acreage	40	40	40
Habitat Units (H.U.)	21	21	23

Aquatic Habitat Value

The USACE hydrodynamic model predicts that sediment deposition in this reach would be similar to the Alternative 1 No Action Alternative, but occur earlier in time. Depositional impacts are greater for TY1 and approximately the same for TY10 and TY50. Thus, although some initial scour would be followed by some deposition in the upper portion of the reach, aquatic habitat would not be adversely affected overall. By TY50, a stable sediment regime would be established. Evidence of increased erosion throughout the reach is seen in the bed elevation graphs for TY 5 and TY10 leading to a deepening of the reach. Habitat value is therefore assigned a score of 0.75 for all future time intervals.

The lower portion (nearest Cross Creek Bridge) of this reach would receive greater than 5 ft of deposition at TY1, TY10, and TY50. Although this represents less than one quarter of the reach, steelhead use could be affected through TY10. Therefore steelhead use is assigned a value of 1.00 for TY1, 0.75 for TY10, and 1.00 for TY 50

Steelhead Connectivity is assigned a value of 0.75 for TY1 and TY10 but improves to 1.00 by TY 50.

Mullet Pool goes dry in the summer on an annual basis for the period of record. The erosion of the upper portion of the reach could reduce the possibility of the pool drying out. Aquatic Connectivity is assigned a value of 0.25 TY1 and 0.50 for TY10 and TY50.

Riparian Habitat Value

%Native Vegetation Cover is assigned a value of 0.75 for all future time intervals because no change is expected to vegetation cover.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

Natural Process Value

Removal of Rindge Dam would not appreciable alter the hydrologic and sediment regimes, which are dominated by adjacent man-made structures (Cross Creek Bridge) in the lower portion of the reach. These are considered to be moderate alterations resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

However, these man-made structures has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.2.4 Alternative 2: Reach 4 Big Bend Area to Rindge Dam

Table 5.2-4 Habitat Units for Alternative 2: Reach 4 – Big Bend Area to Rindge Dam

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.75	0.75	0.75
B. Steelhead Use	0.00	1.00	1.00
C. Steelhead Connectivity	0.50	0.50	0.50
D. Aquatic Connectivity	0.25	0.25	0.25
Score = (A+B+C+D)/4	0.38	0.63	0.63
Riparian Habitat Value			
A. %Native Vegetation Cover	0.50	0.75	0.75
B. % Non-native Vegetation Cover	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.50	0.50
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.75	0.75
B. Natural Sediment Regime	0.50	0.75	0.75
Score=(A+B)/2	0.50	0.75	0.75
Total Score	0.42	0.63	0.63
Acreage	35	35	35
Habitat Units (H.U.)	15	22	22

<u>Aquatic Habitat Value</u>

The sediment model predicts scour in the reach similar to Alternative 1. Habitat value is therefore assigned a score of 0.75 for TY1, 0.75 for TY10, and 0.75 for TY50.

At TY1, spawning would be eliminated in the dam area by construction impacts but could continue in downstream portions of the reach. Extensive scour in the area below the dam would eventually restore a large pool area. By TY10, a more natural sediment regime would result where both aquatic habitat quality and steelhead use scores improve to the existing conditions score. Steelhead use is assigned a value of 0 for TY1, 1.00 for TY10, 1.00 for TY50.

This reach would be passable for steelhead at moderate flows; assumed constant to TY50. Steelhead Connectivity is assigned a value of 0.50 for all future time intervals.

Lower and Upper Twin Pools have gone dry for periods during the period of record (2005-2013). These pools are located within this reach. In addition, Mullet Pool also goes dry during the summer on an annual basis for the period of record. This pool is located in the reach below this reach. Aquatic Connectivity is assigned a value of 0.25 for all future time intervals.

Riparian Habitat Value

Sediment model predicts significant scour, which would degrade aquatic habitat starting in TY1. Recovery is expected by TY10. %Native Vegetation Cover is assigned a value of 0.50 for TY1 and 0.75 for TY10 and TY50.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

Natural Process Value

The dam would still largely be in place at TY1, therefore its score is the same as for Alternative 1 No Action Alternative. Full dam removal would be in effect at TY 5. Scores for TY10 and TY50 thus reflect a return to a more natural hydraulic regime with minimal alteration from man-made flows from Tapia. Natural Hydraulic Regime is assigned a value of 0.50 for TY1 and 0.75 for TY10 and TY50.

Substantial scour of sediment at TY1 is predicted but becomes more stable natural sediment regime by TY10. Natural Sediment Regime is assigned a value of 0.50 for TY1 and 0.75 for TY10 and TY50.

5.2.5 Alternative 2: Reach 5 Rindge Dam to Cold Creek Confluence

Table 5.2-5 Habitat Units for Alternative 2: Reach 5 – Rindge Dam to Cold Creek Confluence

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.50	0.75	0.75
B. Steelhead Use	0.00	1.00	1.00
C. Steelhead Connectivity	0.00	0.50	0.50
D. Aquatic Connectivity	0.00	0.50	0.50
Score = (A+B+C+D)/4	0.13	0.69	0.69
Riparian Habitat Value			
A. %Native Vegetation Cover	0.00	0.75	0.75
B. % Non-native Vegetation Cover	1.00	1.00	1.00
Score=(A+B)/2	0.50	0.88	0.88
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.75	0.75
B. Natural Sediment Regime	0.25	0.75	0.75
Score=(A+B)/2	0.38	0.75	0.75
Total Score	0.33	0.77	0.77
Acreage	28	28	28
Habitat Units (H.U.)	9	22	22

Aquatic Habitat Value

According to the model, this reach would experience substantial scour in the lower section at TY1 and TY 5. By TY10, no additional scour is predicted and by TY50, a stable sediment regime would be established. Aquatic habitat value and steelhead use are all adversely affected at TY1, recovering fully by TY50. Habitat value is therefore assigned a score of 0.5 for TY1 and 0.75 for TY10 and TY50.

The dam would still largely be in place at TY1, therefore no steelhead access. Starting at TY 5 full access would be provided by completion of dam removal. Steelhead use is assigned a value of 0 for TY1 and 1.00 for TY110 and TY50.

The dam would still largely be in place at TY1. Following removal of Rindge Dam, this reach would remain passable at high flows due to "Tunnel Falls"; assumed constant to TY50. Steelhead Connectivity is assigned a value of 0 for TY1 and 0.50 for TY10 and TY50.

The dam would still largely be in place at TY1. Following removal of Rindge Dam, this reach would remain passable at high flows due to "Tunnel Falls"; assumed constant to TY50. Aquatic Connectivity is assigned a value of 0 for TY1 and 0.50 for TY10 and TY50.

Riparian Habitat Value

Native riparian vegetation would be completely removed at TY1 only, increasing in score following transplants during years 5-8 to TY50. Assumed restoration of native vegetation cover beginning at TY10 reaching maturity at TY50. %Native Vegetation Cover is assigned a value of 0.00 for TY1, and 0.75 for TY10 and TY50.

Assumed removal of all non-native vegetation at TY1; assumed maintenance to TY50. %Non-native Vegetation is assigned a value of 1.00 for all future time intervals.

Natural Process Value

The dam would still largely be in place at TY1, therefore there is no change from no-action conditions. Starting at TY 5 a more natural hydraulic regime would be provided by completion of dam removal. Scores for TY10 and TY50 thus reflect a return to a more natural hydraulic regime with minimal alteration from man-made flows from Tapia. Natural Hydraulic Regime is assigned a value of 0.50 for TY1 and 0.75 for TY10 and TY50.

Substantial scour of sediment at TY1; stable natural sediment regime by TY50. Natural Sediment Regime is assigned a value of 0.25 for TY1 and 0.75 for TY10 and TY50.

5.3 Alternative 3 Dam Removal with Natural Transport Habitat Value Calculations

Under this restoration alternative, the entire concrete arch of Rindge Dam and the spillway would be removed and the sediment behind the Dam would then be allowed to move by natural sediment transport. Restoration of native vegetation and removal of non-native vegetation in the riparian area of Reach 5 is assumed with this alternative. Full dam removal and disposal of the concrete that forms the dam may take twenty to one hundred years to complete, however for purposes of this evaluation, are assumed to be completed within fifty years. The hydrology and hydraulics analyses for this alternative assumed a one-year period for removal of the entire dam followed by erosion of the accumulated sediment. This has been shown to have potential downstream impacts on safety owing to deposition of sediments in downstream reaches that would increase flood risks. For that reason, this alternative has been modified to reflect 5-foot increments removed from the dam during the summer construction period, allowing the sediment in that increment to erode and flow downstream during the subsequent winter rainy season. While not specifically modeled, this approach can be evaluated using existing modeling data. TY1 represents the first 5-foot increment. This is similar to TY1 for Alternative 4 Dam Removal with Hybrid and Mechanical Transport where a 5-foot increment of sediment is left to erode in a similar manner. Therefore, we will be using the TY1 model results for the combined transport alternative to represent TY1 for the modified natural transport alternative. This cannot be applied to the reach above Rindge Dam because the model assumes that half the dam is gone at TY1 where only the first 5-foot increment would be removed under this alternative, thus impacts affecting hydraulic regimes for Reach 5 above the dam have not been modeled. TY1 for the reach above Rindge Dam and all reaches for TY 5, TY10, and TY50 cannot be compared to any existing data sets, so the scoring for conditions has to be determined based on the best professional judgment of the TAC without benefit of the **Appendix B** modeling results.

We are assuming that, for this revised alternative, the bulk of the dam will remain in place at TY10, thus affecting scoring of other indices for this milestone year. Material will likely still be in place at TY50, representing an impassable barrier.

The estimated amount of sediment behind the dam is currently 780,000 CY. In general, according to the USACE's hydrodynamic model, natural transport of this amount of sediment results in significant scour in Reach 4 below Rindge Dam. Significant amounts of deposition in Reach 3 from Cross Creek Bridge to Big Bend area and in Reach 2 from PCH Bridge to Cross Creek Bridge could occur. Malibu Lagoon (Reach 1) would receive approximately 2-5 ft of deposition within 50 years. By TY50, the sediment regime for each reach would not have stabilized. The effects of predicted sedimentation and scour on habitat values and the assumptions made in determining these effects are presented in the habitat value calculations for each reach below.

USACE considered several options for protecting property from potential predicted increased flood hazard. Ultimately, floodwalls were used because they are the easiest, least costly, and most feasible mechanism for providing the needed flood protection. Buying out properties is considered infeasible due to local inflated real estate costs, and any other mechanism (i.e. levees) would be far larger in scope, cost, and impact.

To offset increased risk of flooding due to this alternative, approximately 3,100 ft of floodwalls would be constructed on both sides of the creek from about Cross Creek Bridge downstream to Pacific Coast Highway, for a total combined length of about 6,200 ft (**Figure 5.3-1**). The proposed floodwall design would be an I-wall, which consists of a sheetpile driven vertically into the top of the creek bank approximately 25 ft down to protect against potential bank erosion. The sheetpile would be capped on top with a pile cap, approximately 3 ft by 3 ft. An approximate 10 foot concrete floodwall would be constructed on top of the pile cap. The wall alignment would follow the top of the creek bank on both sides. An approximate 45-ft width area extending the length of the wall alignment would be needed for construction. Equipment needed for the wall construction includes two cranes, a dozer, a grader, and four to five trucks. At completion of construction, about a 15-ft wide access road would need to be maintained along portions of the floodwall to accommodate for future maintenance of the structure. Construction of the floodwall would occur during TY 1.

The floodwall is anticipated to affect the lateral movement of all terrestrial animals by interrupting and constricting wildlife migration and movement opportunities, and increasing the potential for invasive plant species. Armoring the creek bank may increase flow velocities during flood events that could be problematic for tidewater gobies and migrating steelhead trout, as well as decrease extent of riparian vegetation and reduce the availability of velocity refugia. On-going maintenance would decrease habitat value overall. The dynamics of flow changes, sediment deposition and scour within the main body of the lagoon and how these could potentially affect tidewater goby breeding areas as well as potential alteration of berm breaching have not been specifically modeled. Given these uncertainties, the TAC assumed that overall habitat values would be impacted and would subsequently decrease, rather than recover over time.

This evaluation assumes a fifty-year dam removal process. TY1 results are for conditions immediately following the first incremental removal and erosion of the accumulated sediments. Under the Alternative 3 Dam Removal with Natural Transport, significant amounts of deposition (and some scour) in most reaches of the Malibu Creek Ecosystem are expected.

HE valuations for the Alternative 3 Dam Removal with Natural Transport for all reaches are presented in **Table 5.3-1** through **Table 5.3-5**. The first column lists the variables associated with each of the three primary ecosystem components (Aquatic Habitat Value, Riparian Habitat Value, and Natural Process Value). The next three columns present the scores assigned to each variable at Target Year (TY) 1, 10 and 50. Comments and assumptions are provided to explain the score for each variable.

Figure 5.3-1 Preliminary Concept for Floodwalls required for Alternatives 3 and 4.

5.3.1 Alternative 3: Reach 1 Malibu Lagoon

Table 5.3-1 Habitat Units for Alternative 3: Reach 1 – Malibu Lagoon

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.50	0.25	0.25
B. Steelhead Use	1.00	0.50	0.50
C. Steelhead Connectivity	0.50	0.50	0.50
D. Aquatic Connectivity	0.50	0.50	0.50
Score = (A+B+C+D)/4	0.63	0.44	0.44
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	1.00	1.00
B. % Non-native Vegetation Cover	1.00	1.00	1.00
Score=(A+B)/2	0.88	1.00	1.00
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.63	0.60	0.60
Acreage	16	16	16
Habitat Units (H.U.)	10	10	10

<u>Aquatic Habitat Value</u>

Vegetation planted as part of the lagoon restoration effort will mature, ongoing maintenance will ensure that non-native plants are removed. Ongoing monitoring and maintenance will ensure that conditions are able to support robust populations of native fish despite ongoing recreational uses of the lagoon and the pressure of adjacent development. This alternative is predicted to result in slightly less than 2 ft of sediment deposition in one station in the Lagoon at TY1. At TY50, slightly more than 3 ft of additional deposition would occur. Aquatic habitat, as well as native vegetation, would be the same as existing conditions at TY1, but adversely affected at TY10 and TY50. The lagoon, following restoration, is expected to be moderately impaired from its historic condition. This is because although the restoration is anticipated to significantly improve tidal circulation and upland and wetland habitat values via restoration efforts, the lagoon is still substantially reduced in size, has significant challenges associated with water quality and adjacent development. Floodwalls in the reach upstream of the lagoon would increase the velocity and volume of storm flows above the five-year storm event, but would not affect hydrologic conditions of the lagoon (timing and duration of breaching) under non-storm conditions (Kerry Casey, USACE, personal communication). Habitat value is therefore assigned a score of 0.50 for TY1, 0.25 TY10 and TY50.

Adults and smolts are expected to continue to be present, however no spawning occurs in the lagoon. Therefore, for TY1 Steelhead use is assigned a value of 1.00. Reduction of lagoon depth associated with increased sedimentation could result in constrained conditions for steelhead, so use is reduced to 0.50 in TY10 and TY50.

The sand berm will continue to form for all future conditions. Therefore this score will remain the same as for existing conditions. Steelhead Connectivity is assigned a value of 0.50 for all future time intervals.

The sand berm will continue to form for all future conditions. Therefore this score will remain the same as for existing conditions. Aquatic Connectivity is assigned a value of 0.50 for all future time intervals.

Riparian Habitat Value

Vegetation planted as part of the lagoon restoration effort will mature, ongoing maintenance will ensure that non-native plants are removed. TY1 will be unchanged from existing conditions; however TY10 and TY50 are expected to improve to 80-100% cover. %Native Vegetation Cover is assigned a value of 0.75 for TY1 and 1.00 for TY10 and TY50.

Malibu Lagoon Restoration Project removed non-native vegetation to 0-5% cover; assumed maintenance at this level to TY50. %Non-native Vegetation is assigned a value of 1.00 for all future intervals.

Natural Process Value

Removal of Rindge Dam would not appreciably alter the hydrologic regimes, which are dominated by adjacent man-made structures (PCH Bridge and associated riprap) and by nearby development (city of Malibu). These are considered to be moderate alterations resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

However, these man-made structures, including the floodwalls, combined with the seasonal closing of the lagoon mouth has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.3.2 Alternative 3: Reach 2 PCH Bridge to Cross Creek Bridge

Table 5.3-2 Habitat Units for Alternative 3: Reach 2 – PCH Bridge to Cross Creek Bridge

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.50	0.50	0.25
B. Steelhead Use	0.25	0.25	0.25
C. Steelhead Connectivity	0.75	0.75	0.50
D. Aquatic Connectivity	0.75	0.75	0.75
Score = (A+B+C+D)/4	0.56	0.56	0.44
Riparian Habitat Value			
A. %Native Vegetation Cover	0.25	0.25	0.25
B. % Non-native Vegetation Cover	0.25	0.00	0.00
Score=(A+B)/2	0.25	0.13	0.13
Natural Process Value			
A. Natural Hydrologic Regime	0.25	0.25	0.25
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.25	0.25	0.25
Total Score	0.35	0.31	0.27
Acreage	43	43	43
Habitat Units (H.U.)	15	13	12

Aquatic Habitat Value

The USACE hydrodynamic model predicts 2-5 ft of sediment deposition at TY1 and TY10 in most parts of this reach, especially near Cross Creek Bridge, where 7-11 ft of deposition would occur by TY50. Deposition of that magnitude could cause portions of the reach to flow subsurface and cause interrupted surface flows that would negatively impact steelhead. Aquatic habitat and native riparian vegetation would be adversely affected at TY10 and TY50, and only adult steelhead are predicted to use the reach. Floodwalls in this reach would increase the velocity and volume of storm flows above the five-year storm event, but would not affect the reach under non-storm conditions. Habitat value is therefore assigned a score of 0.50 for TY1, 0.50 for TY10, and 0.25 for TY50.

Steelhead use at TY1, TY10, and TY50 are expected to be possible for adults only, but conditions would be poor. Due to the potential impact of the floodwalls, a score of 0.25 was assigned by the TAC.

Steelhead Connectivity is assigned a value of 0.75 for TY1 and TY10 due to potential passage restrictions associated with the sedimentation, decreasing further to 0.50 at TY50.

Aquatic Connectivity is assigned a value of 0.75 for all future time intervals as it is quite possible that the additional deposition will result in partial subsurface flow in the reach.

Riparian Habitat Value

The upper portion (nearest Cross Creek Bridge) of this reach would receive nearly 6 ft of deposition at TY1. Although this represents less than one quarter of the reach, aquatic habitat overall would be affected through TY50. Construction of the floodwall in TY1 impacts a 45-ft construction corridor along its 6,200-ft length for a loss of approximately 6 acres of vegetative cover, a reduction of 5%. Maintenance roads for the floodwall would result in the permanent loss of 0.6 acres of vegetative cover (15-ft access road along 1,700 ft of wall requiring construction of a permanent access road), a reduction of 0.5%. When wildlife corridor impacts were considered, long term impacts to native vegetation were considered to be substantial enough to warrant a score of 0.25 for all TY's. %Native Vegetation Cover is assigned a value of 0.25 for TY 1, TY 10, and TY50.

%Non-native Vegetation is assigned a value of 0.25 for TY1 and 0 for TY10 and TY50 as existing management programs will maintain existing conditions, however flood walls will likely lead to an increase in non-native plants leading to a reduced score.

Natural Process Value

Removal of Rindge Dam would not appreciably alter the hydrologic regimes, which are dominated by adjacent man-made structures (PCH Bridge and associated riprap, Cross Creek Bridge) and by nearby development (city of Malibu). The addition of flood walls to the other structures are considered to be substantial alterations resulting in reduced percolation and altered surface run-off patterns. Thus a value of 0.25 for Natural Hydraulic Regime for all future time intervals was assigned.

However, these man-made structures combined with the seasonal closing of the lagoon mouth has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.3.3 Alternative 3: Reach 3 Cross Creek Bridge to Big Bend Area

Table 5.3-3 Habitat Units for Alternative 3: Reach 3 – Cross Creek Bridge to Big Bend Area

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.50	0.50	0.50
B. Steelhead Use	0.50	0.50	0.50
C. Steelhead Connectivity	0.50	0.50	0.50
D. Aquatic Connectivity	0.25	0.25	0.25
Score = (A+B+C+D)/4	0.44	0.44	0.44
Riparian Habitat Value			
A. %Native Vegetation Cover	0.50	0.50	0.50
B. % Non-native Vegetation Cover	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.40	0.40	0.40
Acreage	40	40	40
Habitat Units (H.U.)	16	16	16

Aquatic Habitat Value

Significant deposition of up to 5 ft is predicted by the USACE model at TY1. While sediment amounts could be less at TY10, significant deposition could still take place. This sedimentation is predicted to adversely affect aquatic habitat and native riparian vegetation at TY10. By TY50, aquatic habitat and native vegetation scores improve to excellent. Habitat value is therefore assigned a score of 0.50 for TY1, TY10, and TY50.

The effects of this sedimentation are predicted to adversely affect steelhead at TY10 and TY50, and only adult steelhead would be predicted to use the reach. Steelhead use is assigned a value of 0.50 for TY1, TY10, and TY50.

Steelhead Connectivity is assigned a value of 0.50 for all future time intervals as increased sedimentation could further result in more subsurface flow reducing passage under low flow conditions during summer months and is assumed constant.

Within the reach, Mullet Pool goes dry on an annual basis for short time periods for the period of record (2005-2013). Aquatic Connectivity is assigned a value of 0.25 for all future time intervals.

Riparian Habitat Value

The effects of sedimentation are predicted to adversely affect aquatic habitat and native riparian vegetation at TY10 and TY50. %Native Vegetation Cover is assigned a value of 0.50 for TY1, TY10, and TY50.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

Natural Process Value

Removal of Rindge Dam would not appreciably alter the hydrologic regimes, which are dominated by adjacent man-made structures (Cross Creek Bridge) in the lower portion of this reach. These are considered to be moderate alterations resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

However, the deposition of up to 7 ft of sediment could result in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.3.4 Alternative 3: Reach 4 Big Bend Area to Rindge Dam

Table 5.3-4 Habitat Units for Alternative 3: Reach 4 – Big Bend Area to Rindge Dam

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.25	0.25	0.25
B. Steelhead Use	0.25	0.25	0.25
C. Steelhead Connectivity	0.50	0.50	0.50
D. Aquatic Connectivity	0.25	0.25	0.25
Score = (A+B+C+D)/4	0.31	0.31	0.31
Riparian Habitat Value			
A. %Native Vegetation Cover	0.50	0.50	0.50
B. % Non-native Vegetation Cover	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.35	0.35	0.35
Acreage	35	35	35
Habitat Units (H.U.)	12	12	12

Aquatic Habitat Value

Sediment model predicts significant deposition, which would degrade aquatic habitat starting in TY1. Degradation is still assumed to be present at TY10 and TY50. Habitat value is therefore assigned a score of 0.25 for TY1, 0.25 for TY10, and 0.25 for TY50.

At TY1, TY10, and TY50, spawning would be eliminated. Only adult steelhead would be present as breeding/rearing likely to cease due to deposition of fine materials. Deposition in this reach is expected to consist of the finer materials, as the coarser fraction is assumed to settle out higher in the stream where the stream widens out and slows. Steelhead use is assigned a value of 0.25 for all future intervals.

This reach would be passable for steelhead at moderate flows. Steelhead Connectivity is assigned a value of 0.50 for all future time intervals.

Lower and Upper Twin Pools have gone dry in the summer on an annual basis for the period of record (2005-2013). These pools are located within this reach. Mullet Pool also goes dry in the summer on an annual basis for the period of record. This pool is located in the reach below this reach. Aquatic Connectivity is assigned a value of 0.25 for all future time intervals.

Riparian Habitat Value

Sediment model predicts significant deposition/scour, which would degrade aquatic habitat starting in TY1 through TY50. %Native Vegetation Cover is assigned a value of 0.50 for TY1, TY10, and TY50.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

Natural Process Value

Full dam removal would take 50 yrs, therefore the stream would still be substantially altered by the presence of the dam for all target years. The score for TY1, TY10, and TY50 reflect this dam remaining in place, although reduced in height, which is the same as for existing conditions. Natural Hydraulic Regime is assigned a value of 0.50 for all target years.

Substantial scour of sediment at TY1 through TY50. Natural Sediment Regime is assigned a value of 0.25 for all target years.

5.3.5 Alternative 3: Reach 5 Rindge Dam to Cold Creek Confluence

Table 5.3-5 Habitat Units for Alternative 3: Reach 5 – Rindge Dam to Cold Creek Confluence

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.75	0.25	0.25
B. Steelhead Use	0.00	0.00	0.00
C. Steelhead Connectivity	0.00	0.00	0.00
D. Aquatic Connectivity	0.00	0.00	0.00
Score = (A+B+C+D)/4	0.19	0.06	0.06
Riparian Habitat Value			
A. %Native Vegetation Cover	0.00	0.00	0.00
B. % Non-native Vegetation Cover	1.00	1.00	1.00
Score=(A+B)/2	0.50	0.50	0.50
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.35	0.31	0.31
Acreage	28	28	28
Habitat Units (H.U.)	10	9	9

Aquatic Habitat Value

This reach would remain unaffected by scour under this alternative for TY1. Significant scouring (up to 50 ft) occurs over the life of the project as the dam is slowly removed. Habitat value is therefore assigned a score of 0.75 for TY1, 0.25 for TY10, and 0.25 for TY50.

Steelhead would not gain access to this reach until complete removal of Rindge Dam, likely not for 50 years, 20 years, at the earliest. Steelhead would still not have access at TY1, TY10, and TY50 and low habitat quality precludes use by all life stages. Steelhead use is assigned a value of 0 for TY1, 0 for TY10, and 0 for TY50.

Portions of the dam and accumulated sediments would still largely be in place at TY1, TY10, and TY50. Following removal of Rindge Dam, this reach would become passable at high flows due to “Tunnel Falls”; assumed sometime after TY50. Steelhead Connectivity is assigned a value of 0 for TY1, TY10, and TY50.

Portions of the dam and accumulated sediments would still largely be in place at TY1, TY10, and TY50. Following removal of Rindge Dam, this reach would become passable at high flows due to “Tunnel Falls”; assumed sometime after TY50. Aquatic Connectivity is assigned a value of 0 for TY1, TY10, and TY50.

Riparian Habitat Value

Native riparian vegetation would be completely removed at TY1, TY10, and TY50. Restoration of native vegetation cover would not begin until after complete removal of the dam. %Native Vegetation Cover is assigned a value of 0.00 for TY1, TY10, and TY50.

Removal of all non-native vegetation would be completed at TY1. %Non-native Vegetation is assigned a value of 1.00 for TY1, TY10, and TY50.

Natural Process Value

The dam would still be in place through TY50, therefore there is no change from Alternative 1 No Action conditions. Natural Hydraulic Regime is assigned a value of 0.50 for TY1, TY10, and TY50.

Substantial downstream deposition of sediment is anticipated from TY1 through TY50. Natural Sediment Regime is assigned a value of 0.25 for TY1, TY10, and TY50.

5.4 Alternative 4 Dam Removal with Hybrid Mechanical and Natural Transport Habitat Value Calculations

The basic concept for this alternative is to notch or lower the dam height at the same rate as the impounded sediment is removed from behind the dam using mechanical means (excavators, bulldozers etc.) during the summer and fall. At the end of the construction season, the dam height would be notched down an additional 5 ft, with the sediment behind the notched area allowed to naturally erode and wash away downstream by creek flows during the following winter storm season. Removal of the dam and impounded sediment would take place in stages over five to eight years with no active construction during the winter rain season. TY 5 represents the end of construction for this alternative for purposes of this HE. Restoration of native vegetation and removal of non-native vegetation in the riparian area would occur in Reach 5 from this alternative.

According to the USACE' hydrodynamic model, significant scour would occur in the upstream reach from Rindge Dam to Cold Creek as well as in the reach immediately downstream of Rindge Dam. Scour would be slightly higher than for Alternative 2 Dam Removal with Mechanical Transport. Deposition would occur in the lower portion of Reach 3 Cross Creek Bridge to Big Bend area, and in all lower reaches at levels equivalent to those of Alternative 2. In Malibu Lagoon, up to approximately 2-4 ft of sediment would be deposited. This is more than for Alternative 2. Deposition amounts in all reaches are less under this alternative than those predicted under Alternative 3 Dam Removal with Natural Transport. By TY50, the sediment regime would have stabilized such that in each reach less than 1 foot of additional deposition or scour would occur from TY10 to TY50 in most portions of each reach. The effects of predicted sedimentation and scour on habitat values and the assumptions made in determining these effects are presented in the habitat value calculations for each reach below.

USACE considered several options for protecting property from potential predicted increased flood hazard. Ultimately, floodwalls were used because they are the easiest, least costly, and most feasible mechanism for providing the needed flood protection. Buying out properties is considered infeasible due to local inflated real estate costs, and any other mechanism (i.e. levees) would be far larger in scope, cost, and impact.

To offset increased risk of flooding due to this alternative, approximately 3,100 ft of floodwalls would be constructed on both sides of the creek from about Cross Creek Bridge downstream to Pacific Coast Highway, for a total combined length of about 6,200 ft (**Figure 5.3-1**). The proposed floodwall design would be an I-wall, which consists of a sheetpile driven vertically into the top of the creek bank approximately 25 ft down to protect against potential bank erosion. The sheetpile would be capped on top with a pile cap, approximately 3 ft by 3 ft. An approximate 10-ft concrete floodwall would be constructed on top of the pile cap. The wall alignment would follow the top of the creek bank on both sides. An approximate 45-ft width area extending the length of the wall alignment would be needed for construction. Equipment needed for the wall construction includes two cranes, a dozer, a grader, and four to five trucks. At completion of construction, about a 15-ft wide access road would need to be maintained along portions of the floodwall to accommodate for future maintenance of the structure. Construction of the floodwall would occur during TY 1.

The floodwall is anticipated to affect the lateral movement of all terrestrial animals by interrupting and constricting wildlife migration and movement opportunities, and increasing the potential for invasive plant species. Armoring the creek bank may increase flow velocities during flood events that could be problematic for tidewater gobies and migrating steelhead trout, as well as decrease extent of riparian vegetation and reduce the availability of velocity refugia. On-going maintenance would decrease habitat value overall. The dynamics of flow changes, sediment deposition and scour within the main body of the lagoon and how these could potentially affect tidewater goby breeding areas as well as potential alteration of berm breaching have not been specifically modeled. Given these uncertainties, the TAC assumed that overall habitat values would be impacted and would subsequently decrease, rather than recover over time.

According to the USACE hydrodynamic model, significant scour would occur in the upstream Reach 5 from Rindge Dam to Cold Creek as well as in Reach 4 immediately downstream of Rindge Dam. Deposition would occur in the lower portion of Reach 3 Cross Creek Bridge to Big Bend reach, and in all lower reaches. In Reach 1 Malibu Lagoon, up to approximately 1 foot of sediment would be deposited due to the project. Deposition amounts in all reaches are less under this alternative than those predicted under Alternative 3 Dam Removal with Natural Transport and Alternative 4 Dam Removal with Hybrid Mechanical and Natural Transport. By TY50, the sediment regime would have stabilized such that less than 1 foot of additional deposition or scour would occur from TY10 to TY50 in most portions of each reach. The effects of predicted sedimentation and scour on habitat values and the assumptions made in determining these effects are presented in the habitat value calculations for each reach below.

HE valuations for all reaches for the Alternative 4 Dam Removal with Hybrid Mechanical Transport and Natural Transport are presented in **Table 5.4-1** through **Table 5.4-5**. The first column lists the variables associated with each of the three primary ecosystem components (Aquatic Habitat Value, Riparian Habitat Value, and Natural Process Value). The next three columns present the scores assigned to each variable at Target Year (TY) 1, 10 and 50. Comments and assumptions are provided to explain the score for each variable.

5.4.1 Alternative 4: Reach 1 Malibu Lagoon

Table 5.4-1 Habitat Units for Alternative 4: Reach 1 – Malibu Lagoon

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.50	0.50	0.75
B. Steelhead Use	1.00	0.50	1.00
C. Steelhead Connectivity	0.50	0.50	0.50
D. Aquatic Connectivity	0.50	0.50	0.50
Score = (A+B+C+D)/4	0.63	0.50	0.69
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	1.00	1.00
1.00B. % Non-native Vegetation Cover	1.00	1.00	1.00
Score=(A+B)/2	0.88	1.00	1.00
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.63	0.63	0.69
Acreage	16	16	16
Habitat Units (H.U.)	10	10	11

<u>Aquatic Habitat Value</u>

Vegetation planted as part of the lagoon restoration effort will mature, ongoing maintenance will ensure that non-native plants are removed. Ongoing monitoring and maintenance will ensure that conditions are able to support robust populations of native fish despite ongoing recreational uses of the lagoon and the pressure of adjacent development. This alternative is predicted to result in slightly less than one foot of sediment deposition in one station in the Lagoon at TY1. At TY 5, between two - four ft of additional deposition would occur with negligible deposition by TY10, and a natural sediment regime would return by TY50. Aquatic habitat, as well as native vegetation, would be the same as existing conditions at TY1, but adversely affected at TY10, and a more natural condition at TY50. The lagoon, following restoration, is expected to be moderately impaired from its historic condition. This is because although the restoration is anticipated to significantly improve tidal circulation and upland and wetland habitat values via restoration efforts, the lagoon is still substantially reduced in size, has significant challenges associated with water quality and adjacent development. Floodwalls in the reach upstream of the lagoon would increase the velocity and volume of storm flows above the five-year storm event, but would not affect the lagoon under non-storm conditions. Habitat value is therefore assigned a score of 0.50 for TY1 and TY10, and 0.75 for TY50.

Adults and smolts are expected to continue to be present, however no spawning occurs in the lagoon. Therefore, for TY1 Steelhead use is assigned a value of 1.00. Reduction of lagoon depth associated with increased sedimentation could result in constrained conditions for steelhead in the mid-term, so use is reduced to 0.50 in TY10. By TY50 the sediment regime will have stabilized, so a value of 1.00 is assigned.

The sand berm will continue to form for all future conditions. Therefore this score will remain the same as for existing conditions. Steelhead Connectivity is assigned a value of 0.50 for all future time intervals.

The sand berm will continue to form for all future conditions. Therefore this score will remain the same as for existing conditions. Aquatic Connectivity is assigned a value of 0.50 for all future time intervals.

<u>Riparian Habitat Value</u>

Vegetation planted as part of the lagoon restoration effort will mature; ongoing maintenance will ensure that non-native plants are removed. TY1 will be unchanged from existing conditions; however TY10 and TY50 are expected to improve to 80-100% cover. %Native Vegetation Cover is assigned a value of 0.75 for all target years.

Malibu Lagoon Restoration Project removed non-native vegetation to 0-5% cover; assumed maintenance at this level to TY50. %Non-native Vegetation is assigned a value of 1.00 for all future intervals.

<u>Natural Process Value</u>

Removal of Rindge Dam would not appreciably alter the hydrologic regimes, which are dominated by adjacent man-made structures (PCH Bridge and associated riprap) and by nearby development (city of Malibu). These are considered to be moderate alterations resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

However, these man-made structures, including the floodwalls, combined with the seasonal closing of the lagoon mouth, with the addition of downstream sediments would result in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.4.2 Alternative 4: Reach 2 PCH Bridge to Cross Creek Bridge

Table 5.4-2 Habitat Units for Alternative 4: Reach 2 – PCH Bridge to Cross Creek Bridge

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.75	0.50	0.75
B. Steelhead Use	1.00	0.25	0.75
C. Steelhead Connectivity	0.75	0.75	0.75
D. Aquatic Connectivity	1.00	1.00	1.00
Score = (A+B+C+D)/4	0.88	0.63	0.81
Riparian Habitat Value			
A. %Native Vegetation Cover	0.50	0.50	0.50
B. % Non-native Vegetation Cover	0.25	0.00	0.00
Score=(A+B)/2	0.38	0.25	0.25
Natural Process Value			
A. Natural Hydrologic Regime	0.25	0.25	0.25
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.25	0.25	0.25
Total Score	0.50	0.38	0.44
Acreage	43	43	43
Habitat Units (H.U.)	22	16	19

<u>Aquatic Habitat Value</u>

Under this alternative, deposition of over 2 ft is expected at TY10 throughout the reach, up to a maximum of over 3 ft. This deposition is considered to adversely affect the aquatic habitat score at TY10. Aquatic habitat is slightly impaired at TY1 with deposition in the upper third of the reach, similar to existing conditions. Sedimentation lowers value at TY10 and TY50, but a more naturalized sediment regime would improve habitat quality by TY50. Floodwalls in this reach would increase the velocity and volume of storm flows above the five-year storm event, but would not affect the reach under non-storm conditions. Habitat value is therefore assigned a score of 0.75 for TY1, and 0.50 for TY10, and 0.75 for TY50.

Steelhead use is expected to remain unchanged for TY1. Deposition of sediments is expected to impact spawning as deposited materials are expected to be finer than those deposited in upstream reaches. The sediment may no longer be suitable for spawning habitat. This is an area of the stream that widens out reducing water velocities that carried the finer sediments to this point. As this area is also estuarine, salinity changes will contribute to the flocculation and deposition of finer sediment fractions in this area. Steelhead use at TY10 is expected to be poor, with adults only and a score of 0.25 was assigned by the TAC, with only partial recovery of suitable spawning gravel by TY50. Steelhead use is assigned a value of 1.00 for TY1, 0.25 for TY10, and 0.75 for TY50.

Steelhead Connectivity is assigned a value of 0.75 for all future time intervals as it is assumed a slight decrease in passability due to sediment buildup at the PCH Bridge could occur.

Aquatic Connectivity is assigned a value of 1.00 for all future time intervals as it is assumed to be constant.

Riparian Habitat Value

Construction of the floodwall in TY1 impacts a 45-ft construction corridor along its 6,200-ft length for a loss of 6 ac of vegetative cover, a reduction of 5%. Maintenance roads for the floodwall would result in the permanent loss of 0.6 acres of vegetative cover (15-ft access road along 1,700 ft of wall requiring construction of a permanent access road), a reduction of 0.5%. When wildlife corridor impacts were considered, long-term impacts to native vegetation were considered to be substantial enough to warrant a score of 0.50 for all TY's. %Native Vegetation Cover is assigned a value of 0.50 for TY 1, TY 10, and TY50.

%Non-native Vegetation is assigned a value of 0.25 for TY1 and 0 for TY10 and TY50 as existing management programs will maintain existing conditions, however flood walls will likely lead to an increase in non-native plants leading to a reduced score.

Natural Process Value

Removal of Rindge Dam would not appreciably alter the hydrologic regime, which is dominated by adjacent man-made structures (PCH Bridge and associated riprap, Cross Creek Bridge) and be nearby development (city of Malibu). The addition of floodwalls to the other structures are considered to be substantial alterations resulting in reduced percolation and altered surface run-off patterns. Thus a value of 0.25 for Natural Hydraulic Regime was used for all future time intervals.

However, these man-made structures, including the proposed floodwalls, combined with the seasonal closing of the lagoon mouth and the deposition of materials from upstream has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.4.3 Alternative 4: Reach 3 Cross Creek Bridge to Big Bend Area

Table 5.4-3 Habitat Units for Alternative 4: Reach 3 – Cross Creek Bridge to Big Bend Area

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.75	0.75	0.75
B. Steelhead Use	0.25	0.75	0.75
C. Steelhead Connectivity	0.50	0.50	0.75
D. Aquatic Connectivity	0.25	0.50	0.50
Score = (A+B+C+D)/4	0.44	0.63	0.69
Riparian Habitat Value			
A. %Native Vegetation Cover	0.75	0.75	0.75
B. % Non-native Vegetation Cover	0.25	0.25	0.25
Score=(A+B)/2	0.50	0.50	0.50
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.38	0.38
Total Score	0.44	0.50	0.52
Acreage	40	40	40
Habitat Units (H.U.)	18	20	21

<u>Aquatic Habitat Value</u>

The USACE hydrodynamic model predicts that sediment deposition in this reach would be similar to Alternative 1 No Action Alternative, but occur earlier in time. Predicted Alternative 1 No Action Alternative deposition at TY 5 is approximately the same as that predicted for Alternative 4 Dam removal with Hybrid Mechanical and Natural Transport removal for TY1. Depositional impacts are greater for TY1 and approximately the same for TY10 and TY50. Thus, aquatic habitat would not be adversely affected in this reach overall. By TY50, a stable sediment regime would be established. Evidence of increased erosion throughout the reach is seen in the bed elevation graphs for TY 5 and TY10 leading to a deepening of the reach. Habitat value is therefore assigned a score of 0.75 for all future time intervals.

The lower portion (nearest Cross Creek Bridge) of this reach would receive greater than 5 ft of deposition at TY1, TY10 and TY50. This represents less than one quarter of the reach, however steelhead use would be affected through TY50 because sediment deposition would cause a loss of existing refugia habitat. Steelhead use is assigned a value of 0.25 for TY1 and 0.75 for TY 10 and TY50.

Steelhead Connectivity is assigned a value of 0.50 for TY1 and TY10 as the addition of up to 5 ft of sediment could reduce passage during low flows. Passage should be restored by TY50 increasing the score to 0.75.

Mullet Pool goes dry in the summer on an annual basis for the period of record (2005-2013). The overall erosion of the reach predicted for Alternative 4 compared to Alternative 1 No Action Alternative should reduce the possibility of the pools drying out. However, the lower portion (nearest Cross Creek Bridge) of this reach would receive greater than 5 ft of deposition at TY1, TY10 and TY50 that is expected to result in drying out more frequently. Aquatic Connectivity should be assigned a value of 0.25 for TY1 and 0.50 for TY10 and TY50.

<u>Riparian Habitat Value</u>

%Native Vegetation Cover is assigned a value of 0.75 for all future time intervals because no change is expected to vegetation cover.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

<u>Natural Process Value</u>

Removal of Rindge Dam would appreciably alter the hydrologic regime which is dominated by adjacent man-made structures (Cross Creek Bridge and proposed floodwalls) in the lower portion of the reach. These are considered to be moderate alterations resulting in an assigned a value of 0.50 for Natural Hydraulic Regime for all future time intervals.

These man-made structures, including the proposed floodwalls, combined with the seasonal closing of the lagoon mouth and the deposition/erosion patterns predicted has resulted in substantial alteration to the Natural Sediment Regime resulting in an assigned a value of 0.25 for all future time intervals.

5.4.4 Alternative 4: Reach 4 Big Bend Area to Rindge Dam

Table 5.4-4 Habitat Units for Alternative 4: Reach 4 – Big Bend Area to Rindge Dam

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.50	0.75	0.75
B. Steelhead Use	0.00	0.75	1.00
C. Steelhead Connectivity	0.50	0.50	0.50
D. Aquatic Connectivity	0.25	0.25	0.25
Score = (A+B+C+D)/4	0.31	0.56	0.63
Riparian Habitat Value			
A. %Native Vegetation Cover	0.50	0.75	0.75
B. % Non-native Vegetation Cover	0.25	0.25	0.25
Score=(A+B)/2	0.38	0.50	0.50
Natural Process Value			
A. Natural Hydrologic Regime	0.25	0.75	0.75
B. Natural Sediment Regime	0.25	0.75	0.75
Score=(A+B)/2	0.25	0.75	0.75
Total Score	0.31	0.60	0.63
Acreage	35	35	35
Habitat Units (H.U.)	11	21	22

<u>Aquatic Habitat Value</u>

The step pool and mid-channel pools distributed throughout this reach that represent important summer refugia habitat would be significantly impacted according to the sediment model, which predicts some scour throughout this reach. This would degrade aquatic habitat starting in TY1. Degradation is still assumed to be present at TY10. The model indicates stabilization in sediment regime by TY10. Habitat value is therefore assigned a score of 0.50 for TY1, 0.75 for TY10, and 0.75 for TY50.

At TY1, spawning would be severely limited due to habitat loss throughout the reach. The pool below the dam would likely no longer support any life stages of steelhead. By TY10, a more natural sediment regime would result, where both aquatic habitat quality and steelhead use scores improve to the existing conditions score. Steelhead use is assigned a value of 0 for TY1, 0.75 for TY10, 1.00 for TY50.

This reach would be passable for steelhead at moderate flows. Steelhead Connectivity is assigned a value of 0.50 for all future time intervals.

Lower and Upper Twin Pools have gone dry for periods during the summer for the period of record (2005-2013). These pools are located within this reach. In addition, Mullet Pool also goes dry in the summer on an annual basis for the period of record. This pool is located in the reach below this reach. Aquatic Connectivity is assigned a value of 0.25 for all future time intervals.

<u>Riparian Habitat Value</u>

Sediment model predicts significant scour, which would degrade aquatic habitat starting in TY1. Recovery is expected by TY10. %Native Vegetation Cover is assigned a value of 0.50 for TY1 and 0.75 for TY10 and TY50.

%Non-native Vegetation is assigned a value of 0.25 for all future time intervals as existing management programs will maintain existing conditions.

<u>Natural Process Value</u>

The dam would still largely be in place at TY1, therefore its score is the same as for Alternative 1 No Action Alternative. Full dam removal would be in effect at TY 5. Scores for TY10 and TY50 thus reflect a return to a more natural hydraulic regime with minimal alteration from man-made flows from Tapia. Natural Hydraulic Regime is assigned a value of 0.25 for TY1 and 0.75 for TY10 and TY50.

Substantial scour of sediment is predicted at TY1, returning to a more stable natural sediment regime by TY50. Natural Sediment Regime is assigned a value of 0.25 for TY1 and 0.75 for TY10 and TY50.

5.4.5 Alternative 4: Reach 5 Rindge Dam to Cold Creek Confluence

Table 5.4-5 Habitat Units for Alternative 4: Reach 5 – Rindge Dam to Cold Creek Confluence

	TY1	TY10	TY50
Aquatic Habitat Value			
A. Habitat Value	0.50	0.75	0.75
B. Steelhead Use	0.00	1.00	1.00
C. Steelhead Connectivity	0.00	0.50	0.50
D. Aquatic Connectivity	0.00	0.50	0.50
Score = (A+B+C+D)/4	0.13	0.69	0.69
Riparian Habitat Value			
A. %Native Vegetation Cover	0.00	0.75	0.75
B. % Non-native Vegetation Cover	1.00	1.00	1.00
Score=(A+B)/2	0.50	0.88	0.88
Natural Process Value			
A. Natural Hydrologic Regime	0.50	0.75	0.75
B. Natural Sediment Regime	0.25	0.75	0.75
Score=(A+B)/2	0.38	0.75	0.75
Total Score	0.33	0.77	0.77
Acreage	28	28	28
Habitat Units (H.U.)	9	22	22

Aquatic Habitat Value

According to the USACE' model, this reach would experience substantial scour in the lower section at TY1 and TY 5. At TY10, no additional scour is predicted. By TY50, a stable sediment regime would be established. Aquatic habitat value and steelhead use are all adversely affected at TY1, recovering fully by TY50. Habitat value is therefore assigned a score of 0.50 for TY1 and 0.75 for TY10 and TY50.

The dam would still largely be in place at TY1, therefore there will be no steelhead access. Starting at TY 5 full access would be provided by completion of dam removal. Steelhead use is assigned a value of 0 for TY1 and 1.00 for TY10 and TY50.

The dam would still largely be in place at TY1. Following removal of Rindge Dam, this reach would remain passable at high flows due to "Tunnel Falls" (jump 2.62 meters); assumed constant to TY50. Steelhead Connectivity is assigned a value of 0 for TY1 and 0.50 for TY10 and TY50.

The dam would still largely be in place at TY1. Following removal of Rindge Dam, this reach would remain passable at high flows due to "Tunnel Falls"; assumed constant to TY50. Aquatic Connectivity is assigned a value of 0 for TY1 and 0.50 for TY10 and TY50.

Riparian Habitat Value

Native riparian vegetation would be removed at TY1 only, increasing in score after transplants in years 5-8 to TY50. Assumed restoration of native vegetation cover beginning at TY10 reaching maturity at TY50. %Native Vegetation Cover is assigned a value of 0.00 for TY1, and 0.75 for TY10 and TY50.

Assumed removal of all non-native vegetation at TY1; assumed maintenance to TY50. %Non-native Vegetation is assigned a value of 1.00 for all future time intervals.

Natural Process Value

The dam would still largely be in place at TY1, therefore there is no change from Alternative 1 No Action conditions. Starting at TY 5, a more natural hydraulic regime would be provided by completion of dam removal. With the dam and all accumulated sediment removed, conditions for TY10 and TY50 thus reflect a return to a more natural hydraulic regime with minimal alteration from man-made flows from Tapia. Natural Hydraulic Regime is assigned a value of 0.50 for TY1 and 0.75 for TY10 and TY50.

Substantial scour of sediment is predicted at TY1 with a return to a more stable natural sediment regime by TY50. Natural Sediment Regime is assigned a value of 0.25 for TY1 and 0.75 for TY10 and TY50.

5.5 Summary of Results for Mainstem Reaches

5.5.1 Reach Level Impact for each Alternative

Reach 1 Lagoon – PCH

- Alternatives 1 and 2a are similar with 4.8-4.9 ft of deposition,
- Alternatives 3a and 4a similar with 5.1-5.3 ft of deposition.

Reach 2 PCH – Cross Creek (0.6 mi)

- Alternatives 1 and 2 similar for TY50 with deposition of 5-10 ft
- Alternatives 3 and 4 similar with deposition of 6-12 ft.

Reach 3 Cross Creek – Big Bend (1.5 mi)

- Alternative 1 has pattern of minor initial scour throughout the reach, but then deposition in the upper section of the reach.
- Alternative 2 has minor initial scour in TY1, followed by deposition in the upper section of the reach.
- Alternative 3 has little scour and more deposition (up to 15 ft), which could eliminate all step pools and potentially also the refugia pools in that reach.
- Alternative 4 experiences initial scour, but also some deposition.

Reach 4 Big Bend- Rindge Dam (0.7 mi)

- Alternative 1 suggests an overall pattern of scour in this reach as the dam completes its filling process.
- Alternative 2 predicts scour in this reach of 2-3 ft.
- Alternative 3 includes a mix of scour and deposition, with long-term scour at TY50.
- Alternative 4 predicts scour in this reach of 2-3 ft.

Reach 5 – Rindge Dam – Cold Creek (1.5 mi)

- Alternative 1 predicts little change in this reach, with minor areas of erosion and deposition as the dam completes filling.
- Alternative 2 predicts an extreme scour characterized by removal of the upstream sediments that will stabilize after dam removal at TY5.
- Alternative 3 experiences less extreme scour, as the removal of the impounded sediments occur over 50 to 100 years.
- Alternative 4 predicts a scour pattern similar to Alternative 2, as the impounded sediments are removed on a similar timeline.

5.6 Average Annual Habitat Units Comparison

Table 5-21 and **Table 5-22** present summaries of the HE analysis. **Table 5-21** provides the Average Annual Habitat Units (AAHUs) for the three ecosystem components for each alternative, and **Table 31** presents the overall AAHUs for each alternative for the ecosystem components combined. AAHU values were calculated using an annualizer model prepared by the IWR. Nonetheless, the AAHUs clearly represent the differences among the project alternatives with respect to the benefits for the ecosystem components evaluated.

Alternatives 2a Dam Removal with Mechanical Transport would result in the most increase in AAHUs (16.5%) for each of the three ecosystem components over the 50 year period of analysis as compared to Alternative 1 No Action Alternative. Alternative 3a Dam Removal with Natural Transport shows a significant decline in habitat units as compared to Alternative 1 No Action Alternative (-22.8%). Although there is a slight increase in habitat units predicted with Alternative 4a Dam Removal with Hybrid Mechanical and Natural Transport (2.5%), it is much less than that predicted for Alternative 2. Habitat Units were averaged over the 50-year project life to yield Average Annual Habitat Units (AAHU) as shown in **Table 5.6-1**.

Table 5.6-1 Comparison of Average Annual Habitat Units for each Restoration Alternative Compared to Alternative 1 No Action Alternative

Target Year	Future w/o Project (Alternative 1 No Action)	Alternative 2 Dam Removal w/ Mechanical Transport	Alternative 3 Dam Removal w/ Natural Transport	Alternative 4 Dam Removal with Hybrid Mechanical and Natural Transport
0	85	85	85	85
1	84	91	63	69
10	80	99	60	89
50	84	103	58	94
AAHUs*	82	100	60	89
Change in AAHUs**		18	-22	7
%Change		22.0%	-26.8%	8.5%

5.6.1 Aquatic Habitat Value Comparison

All alternatives show a drop in value for TY1 reflecting construction-related impacts. Alternative 2 values reflect the benefits of mechanical removal of all accumulated sediments while Alternative 3 values reflect potential environmental damages resulting from the introduction of the accumulated sediments into the system by natural transport. Alternative 4 is similar to Alternative 2, but shows reduced values due to natural transport of some of the accumulated sediments. Values then increase for Alternatives 2 and 4, but not for Alternative 3 that assumes continued impacts through the life of the project.

5.6.2 Riparian Habitat Value Comparison

These values reflect the relatively small footprint of actual removal of riparian habitat during construction of all alternatives. Alternatives 2 and 4 are virtually the same as the timing of the impact and restoration are the same. Lower values for Alternative 4 reflect downstream impacts from the natural transport of some of the accumulated sediments. Alternative 3 reflects the ongoing impacts for all target years and the lack of restoration until after TY50.

5.6.3 Natural Process Value

Natural processes for Alternatives 2 and 4 are similarly affected over time, as reflected by the natural process value scores. Lower values for Alternative 4 reflect downstream impacts from the natural transport of some of the accumulated sediments. Alternative 3 reflects the ongoing impacts for all target years and the lack of restoration of a natural sediment regime until after TY50.

Table 5.6-2 Comparison of Average Annual Habitat Units for each Restoration Alternative Compared to Alternative 1 No Action Alternative According to Ecosystem Component

	Aquatic Habitat Value				Riparian Habitat Value				Natural Process Value			
Target Year	Alternative 1 No Action Future w/o Project	Alternative 2 Dam Removal w/ Mechanical Transport	Alternative 3 Dam Removal w/ Natural Transport	Alternative 4 Dam Removal with Hybrid Mechanical and Natural Transport	Future w/o Project (Alternative 1 No Action)	Alternative 2 Dam Removal w/ Mechanical Transport	Alternative 3 Dam Removal w/ Natural Transport	Alternative 4 Dam Removal with Hybrid Mechanical and Natural Transport	Future w/o Project (Alternative 1 No Action)	Alternative 2 Dam Removal w/ Mechanical Transport	Alternative 3 Dam Removal w/ Natural Transport	Alternative 4 Dam Removal with Hybrid Mechanical and Natural Transport
0	34	34	34	34	29	29	29	29	22	22	22	22
1	35	31	23	27	29	28	22	26	20	22	18	17
10	30	38	20	33	30	33	21	30	20	28	18	26
50	34	42	19	38	30	33	21	30	20	28	18	26
AAHUs*	32	36	20	34	30	32	21	30	20	27	18	25
Change in AAHUs**		4	-12	2		2	-9	0		7	-2	5
%Change		12.5%	-37.5%	6.3%		6.7%	-30.0%	0%		35.0%	-10.0%	25.0%

6.0 DEFINING THE PROJECT – UPSTREAM REACHES

For the purposes of this HE analysis, the Project has thirteen upstream reaches as bounded by removal or modification of the following 10 barriers upstream of Rindge Dam defined in **Table 3-3**: Crags Rd. culvert (LV1), White Oak Farms dam (LV2), Meadow Creek Lane channel (LV3), and I-101 Freeway bridge (LV4) on Las Virgenes Creek, Piuma Rd. Pipe Arch culvert (CC1), Malibu Meadows Rd. Bridge (CC2), Crater Camp Rd. Bridge (CC3), Cold Creek barrier (CC4), Cold Canyon Rd. culvert (CC5) on Cold Creek, a natural barrier (CC6), Cold Creek Check Dam (CC7) removed by the city of Calabasas. Although the Stunt Rd. culvert (CC8) was evaluated in this HE, it is likely not to be removed due to its relatively high cost of removal for little stream length gained, the presence of close upstream impassable barrier, and its perceived benefit to limiting the spread of New Zealand mud snail upstream. The results of this section of the HE provide data needed for the CE/ICA to determine the incremental increase in costs associated with incremental removal of barriers within the project. This allows the USACE to identify the best "value" for barrier removals and identify if all barriers or a subset are recommended for removal.

The Project includes full removal of Rindge Dam and removal or modification of up to each of the nine upstream barriers listed above, to allow fish passage under most flows. Following barrier removal or modification, areas disturbed by construction around each barrier would be restored, but there would be no large-scale removal of invasive vegetation, in-stream habitat improvements, bank stabilization, or other restoration efforts within the upstream reaches.

The upstream reaches were not in areas included in the Hydraulics and Hydrodynamics evaluation and modeling of Malibu Creek. They were also not included in the plans to revegetate/remove non-native species that are included in Mainstem Reach 5. Therefore, it was not appropriate to evaluate these reaches using the procedures identified for the Mainstem Reaches. Evaluation procedures were modified for these reaches as described below.

6.1 Assumptions Specific to Upstream Reaches

Removal of all barriers is expected to be completed by TY10 for all action alternatives. For Alternative 1 No Action Alternative scores, it is assumed that there would be negligible changes in the reach with regard to the three ecosystem components (Aquatic Habitat Value, Riparian Habitat Value, and Natural Process Value) over time. Therefore, scores for TY1, 10, and 50 are the same as the Existing Conditions score for all reaches.

The habitat unit (HU) value scores are primarily assigned assuming implementation of either Alternative 2 Dam Removal with Mechanical Transport or Alternative 4 Dam Removal with Hybrid Mechanical and Natural Transport, both of which assume project completion within 5 years. It is assumed that the only changes each of the reaches would occur within the Aquatic Habitat Value ecosystem component. Specifically, Steelhead Use, Steelhead Connectivity, and Aquatic Connectivity scores would be expected to improve. Steelhead and Aquatic Connectivity would improve at TY10 when all upstream barriers are assumed to be removed with the Project, while Steelhead Use would improve over time beginning at TY10. No changes in Riparian Habitat Value or Natural Process Value are assumed, since removal or modification of the upstream barriers would not substantially affect these ecosystem components.

For Alternative 3 Dam Removal with Natural Transport, we are assuming that, the bulk of the dam will remain in place at TY10, thus affecting scoring of other indices for this milestone year. At TY50 we assume the dam would be removed, but some natural material would still likely be in place, representing an impassable barrier. It is assumed that the only changes in each of the reaches would occur within the Aquatic Habitat Value ecosystem component. Specifically, Aquatic Connectivity scores would be expected to improve, however Steelhead Connectivity would remain unchanged. Aquatic Connectivity would improve at TY10 when all barriers would be removed with the Project. Values are the same as Alternatives 2 & 4. No changes in Riparian Habitat Value or Natural Process Value are assumed, since removal or modification of the upstream barriers would not substantially affect these ecosystem components.

The habitat conditions of each reach were based primarily on data found in Abramson and Grimmer (2005), visual observation of aerial photography (Google Earth, April 2011), with additional input following a site visit in June 2012 by members of the TAC. Abramson and Grimmer (2005) defined reaches differently than those evaluated here; however, habitat quality ratings for the upstream reaches can be derived using closed related reaches, as shown in **Appendix J6**.

As explained above, the TAC assumed that native vegetation was more conducive to supporting a variety of wildlife species, especially those that rely upon native cover to move safely across the landscape. Loss of native vegetation was considered to negatively affect wildlife habitat and movement potential. Additionally, the hardening and erosion/stability of banks is associated with the decrease in native vegetation and serves as a reasonable proxy for evaluating impacts to habitat quality associated with those problems. Therefore, the percent native vegetation relative to the percent of non-native vegetation was used to capture the more extensive benefits provided by less altered riparian areas which support greater diversity.

It is important to note that some native vegetation restoration may occur with the barrier removal projects as part of environmental commitments that may be required by the resource agencies. These would provide additional benefits to riparian habitat and natural processes within the watershed. As they are both highly speculative and difficult to quantify at this time, they are not included in this HE.

6.2 Results of Habitat Evaluation for Upstream Reaches

HE valuations for all upstream reaches are presented in the **tables below**. The first column lists the variables associated with each of the three primary ecosystem components (Aquatic Habitat Value, Riparian Habitat Value, and Natural Process Value), and the second column presents the scores assigned to each variable at Target Year (TY) 0, or existing conditions,

The following target years were selected for habitat value calculations in the HE and are relative to dam and barrier removal activities:

- TY 0 is present day existing conditions;
- TY1 is one year following start of construction associated with the project alternative;
- TY10 is when the riparian restoration efforts at the dam are expected to result in established and maturing vegetation community for Alternatives 2 & 4; in middle of construction for Alternative 3; upstream barriers are assumed to be fully removed by TY10;
- TY50 is the end of the period of analysis of the Feasibility Study.

Full dam removal is assumed by TY 5 for Alternative 2 Dam Removal with Mechanical Transport and Alternative 4 Dam Removal with Mechanical and Natural Transport for purposes of this HE. Full dam removal is delayed until TY50 for the Alternative 3 Dam Removal with Natural Transport. Although the dam is removed, in-stream sediment is assumed to remain, resulting in an impassible barrier still in place.

TY1 conditions for the Future with Project (Alternatives 2-4) would be the same as the Future without Project (Alternative 1) because the dam would still be impeding access and not all barriers would have been removed by this date. The scores for TY10 and TY50 for Alternatives 2 and 4 reflect the improved conditions following dam removal in TY5 and complete removal of all upstream barriers by TY10.

Equations used to calculate the scores for the three primary ecosystem components (Aquatic Habitat, Riparian Habitat and Natural Processes) are shown. The Total Score, is an average of the three ecosystem component scores.

Habitat Units (HUs) are the product of the Total Score and the acres of habitat in each reach. The acreage for each reach was determined using GIS mapping of the reaches to determine stream length, multiplied by a standard 300 foot buffer on either side of the stream to include riparian habitat. Annual Average Habitat Units (AAHUs) are presented in the last row of **each table**, and represent the HUs gained over the life of the proposed action.

HUs were averaged over the 50-yr project life to yield Average Annual Habitat Units (AAHU). The gain or loss of AAHU value relative to the Alternative 1 No Action alternative is what was used in the incremental cost analysis. AAHU values were calculated using an annualized model prepared by the IWR.

The US Army Corps of Engineers Institute for Water Resources has developed IWR Planning Suite Decision Support Software to assist with the formulation and comparison of alternative plans. While the IWR Planning Suite was initially developed to assist with environmental restoration and watershed planning studies, the program can be useful in planning studies addressing a wide variety of problems. IWR Planning Suite can assist with plan formulation by combining solutions to planning problems and calculating the additive effects of each combination, or "plan." IWR Planning Suite can also conduct cost effectiveness and incremental cost analyses, identifying the plans that are the best financial investments, and displaying the effects of each on a range of decision variables. Additional information can be found online at: http://www.pmcl.com/iwrplan/

Annualizing ecosystem costs and outputs is required by the USACE planning guidance. The annualizer utility, a function of the IWR Planning Suite Decision Support Software, allows users to interpolate benefits over the period of analysis, in this case the life of the project. The utility estimates average annual benefits. For purposes of average annual habitat units, the National Ecosystem Restoration (NER) module of the annualizer is used. This module was designed to evaluate average annual habitat values (as opposed to costs). HU values calculated for TY0, TY1, TY10, and TY50 were entered into the calculator. Project life was set to 50 yrs, no maximum score was set, and linear interpolation selected. This is a conservative approach. Most restoration projects see a large initial increase, followed by a gradual approach to full functionality. However, this would be extremely difficult to model and so a more conservative approach was selected. HUs were averaged over the 50-yr project life to yield Average Annual Habitat Units (AAHU) using the annualizer function. The gain or loss of AAHU value relative to the Alternative 1 No Action Alternative is what is used in the incremental cost analysis.

Photos of the upstream barriers were provided by USACE, Santa Monica Bay Restoration Foundation, and Mountains Restoration Trust in 2013.

Figure 6.2-1 Upstream Barrier Severity Ranking (based on Abramson and Grimmer 2005, Caltrout 2006)

6.2.1 Cold Creek Confluence to Century Dam Reach

Table 6.2-1 Cold Creek Confluence to Century Dam Reach

	Existing	Future Without Project			Alts 2 & 4			Alt 3		
Aquatic Habitat Value	**TY0**	**TY 1**	**TY 10**	**TY 50**	**TY 1**	**TY 10**	**TY 50**	**TY 1**	**TY 10**	**TY 50**
A. Habitat Value	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A + B + C + D)/4	0.44	0.44	0.44	0.44	0.44	0.75	0.81	0.44	0.44	0.44
Riparian Habitat Value										
A. %Native Vegetation Cover	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Natural Process Value										
A. Natural Hydrologic Regime	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
B. Natural Sediment Regime	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Score = (A + B)/2	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Total Score	0.56	0.56	0.56	0.56	0.56	0.67	0.69	0.56	0.56	0.56
Acreage	257	257	257	257	257	257	257	257	257	257
Habitat Units (H.U.)	145	145	145	145	145	171	177	145	145	145
Average Annual Habitat Units				145			171			145
*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).										
**Downstream barrier in adjacent downstream reach=no barrier at Cold Creek confluence with Malibu Creek										

<u>Existing and Future without Project Conditions (Alternative 1 No Action)</u>

Aquatic Habitat Value

The reach from the Cold Creek Confluence to Century Dam includes several reaches evaluated by Abramson and Grimmer (2005): Rindge Dam to Tunnel Falls; Tunnel Falls to the Texas Crossing (which has been removed); and the Texas Crossing to Century Dam. Based on this information, weighted pool habitat quality from Rindge Dam to Tunnel Falls is excellent, from Tunnel Falls to the Texas Crossing is good, and from Texas Crossing to Century Dam is good (see **Appendix J3**). Therefore, Variable A for the combined reach was given a good score (0.75).

Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam.

Aquatic Connectivity to the adjacent downstream reach (Variable D) scores a 1.00 under Existing and Future Without Project, because there is no barrier at the Cold Creek Confluence that would block access to the downstream reach. Tunnel Falls is located within the adjacent downstream reach, but a large portion of that reach is accessible down to Tunnel Falls. Tunnel Falls presents a moderate flow barrier but is considered passable during all flows when adult steelhead would be attempting to move upstream.

Riparian Habitat Value

The Cold Creek Confluence to Century Dam reach has 60-80 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011); score is a 0.75. Using the percentage of *Arundo donax* within each reach (based on Abramson and Grimmer, 2005; see **Appendix J5**), the Variable B score is high (less than 5 percent *Arundo donax*); score is a 1.00.

Natural Process Value

The Natural Hydrologic Regime score (0.50) reflects moderate alteration due to the presence of Century Dam on the upstream end but large areas of natural vegetation communities present. The Natural Sediment Regime scores (0.25) reflect substantial alteration, as Century Dam has a significant effect on sediment transport (**Figure 6.2-1)**.

<u>Future with Project Conditions (Alternatives 2-4)</u>

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions.

Steelhead Use (Variable B) under Future With Project reflects increased access following the removal of Rindge Dam by TY5 in Alternative 2 or 4. The reach would still be inaccessible by TY1 so the score is 0. Assuming implementation of Alternative 2 (and possibly Alternative 4), adults and young steelhead could be expected by TY10, increasing the score to 0.75. With either Alternative 2 or 4, all appropriate life stages could be expected by TY50, increasing the score to 1.00. The dam would still be a barrier for all target years if Alternative 3 is implemented.

By TY10, Steelhead Connectivity (Variable C) becomes a score of 0.50 (passable at moderate flows) due to the remaining presence of Tunnel Falls, a natural barrier downstream if Alternative 2 or 4 is implemented. Connectivity would not be restored until TY50 for Alternative 3.

Aquatic Connectivity to the adjacent downstream reach (Variable D) remains a 1.00 under Future With Project, because there is no barrier at the Cold Creek Confluence that would block access to the downstream reach. Tunnel Falls is located within the adjacent downstream reach, but a large portion of that reach is accessible down to Tunnel Falls.

Riparian Habitat Value

The Cold Creek Confluence to Century Dam reach has 60-80 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011) resulting in a score of 0.75. Using the percentage of *Arundo donax* within each reach (based on aerial photography and Abramson and Grimmer (2005), see **Appendix J5**), the Variable B score is 1.00 (less than 5 percent *Arundo donax*).

Natural Process Value

The Natural Hydrologic Regime score (0.50) reflects moderate alteration due to the presence of Century Dam on the upstream end but large areas of natural vegetation communities present.

The Natural Sediment Regime scores (0.25) reflect substantial alteration, as Century Dam has a significant effect on sediment transport (**Figure 6.2-1**).

6.2.2 Las Virgenes Creek Confluence to Crags Road Culvert Reach (LV confluence – LV1)

BARRIER- LV1
Crags Road Culvert Crossing

Stream: Las Virgenes Creek
Severity: Passable at high flows
Type: Dam
Number of downstream barriers: 4
Downstream habitat quality (wPHQ): Good
Upstream habitat quality (wPHQ): Excellent
Description: 6 ft high, 87 ft wide, 6 ft long diversion dam with notch
Material: Concrete
Land ownership: Public (Malibu Creek State Park)
Lat./Long – NAD '27:
34.11211457530 / -118.71128380300

Table 6.2-2 Las Virgenes Creek Confluence to Crags Road Culvert Reach (LV Confluence – LV1)

	Existing	**Future Without Project**			**Alts 2 & 4**			**Alt 3**		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A + B + C + D)/4	0.44	0.44	0.44	0.44	0.44	0.75	0.81	0.44	0.44	0.44
Riparian Habitat Value										
A. %Native Vegetation Cover	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Natural Process Value										
A. Natural Hydrologic Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Natural Sediment Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Score = (A + B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Total Score	0.65	0.65	0.65	0.65	0.65	0.75	0.77	0.65	0.65	0.65
Acreage	23	23	23	23	23	23	23	23	23	23
Habitat Units (H.U.)	15	15	15	15	15	17	18	15	15	15
Average Annual Habitat Units				15			17			15
*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).										
**Downstream barrier in adjacent downstream reach=none										

Existing and Future without Project Conditions (Alternative 1 No Action)

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from the Crags Road Culvert to White Oak Farms Dam is good (**Appendix J3**). Habitat Value (Variable A) for the combined reach was given a good score (0.75). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) scores a 1.00 under Existing and Future Without Project, because there is no barrier at the Las Virgenes Creek Confluence that would block access to the downstream reach.

Riparian Habitat Value

The Crags Road Culvert to White Oaks Farm Dam reach has 40-60 percent native vegetation cover (Variable A), resulting in a score of 0.50. Using the percentage of *Arundo donax* within each reach (**Appendix J5**), the Variable B score is 1.00 (less than 5 percent *Arundo donax*).

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.75) reflect minimal alteration as the reach leaves Malibu State Park and traverses upstream across a primarily open space grassland area (**Figure 6.2-1**).

Future with Project Conditions (Alternatives 2-4)

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) remains a 1.00 under Future With Project because there is no barrier at the Las Virgenes Creek Confluence that would block access to the downstream reach.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.3 Crags Road Culvert to White Oak Farm Dam Reach (LV1 – LV2)

BARRIER – LV2
White Oak Farm Dam

Stream: Las Virgenes Creek
Severity: Passable at high flows
Type: Dam
Number of downstream barriers: 4
Downstream habitat quality (wPHQ): Good
Upstream habitat quality (wPHQ): Excellent
Description: 6 ft high, 87 ft wide, 6 ft long diversion dam with notch
Material: Concrete
Land ownership: Public (Malibu Creek State Park)
Lat./Long – NAD ‘27:
34.11211457530 / -118.71128380300

Table 6.2-3 Crags Road Culvert to White Oaks Farms Dam (LV1 – LV2)

	Existin g	Future Without Project			Alts 2 & 4			Alt 3		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00
Score = (A + B + C + D)/4	0.19	0.19	0.19	0.19	0.19	0.75	0.81	0.19	0.44	0.44
Riparian Habitat Value										
A. %Native Vegetation Cover	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Natural Process Value										
A. Natural Hydrologic Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Natural Sediment Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Score = (A + B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Total Score	0.56	0.56	0.56	0.56	0.56	0.75	0.77	0.56	0.65	0.65
Acreage	165	165	165	165	165	165	165	165	165	165
Habitat Units (H.U.)	93	93	93	93	93	124	127	93	107	107
Average Annual Habitat Units				93			122			106

*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).

**Downstream barrier in adjacent downstream reach=LV1, not passable under existing and future without project conditions

Note: LV1-LV2 includes Liberty Canyon Creek, a tributary that would be opened by removal of LV-1.

Existing and Future without Project Conditions (Alternative 1 No Action)

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from the Crags Road Culvert to White Oak Farms Dam is good (**Appendix J3**). Habitat Value (Variable A) for the combined reach was given a good score (0.75). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) is given a score of 0 due the impassable barrier (LV1 Crags Road Culvert Crossing) on the downstream end of the reach.

Riparian Habitat Value

The Crags Road Culvert to White Oaks Farm Dam reach has 40-60 percent native vegetation cover (Variable A) and score is 0.50. Using the percentage of *Arundo donax* within each reach (see **Appendix J5**), the Variable B score is high (less than 5 percent *Arundo donax*), score is 1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.75) reflect minimal alteration as the reach leaves Malibu State Park and traverses upstream across primarily open space grassland area (**Figure 6.2-1**).

Future with Project Conditions (Alternative 2-4)

Aquatic Habitat

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) becomes a 1.00 at TY10 under Future With Project because the downstream barrier that would block access to the downstream reach is removed.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.4 White Oak Farms Dam to Lost Hills Road Culvert (LV2 – LV3)

BARRIER: LV3
Lost Hills Road Culvert

Stream: Las Virgenes Creek
Severity: Not passable
Type: Box culvert
Number of downstream barriers: 4
Downstream habitat quality (wPHQ): Excellent
Upstream habitat quality (wPHQ): Good
Description: 23 ft high, 61 ft wide, 241 ft long box culvert with 4- 14-ft by 14-ft openings; silted in - lots of cattails, rabbits foot grass; nutsedge, etc.
Material: Concrete
Land ownership: Public (City of Calabasas) land;
LA County Flood Control (WMD) owns structure
Lat./Long – NAD '27:
34.12624980800 / -118.70578825000

Upstream culvert entrance looking towards Lost Hills Rd

View upstream from Lost Hills Rd. showing wing walls.

Table 6.2-4 White Oaks Farms Dam to Lost Hills Road Culvert (LV2 – LV3)

	Existing	Future Without Project			Alts 2 & 4			Alt 3		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	0.25	0.25	0.25	0.25	0.25	1.00	1.00	0.25	1.00	1.00
Score = (A + B + C + D)/4	0.31	0.31	0.31	0.31	0.31	0.81	0.88	0.31	0.50	0.50
Riparian Habitat Value										
A. %Native Vegetation Cover	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Natural Process Value										
A. Natural Hydrologic Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Natural Sediment Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Score = (A + B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Total Score	0.56	0.56	0.56	0.56	0.56	0.73	0.75	0.56	0.63	0.63
Acreage	88	88	88	88	88	88	88	88	88	88
Habitat Units (H.U.)	50	50	50	50	50	64	66	50	55	55
Average Annual Habitat Units				50			64			54
*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).										
**Downstream barrier in adjacent downstream reach=LV2, passable under high flows under existing and future without project conditions										

Existing and Future without Project Conditions (Alternative 1 No Action)

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from White Oak Farms Dam to the Lost Hills Road Culvert is excellent (**Appendix J3**). Variable A for the combined reach was given an excellent score (1.00). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) is given a score of 0.25 because barrier on the downstream end of the reach is considered to be passable under high flows.

Riparian Habitat Value

The White Oaks Farm Dam to Lost Hills Road Culvert reach has only 20-40 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011), score is 0.25. Using the percentage of *Arundo donax* within each reach (see **Appendix J5**), the Variable B score is high (less than 5 percent *Arundo donax*), score is 1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.75) reflect minimal alteration as the reach runs through primarily open space grassland (**Figure 6.2-1**).

<u>Future with Project Conditions (Alternatives 2-4)</u>

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) becomes a 1.00 at TY10 under Future With Project because the downstream barrier that would block access to the downstream reach is removed.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.5 Lost Hills Road Culvert to Meadow Creek Lane Channel (LV3 – LV4)

BARRIER LV 4
Meadow Creek Lane Channel
Stream: Las Virgenes Creek
Severity: Not passable
Type: Drop Structure
Number of downstream barriers: 5
Downstream habitat quality (wPHQ): Good
Upstream habitat quality (wPHQ): Fair
Description: 14-foot wide concrete culvert with failing tailwater walls (falling into stream)
Material: Concrete
Land ownership: Public (City of Calabasas) land; LA County Flood Control (WMD) owns structure?
Lat./Long – NAD '27:
34.12856950640 / -118.70673834200

Entrance/intake upstream

Table 6.2-5 Lost Hills Road Culvert to Meadow Creek Lane Channel (LV3 – LV4)

	Existing	Future Without Project			Alts 2 & 4			Alt 3		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00
Score = (A + B + C + D)/4	0.19	0.19	0.19	0.19	0.19	0.75	0.81	0.19	0.44	0.44
Riparian Habitat Value										
A. %Native Vegetation Cover	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Natural Process Value										
A. Natural Hydrologic Regime	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
B. Natural Sediment Regime	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Score = (A + B)/2	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total Score	0.33	0.33	0.33	0.33	0.33	0.52	0.54	0.33	0.41	0.41
Acreage	14	14	14	14	14	14	14	14	14	14
Habitat Units (H.U.)	5	5	5	5	5	7	8	5	6	6
Average Annual Habitat Units				5			7			6
*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).										
**Downstream barrier in adjacent downstream reach=LV3, not passable under existing and future without project conditions										

<u>Existing and Future Without Project Conditions (Alternative 1 No Action)</u>

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from the Lost Hills Road Culvert to the Meadow Creek Lane Channel is good (**Appendix J3**). Variable A for the combined reach was given a good score (0.75). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) is given a score of 0 due the impassable barrier on the downstream end of the reach.

Riparian Habitat Value

The Lost Hills Road Culvert to Meadow Creek Lane Channel reach has only 5-20 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011), score is 0.1. Using the percentage of *Arundo donax* within each reach (see **Appendix J5**), the Variable B score is high (less than 5 percent *Arundo donax*), score is 1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.25) reflect substantial alteration as the reach runs through a highly urbanized area (**Figure 6.2-1**).

Future with Project Conditions (Alternatives 2-4)

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) becomes a 1.00 at TY10 under Future With Project because the downstream barrier that would block access to the downstream reach is removed.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.6 Meadow Creek Lane Channel to I-101 Bridge (LV4 – I-101)

Table 6.2-6 Meadow Creek Lane Channel to I-101 Bridge (LV4 – I-101)

	Existing	**Future Without Project**			**Alts 2 & 4**			**Alt 3**		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00
Score = (A + B + C + D)/4	0.13	0.13	0.13	0.13	0.13	0.69	0.75	0.13	0.38	0.38
Riparian Habitat Value										
A. %Native Vegetation Cover	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Natural Process Value										
A. Natural Hydrologic Regime	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
B. Natural Sediment Regime	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Score = (A + B)/2	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total Score	0.33	0.33	0.33	0.33	0.33	0.52	0.54	0.33	0.42	0.42
Acreage	117	117	117	117	117	117	117	117	117	117
Habitat Units (H.U.)	39	39	39	39	39	61	63	39	49	49
Average Annual Habitat Units				39			59			48
*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).										
**Downstream barrier in adjacent downstream reach=LV4, not passable under existing and future without project conditions										

Existing and Future without Project Conditions (Alternative 1 No Action)

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from the Meadow Creek Lane Channel to Agoura Road Channel is good (**Appendix J3**). However, the TAC determined a revision to fair was warranted based on current conditions. Variable A for the combined reach was given a fair score (0.50). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) is given a score of 0 due the impassable barrier on the downstream end of the reach.

Riparian Habitat Value

The Meadow Creek Lane Channel to Agoura Road Channel reach has 20-40 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011), score is 0.25. Using the percentage of *Arundo donax* within each reach (**Appendix J5**), the Variable B score is high (less than 5 percent *Arundo donax*), score is 1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.25) reflect substantial alteration as the reach runs through a highly urbanized area (**Figure 6.2-1**).

Future with Project Conditions (Alternatives 2-4)

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) becomes a 1.00 at TY10 under Future With Project because the downstream barrier that would block access to the downstream reach is removed.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.7 Cold Creek Confluence to Piuma Pipe Arch Culvert (CC confluence – CC1)

BARRIER CC1
Piuma Pipe Arch Culvert
Stream: Cold Creek
Severity: Not passable
Type: Culvert
Number of downstream barriers: 2
Downstream habitat quality (wPHQ): Excellent
Upstream habitat quality (wPHQ): Good
Description: Pipe arch culvert at Piuma Road with corrugated aluminum at top and concrete bottom. 11 ft high, 12 ft wide, 46 ft long.
Material: Corrugated aluminum and concrete
Land ownership: Public (LA County Roads)
Lat./Long – NAD '27:
34.07874666470 / -118.69865825300

Table 6.2-7 Cold Creek Confluence to Piuma Pipe Arch Culvert (CC confluence – CC1)

	Existi ng	**Future Without Project**			**Alts 2 & 4**			**Alt 3**		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A + B + C + D)/4	0.44	0.44	0.44	0.44	0.44	0.75	0.81	0.44	0.44	0.44
Riparian Habitat Value										
A. %Native Vegetation Cover	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Natural Process Value										
A. Natural Hydrologic Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Natural Sediment Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Score = (A + B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Total Score	0.69	0.69	0.69	0.69	0.69	0.79	0.81	0.69	0.69	0.69
Acreage	10	10	10	10	10	10	10	10	10	10
Habitat Units (H.U.)	7	7	7	7	7	8	8	7	7	7
Average Annual Habitat Units				7			8			7
*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).										
**Downstream barrier in adjacent downstream reach=none										

Existing and Future without Project Conditions (Alternative 1 No Action)

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality is good (**Appendix J3**). Variable A for the combined reach was given a good score (0.75). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) was scored a 1.00 because there is no barrier at the Cold Creek Confluence that would block access to the downstream reach.

Riparian Habitat Value

The Piuma Culvert to Malibu Meadows Road Bridge reach has 60-80 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011), score is 0.75. Using the percentage of *Arundo donax* within each reach (**Appendix J5**), the Variable B score is high (less than 5 percent *Arundo donax*), score is 1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.75) reflect minimal alteration as the reach runs through a small private development (**Figure 6.2-1**).

Future with Project Conditions (Alternatives 2 and 4)

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) remains a 1.00 under Future With Project because there is no barrier at the Cold Creek Confluence that would block access to the downstream reach.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.8 Piuma Pipe Arch Culvert to Malibu Meadows Road Bridge (CC1 – CC2)

BARRIER CC2
Malibu Meadows Rd. Bridge
Stream: Cold Creek
Severity: Passable at high flows
Type: Stream crossing
Number of downstream barriers: 3
Downstream habitat quality (wPHQ): Good
Upstream habitat quality (wPHQ): Poor
Description: Malibu Meadows Road bridge with concrete lined walls and bottom; outlet is a free-fall into a pool. 4 ft high, 28 ft wide, 40 ft long
Material: Concrete
Land ownership: Private (HOA?)
Lat./Long – NAD '27:
34.08156392440 / -118.69494616300

Table 6.2-8 Piuma Pipe Arch Culvert to Malibu Meadows Road Bridge (CC1 – CC2)

	Existing	**Future Without Project**			**Alts 2 & 4**			**Alt 3**		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00
Score = (A + B + C + D)/4	0.19	0.19	0.19	0.19	0.19	0.75	0.81	0.19	0.44	0.44
Riparian Habitat Value										
A. %Native Vegetation Cover	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Natural Process Value										
A. Natural Hydrologic Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Natural Sediment Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Score = (A + B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Total Score	0.60	0.60	0.60	0.60	0.60	0.79	0.81	0.60	0.69	0.69
Acreage	25	25	25	25	25	25	25	25	25	25
Habitat Units (H.U.)	15	15	15	15	15	20	20	15	17	17
Average Annual Habitat Units				15			19			17

*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).

**Downstream barrier in adjacent downstream reach=CC1, not passable under existing and future without project conditions

<u>Existing and Future without Project Conditions (Alternative 1 No Action)</u>

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from the Piuma Culvert to Malibu Meadows Road Bridge is good (**Appendix J3**). Variable A for the combined reach was given a good score (0.75). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) is given a score of 0 due the impassable barrier on the downstream end of the reach.

Riparian Habitat Value

The Piuma Culvert to Malibu Meadows Road Bridge reach has 60-80 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011), score is 0.75. Using the percentage of *Arundo donax* within each reach (**Appendix J4**), the Variable B score is high (less than 5 percent *Arundo donax*), score is 1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.75) reflect minimal alteration as the reach runs through a small private development (**Figure 6.2-1**).

<u>Future with Project Conditions (Alternatives 2-4)</u>

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) becomes a 1.00 at TY10 under Future With Project because the downstream barrier that would block access to the downstream reach is removed.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.9 Malibu Meadows Road Bridge to Crater Camp Road Bridge (CC2 – CC3)

BARRIER CC3
Crater Camp Road Bridge
Stream: Cold Creek
Severity: Not passable
Type: Stream crossing
Number of downstream barriers: 4
Downstream habitat quality (wPHQ): Poor
Upstream habitat quality (wPHQ): Good
Description: Crater Camp Road wooden bridge with concrete lined walls and bottom; outlet is a free-fall into a pool, 3 ft high, 11 ft wide, 46 ft long
Material: Concrete
Land ownership: Private (HOA?)
Lat./Long – NAD '27:
34.08156392440 / -118.69494616300

Table 6.2-9 Malibu Meadows Road Bridge to Crater Camp Road Bridge (CC2 – CC3)

	Existing	**Future Without Project**			**Alts 2 & 4**			**Alt 3**		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	0.25	0.25	0.25	0.25	0.25	1.00	1.00	0.25	1.00	1.00
Score = (A + B + C + D)/4	0.19	0.19	0.19	0.19	0.19	0.69	0.75	0.19	0.38	0.38
Riparian Habitat Value										
A. %Native Vegetation Cover	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Natural Process Value										
A. Natural Hydrologic Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Natural Sediment Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Score = (A + B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Total Score	0.60	0.60	0.60	0.60	0.60	0.77	0.79	0.60	0.67	0.67
Acreage	8	8	8	8	8	8	8	8	8	8
Habitat Units (H.U.)	5	5	5	5	5	6	6	5	5	5
Average Annual Habitat Units				5			6			5
*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).										
**Downstream barrier in adjacent downstream reach=CC2, passable under high flows under existing and future without project conditions										

Existing and Future without Project Conditions (Alternative 1 No Action)

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from the Malibu Meadows Road Bridge to the Crater Camp Road Bridge is poor (**Appendix J3**). However, the TAC determined a revision to fair is warranted based on current conditions. Variable A for the combined reach was given a fair score (0.50). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) is given a score of 0.25 due to the barrier on the downstream end of the reach, which is currently passable only under high flows.

Riparian Habitat Value

The Malibu Meadows Road Bridge to the Crater Camp Road Bridge reach has 60-80 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011), score is 0.75. Using the percentage of *Arundo donax* within each reach (**Appendix J4**), the Variable B score is high (less than 5 percent *Arundo donax*), score is1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.75) reflect minimal alteration as the reach runs through a small private development (**Figure 6.2-1**).

Future with Project Conditions (Alternatives 2-4)

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) becomes a 1.00 at TY10 under Future With Project because the downstream barrier that would block access to the downstream reach is removed.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.10 Crater Camp Road Bridge to Cold Creek Barrier (CC3 – CC4)

BARRIER CC4 (no photo available)
Cold Creek Barrier
Stream: Cold Creek
Severity: Passable at moderate/high flows
Type: Dam
Number of downstream barriers: 5
Downstream habitat quality (wPHQ): Fair
Upstream habitat quality (wPHQ): Good
Description: 30-foot wide concrete dam. 2 ft long, 2.5 ft high, 2-foot jump height.
Material: Concrete
Land ownership: Private
Lat./Long – NAD '27:
34.08640286570 / -118.68292110700

Table 6.2-10 Crater Camp Road Bridge to Cold Creek Barrier (CC3 – CC4)

	Existing	**Future Without Project**			**Alts 2 & 4**			**Alt 3**		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00
Score = (A + B + C + D)/4	0.19	0.19	0.19	0.19	0.19	0.75	0.81	0.19	0.44	0.44
Riparian Habitat Value										
A. %Native Vegetation Cover	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Natural Process Value										
A. Natural Hydrologic Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Natural Sediment Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Score = (A + B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Total Score	0.56	0.56	0.56	0.56	0.56	0.75	0.77	0.56	0.65	0.65
Acreage	60	60	60	60	60	60	60	60	60	60
Habitat Units (H.U.)	34	34	34	34	34	45	46	34	39	39
Average Annual Habitat Units				34			44			38

*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).

**Downstream barrier in adjacent downstream reach=CC3, not passable under existing and future without project conditions

Existing and Future without Project Conditions (Alternative 1 No Action)

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from the Crater Camp Road Bridge to the Cold Creek Barrier is good (**Appendix J3**). Variable A for the combined reach was given a good score (0.75). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) is given a score of 0 due the impassable barrier on the downstream end of the reach.

Riparian Habitat Value

The Crater Camp Road Bridge to Cold Creek Barrier reach has 40-60 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011), score is 0.50. Using the percentage of *Arundo donax* within each reach (**Appendix J4**), the Variable B score is high (less than 5 percent *Arundo donax*), score is 1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.75) reflect minimal alteration as the reach runs through a small private development (**Figure 6.2-1**).

Future with Project Conditions (Alternatives 2-4)

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) becomes a 1.00 at TY10 under Future With Project because the downstream barrier that would block access to the downstream reach is removed.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.11 Cold Creek Barrier to Cold Canyon Road Culvert (CC4 - CC5)

BARRIER – CC5
Cold Canyon Road Culvert
Stream: Cold Creek
Severity: Not passable
Type: Culvert
Number of downstream barriers: 6
Downstream habitat quality (wPHQ): Good
Upstream habitat quality (wPHQ): Fair
Description: 25-foot diameter, 130 ft long large corrugated pipe culvert with concrete bottom at Cold Canyon Road; Short concrete apron into large boulder/bedrock pool at outlet, jump height when measured was 7 ft.
Material: Corrugated metal and concrete
Land ownership: Public (LA County Roads)
Lat./Long – NAD '27:
34.09178093190 / -118.67922658600

Table 6.2-11 Cold Creek Barrier to Cold Canyon Road Culvert (CC4 – CC5)

	Existing	**Future Without Project**			**Alts 2 & 4**			**Alt 3**		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	0.50	0.50	0.50	0.50	0.50	1.00	1.00	0.50	1.00	1.00
Score = (A + B + C + D)/4	0.31	0.31	0.31	0.31	0.31	0.75	0.81	0.31	0.44	0.44
Riparian Habitat Value										
A. %Native Vegetation Cover	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Natural Process Value										
A. Natural Hydrologic Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Natural Sediment Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Score = (A + B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Total Score	0.65	0.65	0.65	0.65	0.65	0.79	0.81	0.65	0.69	0.69
Acreage	30	30	30	30	30	30	30	30	30	30
Habitat Units (H.U.)	19	19	19	19	19	24	24	19	21	21
Average Annual Habitat Units				19			23			21
*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).										
**Downstream barrier in adjacent downstream reach=CC4, passable under moderate flows under existing and future without project conditions										

Existing and Future without Project Conditions (Alternative 1 No Action)

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from the Cold Creek Barrier to the Cold Canyon Road Culvert is good (**Appendix J2**). Variable A for the combined reach was given a good score (0.75). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) is given a score of 0.50 due to the barrier on the downstream end of the reach, which is currently passable under moderate flows.

Riparian Habitat Value

The Cold Creek Barrier to the Cold Canyon Road Culvert reach has 60-80 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011), score is 0.75. Using the percentage of *Arundo donax* within each reach (based on Abramson and Grimmer, 2005; see **Appendix J4**), the Variable B score is high (less than 5 percent *Arundo donax*), score is 1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.75) reflect minimal alteration as the reach leaves the private development and runs through open space within the Santa Monica Mountains (**Table 5-2**).

Future with Project Conditions (Alternatives 2-4)

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) becomes a 1.00 at TY10 under Future With Project because the downstream barrier that would block access to the downstream reach is removed.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.12 Cold Canyon Road Culvert to Stunt Road Culvert (CC5 – CC8)

BARRIER CC6 – natural low flow barrier that does not need action

BARRIER CC7
Cold Creek Check Dam (REMOVED BY MOUNTAINS RESTORATION TRUST 2013)
Stream: Cold Creek
Severity: Passable at moderate/high flows
Type: Dam
Number of downstream barriers: 8
Downstream habitat quality (wPHQ): Fair
Upstream habitat quality (wPHQ): Fair
Description: Old 30-foot wide check dam, which is a barrier during low flows. Barrier is 6 ft long and 3.5 ft high, with a jump height of 1.3 ft, when measured
Material: Concrete
Land ownership: Public preserve (technically County)
Lat./Long – NAD ‘27:
34.09481323120 / -118.67098754700

BARRIER CC8
Stunt Road Crossing
Stream: Cold Creek
Severity: Not passable
Type: Culvert
Number of downstream barriers: 9
Downstream habitat quality (wPHQ): Good
Upstream habitat quality (wPHQ): Fair
Description: 6-foot diameter, 104 ft long corrugated culvert with rebar/concrete along bottom; concrete crumbling; rebar rusted and bent; rust hole in culvert at outlet end; located at Stunt Road crossing
Material: Corrugated metal and concrete
Land ownership: Public (LA County Roads)
Lat./Long – NAD ‘27:
34.09355720530 / -118.64664410600

Table 6.2-12 Cold Canyon Road Culvert to Stunt Road Culvert (CC5 – CC8)

	Existing	Future Without Project			Alts 2 & 4			Alt 3		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.00	0.25	0.25
Score = (A + B + C + D)/4	0.19	0.19	0.19	0.19	0.19	0.56	0.63	0.19	0.25	0.25
Riparian Habitat Value										
A. %Native Vegetation Cover	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Natural Process Value										
A. Natural Hydrologic Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Natural Sediment Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Score = (A + B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Total Score	0.60	0.60	0.60	0.60	0.60	0.73	0.75	0.60	0.63	0.63
Acreage	166	166	166	166	166	166	166	166	166	166
Habitat Units (H.U.)	100	100	100	100	100	121	125	100	104	104
Average Annual Habitat Units				100			120			104
*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).										
**Downstream barrier in adjacent downstream reach=CC5, not passable under existing and future without project conditions. CC6 (natural barrier within reach) is passable under high flows only, thus score reaches only 0.25 under future with project conditions. CC7 is a manmade barrier that was removed in 2013.										

Existing and Future without Project Conditions (Alternative 1 No Action)

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from the Cold Canyon Road Culvert to the Cold Creek Check Dam is good (**Appendix J3**). Variable A for the combined reach was given a good score (0.75). Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) is given a score of 0 due the impassable barrier on the downstream end of the reach and the natural barrier within the reach that is only passable at high flows (CC6).

Riparian Habitat Value

The Cold Canyon Road Culvert to the Cold Creek Check Dam reach has 60-80 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011), score is 0.75. Using the percentage of *Arundo donax* within each reach (**Appendix J4**), the Variable B score is high (less than 5 percent *Arundo donax*), score is 1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.75) reflect minimal alteration as the reach runs through open space within the Santa Monica Mountains (**Figure 6.2-1**).

Future with Project Conditions (Alternatives 2-4)

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) would increase to a score of 0.25 under Future With Project as the barrier on the downstream end of the reach would be made passable at most flows, however the natural barrier (CC6) would remain. CC6 is passable only under high flows

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.2.13 Stunt Road Culvert to 12 foot waterfall (CC8 – upstream limit)

Table 6.2-13 Stunt Road Culvert to 12-ft Waterfall (CC8 – upstream limit)

	Existing	**Future Without Project**			**Alts 2 & 4**			**Alt 3**		
Aquatic Habitat Value	TY0	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50	TY 1	TY 10	TY 50
A. Habitat Value	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
B. Steelhead Use	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.00	0.00
C. Steelhead Connectivity*	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00
D. Aquatic Connectivity**	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00
Score = (A + B + C + D)/4	0.13	0.13	0.13	0.13	0.13	0.69	0.75	0.13	0.38	0.38
Riparian Habitat Value										
A. %Native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
B. %Non-native Vegetation Cover	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Score = (A+B)/2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Natural Process Value										
A. Natural Hydrologic Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
B. Natural Sediment Regime	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Score = (A + B)/2	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Total Score	0.63	0.63	0.63	0.63	0.63	0.81	0.83	0.63	0.71	0.71
Acreage	16	16	16	16	16	16	16	16	16	16
Habitat Units (H.U.)	10	10	10	10	10	13	13	10	11	11
Average Annual Habitat Units				10			13			11

*Downstream barriers to ocean following project completion=Tunnel Falls (passable moderate flows only).

**Downstream barrier in adjacent downstream reach=CC8, not passable under existing and future without project conditions

<u>Existing and Future without Project Conditions (Alternative 1 No Action)</u>

Aquatic Habitat Value

Based on Abramson and Grimmer (2005), weighted pool habitat quality from the Stunt Road Culvert to the waterfall at the upstream limit of Cold Creek varies between poor to good (**Appendix J3**). Therefore, a rating of fair (score = 0.50) was used. Steelhead Use (Variable B) is currently prohibited in the reach and is given a score of 0. Steelhead Connectivity (Variable C) scores a 0 under Existing and Future Without Project, because of the presence of Rindge Dam. Aquatic Connectivity to the adjacent downstream reach (Variable D) is given a score of 0 due the impassable barrier on the downstream end of the reach.

Riparian Habitat Value

The Cold Canyon Road Culvert to the Cold Creek Check Dam reach has 80-100 percent native vegetation cover (Variable A), based on visual observation of aerial photography (using Google Earth, April 2011), score is 1.00. Using the percentage of *Arundo donax* within each reach (**Appendix J4**), the Variable B score is high (less than 5 percent *Arundo donax*), score is 1.00.

Natural Process Value

The Natural Hydrologic Regime and Natural Sediment Regime scores (0.75) reflect minimal alteration as the reach runs through open space within the Santa Monica Mountains (**Figure 6.2-1**).

Future with Project Conditions (Alternatives 2-4)

Aquatic Habitat Value

Variable A for the combined reach was given a good score (0.75). This variable remains unchanged for future conditions. Steelhead Use (Variable B) under Future With Project the reach would still be inaccessible to adult steelhead by TY1 so the score is 0.0. With the removal of Rindge Dam by TY5, adults and young steelhead could be anticipated by TY10 increasing the score to 0.75. All appropriate life stages (score 1.00) are anticipated by TY50.

Under Future With Project (Alternatives 2 and 4), Steelhead Connectivity (Variable C) remains impassable for TY1 due to the presence of Rindge Dam, but becomes a score of 0.50 (passable at moderate flows) after TY5 due to the remaining presence of Tunnel Falls, the only barrier that would remain downstream. Aquatic Connectivity to the adjacent downstream reach (Variable D) would increase to a score of 1.00 at TY10 under Future With Project as the barrier on the downstream end of the reach would be made passable at most flows.

Should Alternative 3 be selected, steelhead use (Variable B) and Steelhead Connectivity (Variable C) would remain scored at 0 until TY50.

6.3 Summary and Conclusions for Upstream Reaches

Using a modified HE approach, Habitat Units were calculated for thirteen reaches upstream of Rindge Dam to provide a quantitative valuation of existing and future conditions following removal or modification of upstream fish passage barriers. The only change from Existing Conditions within each reach was the improvement of scores for Steelhead Use, Steelhead Connectivity, and Aquatic Connectivity. Therefore, an increase in HUs represents simply the benefit gained by opening up each reach for steelhead, and reconnecting each reach to the downstream reach for other aquatic species, which are functions of the quality of the habitat and the acreage. Based on the HE, removal of the barrier that defines the downstream end of the reach provides a gain in HUs to varying extent for every reach.

It is important to note that HUs are considered for each reach, with the understanding that the reach would not be accessible and HUs actually gained unless the downstream barriers are also addressed. For Alternatives 2-4, a barrier would not be removed unless all downstream barriers (except natural barriers) were removed or modified to allow fish passage under most flows.

Table 6.3-1 Habitat Units Gained With Each Reach

Reach	Downstream-Upstream Barrier ID	HUs Gained*	
		Alternatives 2 & 4	Alternative 3
Malibu Creek from Cold Creek Confluence to Century Dam	Cold Creek Confluence (not a barrier)-Century Dam	26	0
Las Virgenes Creek Confluence to Crags Road Culvert Crossing	Las Virgenes Creek Confluence (not a barrier)-LV1	2	0
Crags Road Culvert Crossing to White Oaks Farms Dam	LV1-LV2	29	13
White Oak Farms Dam to Lost Hills Road Culvert	LV2-LV3	14	4
Lost Hills Road Culvert to Meadow Creek Land Channel	LV3-LV4	2	1
Meadow Creek Land Channel to I-101 Bridge	LV4-I-101	20	9
Cold Creek Confluence to Piuma Pipe Arch	Cold Creek Confluence (not a barrier)-CC1	1	0
Piuma Pipe Arch to Malibu Meadows Road Bridge	CC1-CC2	4	2
Malibu Meadows Road Bridge to Crater Camp Road Bridge	CC2-CC3	1	0
Crater Camp Road Bridge to Cold Creek Barrier	CC3-CC4	10	4
Cold Creek Barrier to Cold Canyon Road Culvert	CC4-CC5	4	2
Cold Canyon Road Culvert to Stunt Road Culvert	CC5-CC8	20	4
Stunt Road Culvert to Cold Creek Upstream Limit	CC8-upstream limit	3	2
TOTAL		*136*	*40*
*From Future Without Project Conditions to Future With Project Conditions			
Note: LV1-LV2 includes Liberty Canyon Creek, a tributary that would be opened by removal of LV-1.			

Table 6.3-2 Comparison of AAHU's for each Alternative

	Alternative 1 No Action (Future Without Project)	Alternative 2 Dam Removal with Mechanical Transport	Alternative 3 Dam Removal with Natural Transport	Alternative 4 Dam Removal with Hybrid Mechanical and Natural Transport
Rindge Dam Removal Only (Option A)				
Mainstem Reaches	82	100	60	89
Malibu Creek to Century Dam	145	171	145	171
Cold Creek to CC1	7	8	7	8
Las Virgenes Creek to LV1	15	17	15	17
Subtotal with Dam Removal	*249*	*296*	*227*	*285*
Net Benefit (compared to No Action		*47*	*-22*	*36*
Upper Barrier Removal				
LV1 Removal	93	122	106	122
LV2 Removal	50	64	54	64
LV3 Removal	5	7	6	7
LV4 Removal	39	59	48	59
CC1 Removal	15	19	17	19
CC2 Removal	5	6	5	6
CC3 Removal	34	44	38	44
CC4 Removal	19	23	21	23
CC5 Removal	100	120	104	120
Subtotal Barrier Removal	*360*	*464*	*399*	*464*
Note: Barrier CC8 removal determined to not be economically feasible				

7.0 RESULTS OF THE UPSTREAM REACH HABITAT EVALUATION

The area that would benefit from removal of Rindge Dam is composed of the Mainstem Reaches and three of the Upstream Reaches (on Malibu Creek from Cold Creek Confluence to Century Dam, on Cold Creek from its Confluence with Malibu Creek to CC1, Las Virgenes Creek from its Confluence with Malibu Creek to LV1). Therefore removal of Rindge Dam alone would increase steelhead access from the existing 3 linear miles of stream by 5.5 miles, for a total access for steelhead of 8.5 miles.

Removal of all nine upstream barriers (CC8 would not be removed),would provide an additional 9.3 miles of accessible habitat for steelhead for a total of approximately 15 miles of added access in the Malibu Creek watershed for a total of 18 miles.

As shown in **Table 7-1**, the total AAHUs currently associated with the upstream barriers is 360. Removal of the nine upstream barriers would provide 464 AAHUs under Alternatives 2b and 4b, and would provide 399 AAHUs under Alternative 3b. This would result in a net increase of 104 AAHUs for Alternatives 2b and 3b, and 39 AAHUs for Alternative 3b.

8.0 SUMMARY

Although the benefits of this project are not to steelhead trout alone, they are the species that most directly benefit from project implementation. The changes to habitat suitability for steelhead due to the removal of Rindge Dam are most affected by the time scale associated with the proposed project. Steelhead are a highly flexible species and able to withstand many habitat changes over time. Unfortunately, the long-term effects of changes during the past 100 years has resulted in a remnant population of approximately 500 anadromous adults remaining in the southern California Distinct Population Unit (NOAA 2012). The species is on the brink of extinction at this time. Implementation of recovery actions needs to happen soon. Removal of Rindge Dam has been identified as a high priority action that could significantly benefit the species.

This HE attempts to capture the benefits of Rindge Dam removal and up to ten upstream barriers for the benefit of steelhead and the associated ecosystem of lower Malibu Creek watershed. The summary of AAHUs gained under each alternative is summarized in **Table 8-1** below.

Table 6.3-1 Comparison of AAHU's for each Alternative

Alternative	AAHU	Gain/Loss
Alternative 1 No Action	609	
Alternative 2a Dam Removal with Mechanical Transport	656	47
Alternative 2b Dam Removal with Mechanical Transport and Upstream Barrier Removal	760	151
Alternative 3a Dam Removal with Natural Transport	587	-22
Alternative 3b Dam Removal with Natural Transport and Upstream Barrier Removal	626	17
Alternative 4a Dam Removal with Hybrid Mechanical and Natural Transport	645	36
Alternative 4b Dam Removal with Hybrid Mechanical and Natural Transport and Upstream Barrier Removal	749	140
Gain/Loss is relative to Alternative 1 No Action		

Alternative 1 (the No Action Alternative) shows a decline in habitat values over time with no positive value added by the continued presence of a defunct dam. This alternative is not without impacts, as continued habitat degradation is anticipated due to the presence of Rindge Dam and its anticipated deterioration over time. It is unlikely that funds would be available to address any future maintenance issues associated with it. The continued restricted habitat available below Rindge Dam is also an identified constraint to the steelhead population, other aquatic species, and wildlife movement in general. The dam has also become an attractive nuisance, with increased habitat damage occurring at the site due to a recent marked increase in trespass.

Most Action Alternatives (Alternatives 2a, 2b, 3b, 4a, and 4b) show an increase of 17-151 AAHUs compared to the Alternative 1, No Project. This is because the project alternatives would provide at least an additional 5.5 miles of stream habitat to steelhead under Option A (Alternatives 2a, 3a, and 4a), or an additional 15 miles under Option B (Alternatives 2b,3b, and 4b).

All alternatives that include Option B, the removal of the nine upstream barriers (Alternatives 2b, 3b, and 4b), show an increase in AAHUs compared to alternatives that would not remove these additional barriers (Alternatives 2a, 3a, and 4a). This is because Option B would increase access to an additional 9.3 linear miles of Malibu Creek and its tributaries.

The alternative that would result in the greatest ecosystem benefits is Alternative 2b (Dam Removal with Mechanical Transport and Upstream Barrier Removal). While dam removal alone results in an increase in habitat value, it is dam removal coupled with the removal of nine small upstream barriers that results in the biggest gain. That additional gain comes at a relatively small cost. Downstream impacts associated with scour and sedimentation are very limited compared to Alternative 1, No Project as sediment behind the dam is removed synchronously with dam removal. This alternative also involves a relatively short construction time frame of 5-8 years. Alternative 4b (Dam Removal with Hybrid Mechanical and Natural Transport and Upstream Barrier Removal) would result in the next highest increase in ecosystem benefits. The ecosystem benefits associated with this alterative are not as high as Alternative 2b as the sediment movement associated with the natural transport element of this alternative is anticipated to result in increased impacts to aquatic connectivity, steelhead use, and steelhead movement due to areas of increased scour and deposition within the creek channel. These impacts are anticipated to be greatest at TY5. This alternative would also require floodwalls, which has associated impacts to riparian habitat values due to the footprint of the structures and associated maintenance. This alternative also involves a relatively short construction time frame of 5-8 years.

Alternative 3b (Dam Removal with Natural Transport and Upstream Barrier Removal) would result in the third highest increase in ecosystem benefits. The ecosystem benefits associated with this alterative are not as high as Alternatives 2b and 4b as complete dam removal and associated sediment movement via natural transport element could require 20-100 years. This extended timeframe would prolong impacts to aquatic connectivity, steelhead use, and steelhead movement due to areas of increased scour and deposition within the creek channel. . This alternative would also require floodwalls, which has associated impacts to riparian habitat values due to the footprint of the structures and associated maintenance.

9.0 REFERENCES

Abramson M., and M. Grimmer. 2005. Fish Migration Barrier Severity and Steelhead Habitat Quality in the Malibu Creek Watershed. Produced for California State Coastal Conservancy and California Department of Parks and Recreation.

Aerial Information Systems (AIS), Environmental Systems Research Institute (ESRI), California Department of Fish and Game, California Native Plant Society and National Park Service. 2007. Preliminary Spatial Vegetation Data of Santa Monica Mountains National Recreation Area and Environs. USGS-NPS Vegetation Mapping Program, Santa Monica Mountains National Recreation Area, Thousand Oaks, CA.

Ambrose, R.F. and A. R. Orme. 2000. Lower Malibu Creek and Lagoon Resource Enhancement and Management. Final Report to the California State Coastal Conservancy, May 2000.

Beck, M.W., K. L. Heck, K.W. Able, D. L. Childers, D. B Eggleston, B. M. Gillanders, B. Halpern, C. G. Hayes, K. Hoshino, T. J. Minello, R. J. Orth, P. F. Sheridan, and M.P. Weinstein. 2001. The identification, conservation and management of estuarine and marine nurseries for fish and invertebrates. Bioscience 51:633-641

Bond, M. A., S.A. Hayes, C. V. Hanson, and R. B. MacFarlane. 2008. Marine survival of steelhead (*Oncorhynchus mykiss*) enhanced by a seasonally closed estuary. Can. J. Fish Aquat. Science 65:2242-2252

Boughton, D. A. and M. Goslin. 2006. Potential steelhead over-summering habitat in the South-Central/Southern California Coast Recovery Domain: Maps based on the envelope method. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS, Santa Crus, CA NOAA-TM-NMFS_SSWDC-391. 36 pgs.

Bottom, D. L., C. A. Simenstad, J. Burke, A. M. Baptista, D. A. Jay, K. K. Jones, E. Casillas, and M. H. Schiewe. 2005. Salmon at the River's End: The role of the estuary in the decline and recovery of Columbia Salmon. National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, Washington. NOAA Technical Memorandum NMFS-NWFSC-68.

Caltrout (California Trout, Inc.) 2006. Santa Monica Mountains Steelhead Habitat Assessment Final Project Report. Submitted to California Department of Fish and Game and California State Coastal Conservancy- Santa Monica Bay Restoration Project. January 18, 2006.

CDM (Camp Dresser and McKee). 2008. Habitat Evaluation Procedure (HEP) for the Malibu Creek Ecosystem Restoration Feasibility Study. September 2008.

Collins J. N., E. D. Stein, M. Sutula, R. Clark, A. E. Fetscher, L. Grenier, C. Grosso, A. Wiskinf. 2006. California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas. Version 4.2.2., 136 pg.

Conte, F. P., and H. H. Wagner. 1965. Development of osmotic and ionic regulation in juvenile steelhead trout, Salmo gairdneri. Comp. Biochem. Physiol., 14:603-620.

Dagit, R. 2013. Malibu Lagoon Restoration Fish Relocation Report. Prepared for Angeles District, CA Department of Parks and Recreation and the Santa Monica Bay Foundation. RCD of the Santa Monica Mountains, Agoura Hills, CA.

Dagit, R., and C. Swift. 2005. Malibu Lagoon Fish Survey 20 June 2005. Prepared for California Coastal Conservancy. Resource Conservation District of the Santa Monica Mountains, Topanga, CA.

Dagit, R., B. Meyer, and S. Drill. 2005. Historical Distribution of Southern Steelhead Trout in the Santa Monica Bay. Prepared for NOAA Fisheries and California Department of Fish and Game. Resource Conservation District of the Santa Monica Mountains, Topanga, CA.

Dagit R. and M. Abramson. 2007. Malibu and Arroyo Sequit Creeks Southern Steelhead Monitoring. Prepared for California Department of Fish and Game. Resource Conservation District of the Santa Monica Mountains, Agoura Hills, CA.

Dagit, R., S. Adams, and S. Drill. 2009. Die off and Current Status of Southern Steelhead trout (*Oncorhynchus mykiss*) in Malibu Creek, Los Angeles County, USA. Bulletin of the Southern California Academy of Science 108(1):1-15.

Dagit, R. and J. Krug. 2011. Summary Report Santa Monica Bay Steelhead Monitoring 2009-2011. Final Report to CDFG Contract No. P0850021. Resource Conservation District for the Santa Monica Mountains. Agoura Hills, CA.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 2010. California Salmonid Stream Habitat Restoration Manual, Volume 2, 4th Edition. The Resources Agency, California Department of Fish and Game, Wildlife and Fisheries Division, Sacramento, CA.

Folmar, L. C. and W. W. Dickhoff. 1980. The parr-smolt transformation (smoltification) and seawater adaptation in salmonids – a review of selected literature. Aquaculture, 21:1-37

Hall, A., S. Fengpeng, D. Walton, S. Capps, X. Qu, H. Hsin-Yuan, N. Berg, A. Jousse, M. Schwartz, M. Nakamura, R. Cerzo-Mota. 2013. Mid-Century Warming in the Los Angeles Region. Part 1 of the “Climate Change in the Los Angeles Region” Project. Available at LARC website c-change.la.

Johnson, G.E., R. M. Thom, A. H. Whiting, G. B. Sutherland, T. Berquam, B.D. Ebberts, N. M. Ricci, J. A. Southard, and J. D. Wilcox. 2003. An Ecosystem –Based approach to Habitat Restoration Projects with Emphasis on Salmonids in the Columbia River Estuary. Pacific Northwest National Laboratory. Contract DE-AC06-76L01830. 142pp. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14412.pdf

Keegan, T. P. 1990. Malibu Creek – Santa Monica Mountains steelhead investigations. Report of Entrix, Inc. to California Trout Inc., San Francisco, CA.

Lafferty, K. D., C. Swift, R. F. Ambrose. 1999. Extirpation and recolonization in a metapopulation of an endangered fish, the tidewater goby. Conservation Biology. 13:1447-1453.

McCormick, S. D., and R. L. Saunders. 1987. Preparatory physiological adaptations for marine life of Salmonids: Osmoregulation, Growth and Metabolism. American Fisheries Society Symposium 1: 211-229.

Moffatt & Nichols. 2005. Malibu Lagoon Restoration and Enhancement Plan. Prepared for the California State Coastal Conservancy and the California State Department of Parks and Recreation.

NMFS (National Marine Fisheries Service). 2012. Southern California Steelhead Recovery Plan Summary. Southwest Regional Office, Long Beach, CA.

NMFS. 2007. Federal Recovery Outline for the Distinct Population Segment of Southern California Coast Steelhead. September.

Penrod, K., C. Cabanero, P. Beier, C. Luke, W. Spencer, E. Rubin, R. Sauvejot, S. Riley, and D. Kamradt. 2006. South Coast Missing Linkages Project: A Linkage Design for the Santa Monica-Sierra Madre Connection. Produced by South Coast Wildlands, Idyllwild, CA. in cooperation with National Park Service, Santa Monica Mountains Conservancy, California State Parks and The Nature Conservancy.

Spina, A. P. 2003. Habitat associations of steelhead trout near the southern extent of their range. California Fish and Game 89:81-95.

Spina, A. P. 2007. Thermal ecology of juvenile steelhead in a warm-water environment. Environmental Biology Fish 80:23-34.

Swift, C. C., T. R. Haglund, M. Ruiz, and R. N. Fisher. 1993. The status and distribution of the freshwater fishes of southern California. Bulletin of the Southern CA Academy of Science. 92(3):101-167.

Thompson, L. C., J. L. Voss, R. E. Larsen, W. D. Tietje, R. A. Cooper and P. B. Moyle. 2012. Southern Steelhead, Hard Woody Debris and Temperature in a California Central Coast Watershed. Transactions of the American Fisheries Society 141(2): 275-284.

USACE (US Army Corps of Engineers). 2004. Final Environmental Impact Statement/Environmental Impact Report Matilija Dam Ecosystem Restoration Feasibility Study. September

USFWS (U.S. Fish & Wildlife Service). 1980. Habitat Evaluation Procedures (HEP). ESM (Ecological Service Manual) 102. Div. of Ecological Services, USFWS, Wash., D.C. March 31, 1980.

USFWS. 2013. Draft Fish and Wildlife Coordination Act Report: Malibu Canyon Ecosystem Restoration Study, Los Angeles, CA. Ventura, CA

Wakeley, J. S., and L. J. O'Neil. 1988. Alternatives to increase efficiency and reduce effort in application of the Habitat Evaluation Procedures (HEP). Technical Report EL-88-13. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

This page was intentionally left blank for duplex printing.

APPENDIX J1

Technical Advisory Committee

This page was intentionally left blank for duplex printing.

Malibu Creek Technical Advisory Committee (TAC) Member List

AGENCY	NAME
CA Coastal Commission	Jonna Engel
CA Coastal Commission	Larry Simon
CA Coastal Conservancy	Sam Jenniches
CA Department of Fish and Wildlife	Brock Warmuth
CA Department of Fish and Wildlife	John O'Brien
CA Department of Fish and Wildlife	Loni Adams
CA Department of Fish and Wildlife	Scott Harris
CA Department of Fish and Wildlife	Mary Larson
CA Department of Fish and Wildlife	Bill Paznokas
CA Department of Parks and Recreation	Jerry West
CA Department of Parks and Recreation	Dale Skinner
CA Department of Parks and Recreation	Lynn Mochizuki
CA Department of Parks and Recreation	Craig Sap
CA Department of Parks and Recreation	Suzanne Goode
CA Department of Parks and Recreation	Dennis Weber
CA Department of Parks and Recreation	Jay Chamberlin
CA Department of Parks and Recreation	Alexander Bevil
CA Department of Parks and Recreation	Lynette Brody
CA Department of Parks and Recreation	Barbara Tejada
CA Department of Parks and Recreation	Jamie King
CA Department of Parks and Recreation	Suzanne Goode
California Trout	Kurt Zimmerman
City of Calabasas	Alex Farassati
City of Malibu	Arthur Aladjadjian
City of Malibu	Elizabeth Checca Shavelson
City of Malibu	Reva Feldman
City of Malibu	Bob Brager
Heal the Bay	Sarah Abramson Sikich
Heal the Bay	Katherine Pease
Las Virgenes Municipal Water District	Jan Dougall
Los Angeles County Department of Beaches and Harbors	Cesar Espinosa
Los Angeles County Department of Beaches and Harbors	John Kelly
Los Angeles County Board of Supervisors	Maria Chong Castillo
Los Angeles County Board of Supervisors	Timothy Lippman
Los Angeles County Board of Supervisors	Lourdes Arevalo
Los Angeles County Department of Public Works	Frank Wu
Los Angeles County Department of Public Works	Joshua Svensson
Los Angeles County Department of Public Works	Lani Alfonso
Los Angeles County Sanitation District	Charles Boehmke
Los Angeles Waterkeeper	Mark Abramson
Malibou Lake	Michael Hart
Mountains Restoration and Conservation Authority	Judi Tamasi
National Park Service	Christy Brigham
National Park Service	Katy Semple Delaney
NOAA, National Marine Fisheries Service	Darren Brumback
NOAA	Mark Capelli

NOAA, National Marine Fisheries Service	Anthony Spina
NOAA, National Marine Fisheries Service	Rick Bush
Regional Water Quality Control Board	LB Nye
Resource Conservation District of the Santa Monica Mts.	Rosi Dagit
Resource Conservation District of the Santa Monica Mts.	Debbie Sharpton
Resource Conservation District of the Santa Monica Mts.	Clark Stevens
Santa Monica Bay Restoration Committee	Diana Hurlbert
Santa Monica Bay Restoration Committee	Jack Topel
Surfrider Foundation	Tina Segura
Surfrider Foundation	Stefanie Sekich-Quinn
Surfrider Foundation	Chad Nelson
Surfrider Foundation	Bill Hickman
Surfrider Foundation	Paul Jenkins
UCLA	Gary Bucciarelli
UCSC	Peter Brewitt
US Fish and Wildlife Service	Chris Dellith
USGS	John Warrick
USACE	Susie Ming
USACE	Jodi Clifford
USACE	Jesse Ray
USACE	Jim Hutchinson
USACE	Larry Smith
USACE	Meg McDonald
USACE	Mark Chatman
USACE	Chris Spitzer

APPENDIX J2

Tables excerpted from the Hydrology and Hydraulics Appendix B

This page was intentionally left blank for duplex printing.

Table 1 Reach Descriptions for Malibu Creek

Reach	Upstream River Station	Downstream River Station	Reach Description
5	24500.0	16200.7	Cold Creek to Rindge Dam
4b	16200.7	12689.5	Rindge Dam to RM 2.4
4a	12689.5	9072.9	RM2.4 to Big Bend
3	9072.9	4704.5	Big Bend to Cross Creek Bridge
2b	4704.5	2603.4	Cross Creek Bridge to Malibu Lagoon
2a	2603.4	1320.8	Malibu Lagoon to PCH
1	1320.8	00.0	PCH to Pacific Ocean

Reach 4 was divided into 2 sub-reaches based on initial sediment transport modeling results. The cross section at RM 2.4 is approximately the downstream limit (during the first 5 years) of the sediment deposition for Alt. 2a, the natural transport alternative with full dam removal. Reach 2 was also divided into 2 sub-reaches to show impacts in Malibu Lagoon separate from the creek. The break between Reaches 2a and 2b was for modeling purposes and was determined by visual inspection of the aerial photographs and a noted break in the slope on the profile of the channel. It is understood there is may be a difference between the geomorphology definition of a lagoon and where the upstream end of the lagoon actually is.

Table 2 Sediment Model Output for Years 1, 5, 10, and 50
Bed Elevations and Bed Changes in Ft

		Alternative 1 Future Without Project					Alternative 2 Dam Removal-Mechanical Removal					Alternative 3 Dam Removal-Natural Transport					Alternative 4 Dam Removal Hybrid Mechanical and Natural Transport				
			Change in Bed Elevation After					Change in Bed Elevation After					Change in Bed Elevation After					Change in Bed Elevation After			
Reach	Station	Initial Bed Elev.	1 Yr	5 Yrs	10 Yrs	50 Yrs	Initial Bed Elev.	1 Yr	5 Yrs	10 Yrs	50 Yrs	Initial Bed Elev.	1 Yr	5 Yrs	10 Yrs	50 Yrs	Initial Bed Elev.	1 Yr	5 Yrs	10 Yrs	50 Yrs
Malibu Lagoon	550.6	2.2	0.0	0.8	2.1	2.0	2.2	0.4	1.9	2.2	2.0	2.2	0.0	1.8	2.2	2.1	2.2	0.4	1.7	2.1	2.0
	839.8	1.7	0.0	1.7	3.0	2.7	1.7	0.9	2.3	3.1	2.7	1.7	0.0	2.7	3.3	2.8	1.7	0.9	2.2	3.2	2.7
	1320.8	2.0	0.1	2.2	4.4	4.8	2.0	1.5	3.3	4.6	4.9	2.0	0.9	3.9	5.2	5.3	2.0	2.0	3.1	4.8	5.1
PCH Bridge to Cross Creek Bridge	1846.3	3.0	0.3	1.7	4.3	5.2	3.0	0.9	3.0	4.8	5.4	3.0	0.5	3.4	5.7	6.4	3.0	0.7	3.1	5.0	5.9
	2603.4	5.0	0.0	1.3	4.4	5.9	5.0	0.2	2.9	4.8	6.0	5.0	0.0	3.8	6.3	6.6	5.0	0.3	3.3	5.2	6.4
	3445.8	11.0	-0.3	-0.8	1.5	3.8	11.0	-1.2	0.3	2.3	4.4	11.0	-0.9	2.0	4.5	5.1	11.0	-0.9	1.0	2.9	4.9
	3670.5	11.0	0.0	-0.1	2.5	5.0	11.0	-1.1	1.2	3.3	5.4	11.0	-0.3	3.2	5.7	6.2	11.0	-0.5	2.0	4.0	5.9
	3906.8	11.0	0.0	2.3	4.8	7.5	11.0	2.1	3.4	5.8	8.3	11.0	0.8	6.5	8.8	9.3	11.0	2.2	4.8	6.7	8.7
	4203.5	14.0	-0.3	0.2	3.5	6.5	14.0	0.1	1.8	4.3	6.9	14.0	-0.6	6.0	7.8	8.0	14.0	0.7	3.1	5.5	7.6
	4486.6	14.0	-0.1	1.8	4.2	7.5	14.0	1.4	3.5	5.5	8.4	14.0	0.2	7.9	9.3	9.6	14.0	2.8	4.8	6.5	8.7
	4653.8	16.0	0.0	2.3	5.9	9.4	16.0	2.2	4.2	6.9	10.1	16.0	0.1	8.8	11.3	11.8	16.0	2.4	6.0	8.3	10.5
	4705.1	14.0	0.6	3.3	6.5	10.0	14.0	3.6	5.6	7.7	11.0	14.0	2.8	10.5	12.0	12.5	14.0	5.8	7.6	9.3	11.6
Cross Creek Bridge to Big Bend	4900.6	15.0	1.3	4.4	7.8	11.5	15.0	4.0	6.0	9.0	12.2	15.0	2.1	11.1	13.5	14.1	15.0	3.6	8.2	10.7	12.7
	5117.6	15.0	0.1	4.2	8.0	11.8	15.0	3.6	7.1	9.2	12.8	15.0	1.8	11.7	13.9	14.4	15.0	5.7	8.6	10.4	12.8
	5344.1	19.0	-0.2	2.4	5.5	9.2	19.0	1.5	3.5	6.9	10.0	19.0	-0.2	9.0	11.6	12.3	19.0	1.2	6.2	8.4	10.4
	5844.0	21.0	0.0	2.1	6.9	11.2	21.0	3.9	6.6	7.6	12.0	21.0	0.0	11.5	13.3	13.5	21.0	4.6	7.8	9.4	12.0
	6237.3	28.0	-0.2	-0.3	2.2	6.0	28.0	-0.8	1.5	3.5	6.4	28.0	-0.5	7.1	8.6	9.4	28.0	-0.2	3.5	4.8	6.6
	6490.1	33.0	-0.2	-0.5	-0.8	3.5	33.0	-1.9	-1.3	-0.5	4.6	33.0	-0.4	4.3	6.2	5.7	33.0	-1.4	0.0	1.4	4.4
	6755.7	37.0	-0.1	-0.1	-0.3	1.6	37.0	-1.0	-0.8	-0.8	0.9	37.0	-0.3	2.8	4.6	5.5	37.0	-1.1	-0.4	0.1	2.0
	6993.4	38.0	0.0	0.5	0.9	3.2	38.0	-0.9	0.4	0.8	4.4	38.0	0.3	4.4	6.2	6.9	38.0	-0.2	1.5	1.9	4.5
	7404.4	38.0	0.5	3.0	3.8	5.4	38.0	1.5	2.5	3.2	3.8	38.0	2.0	7.3	9.7	10.4	38.0	1.6	2.8	3.4	4.2
	7917.0	38.0	0.6	6.5	7.7	10.8	38.0	4.6	7.3	8.7	12.3	38.0	5.8	11.7	14.4	15.0	38.0	5.6	9.8	10.2	12.3
	8262.6	43.0	-0.1	4.1	4.8	5.8	43.0	2.0	2.5	3.2	4.3	43.0	1.4	9.8	11.8	13.1	43.0	2.2	3.4	3.6	5.1
	8533.1	50.0	-0.1	0.4	1.5	4.2	50.0	0.2	1.1	1.9	5.2	50.0	-0.1	6.1	8.7	9.6	50.0	0.9	3.4	3.4	5.5
	8770.2	53.0	0.0	-0.3	-1.6	-2.8	53.0	-2.5	-4.0	-3.9	-1.5	53.0	0.1	4.6	5.9	8.6	53.0	-2.4	-3.0	-3.1	-1.1
	9072.9	57.0	0.1	1.3	3.0	4.7	57.0	2.5	2.2	2.5	4.0	57.0	0.2	5.7	7.3	9.5	57.0	3.3	3.5	3.6	4.6
Big Bend to Rindge Dam	9385.9	58.0	-0.1	-0.4	0.0	3.6	58.0	-0.3	1.0	1.2	4.1	58.0	0.0	6.4	8.2	10.1	58.0	0.0	2.3	2.4	5.8
	9556.0	63.0	-0.1	-0.3	-0.4	1.5	63.0	-0.6	-0.4	-0.4	1.5	63.0	-0.3	4.6	6.5	7.9	63.0	-0.7	1.2	1.0	3.1
	9779.9	64.0	0.0	-0.1	-0.2	1.9	64.0	-1.3	-0.2	-0.2	1.8	64.0	0.2	5.0	7.6	9.5	64.0	-1.3	1.1	1.4	3.7
	10082.0	69.0	-0.1	-0.1	-0.8	-0.6	69.0	-2.1	-2.3	-2.3	0.5	69.0	-0.1	4.1	6.3	6.6	69.0	-2.4	-0.8	-0.9	1.9
	10524.0	76.0	0.0	0.2	0.0	-0.7	76.0	-0.8	-3.1	-3.1	-3.2	76.0	0.2	4.3	5.4	6.2	76.0	-1.6	-1.4	-1.5	-0.3
	10839.0	77.0	1.2	3.0	3.2	2.8	77.0	1.4	-0.6	0.3	3.8	77.0	3.1	8.4	10.0	5.7	77.0	1.9	1.8	2.3	4.1
	11121.0	80.0	0.3	2.8	3.3	1.8	80.0	-0.2	-2.2	-1.7	-1.3	80.0	2.7	9.0	10.5	8.3	80.0	0.3	0.1	0.8	1.1
	11648.0	88.0	0.1	0.8	0.9	0.3	88.0	0.7	-3.0	-1.3	5.4	88.0	1.5	9.3	10.0	-1.8	88.0	1.1	1.8	2.9	4.1
	11948.0	92.0	0.0	1.3	2.0	-4.0	92.0	-4.2	-7.3	-6.9	-5.0	92.0	1.6	10.2	14.1	7.0	92.0	-4.4	-5.1	-4.3	-1.9
	12224.0	99.0	0.0	0.1	0.6	-3.7	99.0	-2.2	-5.4	-4.8	0.4	99.0	0.1	9.6	12.9	4.8	99.0	-2.6	-1.7	-1.3	1.7
	12444.0	99.0	0.2	3.4	3.3	-8.9	99.0	-8.9	-8.8	-8.8	-8.8	99.0	2.9	12.9	15.3	7.3	99.0	-8.1	-8.6	-8.7	0.8

Table 2 Sediment Model Output for Years 1, 5, 10, and 50, continued

		Alternative 1 Future Without Project					Alternative 2 Full Dam Removal-Mechanical Removal					Alternative 3 Full Dam Removal-Natural Transport					Alternative 4 Full Dam Removal-Mechanical Removal with Natural Transport				
			Change in Bed Elevation After					Change in Bed Elevation After					Change in Bed Elevation After					Change in Bed Elevation After			
Reach	Station	Initial Bed Elev.	1 Yr	5 Yrs	10 Yrs	50 Yrs	Initial Bed Elev.	1 Yr	5 Yrs	10 Yrs	50 Yrs	Initial Bed Elev.	1 Yr	5 Yrs	10 Yrs	50 Yrs	Initial Bed Elev.	1 Yr	5 Yrs	10 Yrs	50 Yrs
Big Bend to Ringe Dam	12689.0	106.0	-0.2	-1.9	-2.7	-2.7	106.0	-2.7	-2.7	-2.7	-2.7	106.0	0.0	9.8	10.7	1.0	106.0	-2.7	-2.7	-2.7	-2.7
	12999.0	114.0	0.1	-1.6	-1.7	-2.7	114.0	-2.7	-2.1	-2.3	-2.7	114.0	0.0	7.3	8.0	-3.5	114.0	-2.7	-2.7	-2.7	-2.7
	13373.0	117.0	1.9	1.4	-1.5	-2.7	117.0	-2.7	-2.7	-2.7	-2.7	117.0	6.5	11.4	10.2	-2.7	117.0	-2.7	-2.7	-2.7	-2.7
	13647.0	124.0	-1.6	-2.8	-2.8	-2.8	124.0	-2.8	-2.8	-2.8	-2.8	124.0	-1.5	7.4	0.0	-2.8	124.0	-2.8	-2.8	-2.8	-2.8
	13907.0	138.0	-0.9	-2.8	-2.8	-2.8	138.0	-2.8	-2.8	-2.8	-2.8	138.0	-1.2	-0.2	-2.1	-2.8	138.0	-2.8	-2.8	-2.8	-2.8
	14129.0	143.0	0.1	0.0	-1.5	-2.8	143.0	-2.8	-1.6	-2.1	-2.8	143.0	0.4	3.8	-0.3	-2.8	143.0	-2.8	-2.5	-2.1	-2.8
	14394.0	143.0	0.4	3.4	2.2	-2.8	143.0	-2.8	1.8	1.8	0.7	143.0	6.8	3.2	-2.4	-0.3	143.0	-2.8	1.0	1.4	0.9
	14559.0	149.0	0.0	1.9	-1.1	-2.8	149.0	-2.8	-2.3	-2.4	-2.8	149.0	4.1	9.0	1.2	1.4	149.0	-2.8	-1.3	-2.1	-2.8
	14747.0	151.0	0.1	-1.8	-2.8	-2.8	151.0	-2.8	-2.8	-2.8	-2.8	151.0	7.0	14.9	-1.4	-2.8	151.0	-2.8	-2.8	-2.8	-2.8
	14985.0	160.0	-0.5	-2.9	-2.9	-2.9	160.0	-2.9	-2.9	-2.9	-2.9	160.0	3.6	10.2	-2.9	-2.9	160.0	-2.9	-2.9	-2.9	-2.9
	15196.0	165.0	-0.3	-2.9	-2.9	-2.9	165.0	-2.9	-2.9	-2.9	-2.9	165.0	6.4	15.0	-2.9	-2.9	165.0	-2.9	-2.9	-2.9	-2.9
	15512.0	179.0	-0.4	-2.9	-2.9	-2.9	179.0	-2.9	-2.9	-2.9	-2.9	179.0	5.1	5.2	-2.9	-2.9	179.0	-2.9	-2.9	-2.9	-2.9
	15662.0	180.0	-0.4	-2.9	-2.9	-2.9	180.0	-2.9	-2.9	-2.9	-2.9	180.0	6.4	12.9	3.0	1.0	180.0	-2.9	-2.9	-2.9	-2.9
	15764.0	185.0	-0.2	-2.9	-2.9	-2.9	185.0	-2.9	-2.9	-2.9	-2.3	185.0	13.3	8.0	-2.4	-1.4	185.0	-2.9	-2.8	-2.8	-2.7
	15859.0	185.0	-0.1	-2.9	-2.9	-2.9	185.0	-2.9	-2.9	-2.9	-2.9	185.0	17.0	13.2	1.6	-2.9	185.0	-2.9	-2.9	-2.9	-2.9
	15990.0	185.0	5.6	2.2	1.7	0.6	185.0	-1.7	1.1	1.4	3.0	185.0	24.7	13.5	2.8	3.1	185.0	-2.9	0.9	3.1	3.1
	16092.0	185.0	-2.9	-2.9	-2.9	-2.9	185.0	-2.9	-2.9	-2.9	-2.9	185.0	32.1	20.1	7.3	-3.0	185.0	-2.9	-2.9	-2.9	-2.9
Rindge Dam to Cold Creek	16201.0	277.0	0.0	0.0	0.0	0.0	277.0	-19.2	-86.0	-86.0	-84.5	277.0	-55.1	-73.6	-83.5	-87.0	277.0	-24.2	-85.9	-86.0	-84.4
	16326.0	285.0	-5.7	-8.9	-8.5	-8.0	285.0	-27.2	-88.7	-88.2	-88.7	285.0	-50.4	-73.1	-88.7	-92.3	285.0	-41.5	-88.9	-89.7	-88.6
	16409.0	285.0	-5.3	-8.1	-8.2	-7.7	285.0	-26.5	-89.8	-89.5	-86.5	285.0	-39.6	-78.2	-86.9	-91.2	285.0	-32.2	-87.3	-86.3	-86.4
	16503.0	286.0	-3.6	-7.8	-7.4	-6.7	286.0	-27.7	-86.0	-86.0	-86.0	286.0	-28.8	-72.1	-85.2	-89.4	286.0	-33.6	-85.9	-85.9	-85.9
	16704.0	286.0	-0.8	-6.2	-7.4	-7.1	286.0	-26.3	-77.6	-77.1	-77.7	286.0	-16.9	-80.4	-79.8	-82.2	286.0	-32.2	-78.3	-78.3	-78.3
	16943.0	288.0	-0.4	-5.3	-5.6	-4.7	288.0	-28.6	-81.1	-81.1	-81.1	288.0	-4.9	-62.0	-74.1	-75.9	288.0	-34.8	-72.8	-72.9	-72.9
	17143.0	289.0	-0.3	-6.0	-7.6	-7.1	289.0	-26.7	-66.3	-66.3	-66.3	289.0	-1.0	-60.5	-68.8	-69.8	289.0	-32.8	-66.8	-66.9	-66.9
	17389.0	288.0	1.0	-0.9	-2.4	-1.2	288.0	-30.1	-57.9	-57.9	-57.9	288.0	0.9	-47.4	-59.5	-60.1	288.0	-33.7	-57.9	-57.9	-57.9
	17674.0	289.0	1.0	0.3	-1.0	-0.1	289.0	-22.6	-48.9	-48.9	-48.9	289.0	1.6	-35.2	-51.0	-51.0	289.0	-28.3	-48.9	-48.9	-48.9
	18118.0	292.0	0.7	1.2	-0.6	1.4	292.0	-36.2	-36.2	-36.2	-36.2	292.0	0.7	-28.7	-38.3	-38.3	292.0	-36.2	-36.2	-36.2	-36.2
	18376.0	295.0	0.1	1.3	0.3	1.5	295.0	-22.0	-22.3	-22.3	-22.3	295.0	0.3	-22.7	-32.2	-32.2	295.0	-22.0	-22.3	-22.3	-22.3
	18648.0	296.0	0.2	0.6	1.0	4.4	296.0	-18.3	-18.3	-18.3	-18.3	296.0	0.8	-10.5	-20.6	-20.6	296.0	-18.3	-18.3	-18.3	-18.3
	18901.0	299.0	0.9	2.0	1.0	2.8	299.0	-9.1	-9.1	-9.1	-9.1	299.0	1.1	-3.4	-15.9	-16.1	299.0	-9.1	-9.1	-9.1	-9.1
	19374.0	300.0	2.3	5.0	6.9	10.5	300.0	-1.7	-1.0	-1.0	-1.5	300.0	3.2	3.8	-2.4	-9.8	300.0	-1.8	-1.2	-0.4	-0.8
	19769.0	309.0	0.8	2.6	2.9	3.7	309.0	-2.2	-2.8	-1.9	-2.6	309.0	1.5	0.8	-5.4	-9.9	309.0	-1.7	-2.8	-2.0	-2.3
	20271.0	320.0	0.1	1.0	2.9	5.8	320.0	-9.8	-9.9	-9.9	-9.9	320.0	-0.6	0.7	-3.7	-9.9	320.0	-9.8	-9.9	-9.9	-9.9
	20499.0	330.0	0.1	-6.6	-7.8	-7.6	330.0	-9.8	-9.8	-9.9	-9.9	330.0	1.1	-7.5	-9.9	-9.9	330.0	-9.8	-9.8	-9.9	-9.9
	21000.0	341.0	-2.4	-9.8	-9.8	-9.8	341.0	-9.8	-9.8	-9.8	-9.8	341.0	-9.8	-9.8	-9.8	-9.8	341.0	-9.8	-9.8	-9.8	-9.8
	21256.0	355.0	0.0	0.0	0.0	0.0	355.0	0.0	0.0	0.0	0.0	355.0	0.0	0.0	0.0	0.0	355.0	0.0	0.0	0.0	0.0
	21588.0	368.0	0.0	0.0	0.0	0.0	368.0	0.0	0.0	0.0	0.0	368.0	0.0	0.0	0.0	0.0	368.0	0.0	0.0	0.0	0.0
	21928.0	376.0	0.0	0.0	0.0	0.0	376.0	0.0	0.0	0.0	0.0	376.0	0.0	0.0	0.0	0.0	376.0	0.0	0.0	0.0	0.0

Table 2 Sediment Model Output for Years 1, 5, 10, and 50, continued																						
		Alternative 1 Future Without Project					Alternative 2 Full Dam Removal-Mechanical Removal					Alternative 3 Full Dam Removal-Natural Transport					Alternative 4 Full Dam Removal-Mechanical Removal with Natural Transport					
		Initial Bed Elev.	Change in Bed Elevation After				Initial Bed Elev.	Change in Bed Elevation After				Initial Bed Elev.	Change in Bed Elevation After				Initial Bed Elev.	Change in Bed Elevation After				
Reach	Station		1 Yr	5 Yrs	10 Yrs	50 Yrs		1 Yr	5 Yrs	10 Yrs	50 Yrs		1 Yr	5 Yrs	10 Yrs	50 Yrs		1 Yr	5 Yrs	10 Yrs	50 Yrs	
Rindge Dam to Cold Creek	22233.0	391.0	0.0	0.0	0.0	0.0	391.0	0.0	0.0	0.0	0.0	391.0	0.0	0.0	0.0	0.0	391.0	0.0	0.0	0.0	0.0	
	22781.0	405.0	0.4	1.1	1.6	0.4	405.0	1.1	1.1	2.0	0.7	405.0	0.2	1.0	1.6	0.4	405.0	1.2	1.1	2.0	0.8	
	23198.0	415.0	-3.8	-5.9	-9.7	-9.7	415.0	-9.6	-9.6	-9.7	-9.7	415.0	-5.5	-6.0	-9.7	-9.7	415.0	-9.5	-9.6	-9.7	-9.7	
	23661.0	428.0	-2.1	-8.6	-8.7	-8.7	428.0	-8.6	-8.6	-8.7	-8.7	428.0	-5.3	-8.6	-8.6	-8.6	428.0	-8.6	-8.6	-8.7	-8.7	
	24000.0	434.0	-0.5	-6.9	-7.9	-7.8	434.0	-6.4	-7.3	-7.6	-7.8	434.0	-1.1	-7.0	-7.9	-7.8	434.0	-6.4	-7.3	-7.6	-7.8	
	24500.0	439.0	-0.2	-1.2	-1.0	-1.6	439.0	-0.3	-1.7	-2.3	-2.2	439.0	-0.2	-1.3	-1.0	-1.5	439.0	-0.5	-1.7	-2.3	-2.2	

Table 3 Depth of Deposition between Target Years
Bed Elevations and Bed Changes are in Ft

		Alternative 1 Future Without Project					Alternative 2 Full Dam Removal-Mechanical Removal						Alternative 3 Full Dam Removal-Natural Transport					Alternative 4 Full Dam Removal-Mechanical Removal with Natural Transport			
		Sediment Deposition (ft)					Sediment Deposition (ft)						Sediment Deposition (ft)					Sediment Deposition (ft)			
Reach	Station	Year 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 10 to Yr 50	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 10 to Yr 50	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 10 to Yr 50	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 10 to Yr 50
Malibu Lagoon	550.6	0.0	0.8	2.1	1.3	-0.1	0.4	1.5	1.8	0.3	-0.2	0.0	1.8	2.2	0.4	-0.1	0.4	1.3	1.7	0.4	-0.1
	839.8	0.0	1.7	3.0	1.3	-0.3	0.9	1.4	2.2	0.8	-0.4	0.0	2.7	3.3	0.6	-0.5	0.9	1.3	2.3	1.0	-0.5
	1320.8	0.1	2.1	4.3	2.2	0.4	1.5	1.8	3.1	1.3	0.3	0.9	3.0	4.3	1.3	0.1	2.0	1.2	2.8	1.6	0.4
PCH Bridge to Cross Creek Bridge	1846.3	0.3	1.4	4.0	2.6	0.9	0.9	2.1	3.9	1.8	0.6	0.5	2.9	5.2	2.3	0.7	0.7	2.4	4.3	1.9	0.9
	2603.4	0.0	1.3	4.4	3.1	1.5	0.2	2.7	4.6	1.9	1.2	0.0	3.8	6.3	2.5	0.3	0.3	2.9	4.9	2.0	1.2
	3445.8	-0.3	-0.5	1.8	2.3	2.3	-1.2	1.5	3.5	2.0	2.1	-0.9	2.9	5.4	2.5	0.6	-0.9	1.9	3.8	1.9	1.9
	3670.5	0.0	-0.1	2.5	2.6	2.5	-1.1	2.3	4.4	2.1	2.1	-0.3	3.5	6.0	2.5	0.5	-0.5	2.4	4.5	2.0	1.9
	3906.8	0.0	2.3	4.8	2.5	2.7	2.1	1.3	3.7	2.4	2.5	0.8	5.7	8.0	2.3	0.5	2.2	2.6	4.5	1.9	2.0
	4203.5	-0.3	0.5	3.8	3.3	3.0	0.1	1.7	4.2	2.5	2.6	-0.6	6.6	8.4	1.8	0.2	0.7	2.4	4.7	2.4	2.2
	4486.6	-0.1	1.9	4.3	2.4	3.3	1.4	2.1	4.1	2.0	2.9	0.2	7.7	9.1	1.4	0.3	2.8	2.0	3.7	1.7	2.2
	4653.8	0.0	2.3	5.9	3.6	3.5	2.2	2.0	4.7	2.7	3.2	0.1	8.7	11.2	2.5	0.5	2.4	3.6	5.9	2.4	2.2
	4705.1	0.6	2.7	5.9	3.2	3.5	3.6	2.0	4.1	2.1	3.3	2.8	7.7	9.2	1.5	0.5	5.8	1.9	3.5	1.6	2.3
Cross Creek Bridge to Big Bend	4900.6	1.3	3.1	6.5	3.4	3.7	4.0	2.0	5.0	3.0	3.2	2.1	9.0	11.4	2.4	0.6	3.6	4.6	7.1	2.5	2.0
	5117.6	0.1	4.1	7.9	3.8	3.8	3.6	3.5	5.6	2.1	3.6	1.8	9.9	12.1	2.2	0.5	5.7	2.9	4.7	1.8	2.4
	5344.1	-0.2	2.6	5.7	3.1	3.7	1.5	2.0	5.4	3.4	3.1	-0.2	9.2	11.8	2.6	0.7	1.2	5.0	7.2	2.1	2.0
	5844.0	0.0	2.1	6.9	4.8	4.3	3.9	2.7	3.7	1.0	4.4	0.0	11.5	13.3	1.8	0.2	4.6	3.2	4.7	1.6	2.6
	6237.3	-0.2	-0.1	2.4	2.5	3.8	-0.8	2.3	4.3	2.0	2.9	-0.5	7.6	9.1	1.5	0.8	-0.2	3.7	5.0	1.3	1.8
	6490.1	-0.2	-0.3	-0.6	-0.3	4.3	-1.9	0.6	1.4	0.8	5.1	-0.4	4.7	6.6	1.9	-0.5	-1.4	1.4	2.8	1.4	3.0
	6755.7	-0.1	0.0	-0.2	-0.2	1.9	-1.0	0.2	0.2	0.0	1.7	-0.3	3.1	4.9	1.8	0.9	-1.1	0.7	1.1	0.4	2.0
	6993.4	0.0	0.5	0.9	0.4	2.3	-0.9	1.3	1.7	0.4	3.6	0.3	4.1	5.9	1.8	0.7	-0.2	1.7	2.2	0.4	2.6
	7404.4	0.5	2.5	3.3	0.8	1.6	1.5	1.0	1.7	0.7	0.6	2.0	5.3	7.7	2.4	0.7	1.6	1.2	1.7	0.5	0.8
	7917.0	0.6	5.9	7.1	1.2	3.1	4.6	2.7	4.1	1.4	3.6	5.8	5.9	8.6	2.7	0.6	5.6	4.2	4.6	0.5	2.1
	8262.6	-0.1	4.2	4.9	0.7	1.0	2.0	0.5	1.2	0.7	1.1	1.4	8.4	10.4	2.0	1.3	2.2	1.3	1.5	0.2	1.5
	8533.1	-0.1	0.5	1.6	1.1	2.7	0.2	0.9	1.7	0.8	3.3	-0.1	6.2	8.8	2.6	0.9	0.9	2.5	2.5	0.0	2.1
	8770.2	0.0	-0.3	-1.6	-1.3	-1.2	-2.5	-1.5	-1.4	0.1	2.4	0.1	4.5	5.8	1.3	2.7	-2.4	-0.6	-0.7	-0.1	2.0
	9072.9	0.1	1.2	2.9	1.7	1.7	2.5	-0.3	0.0	0.3	1.5	0.2	5.5	7.1	1.6	2.2	3.3	0.2	0.4	0.2	1.0
Big Bend to Rindge Dam	9385.9	-0.1	-0.3	0.1	0.4	3.6	-0.3	1.3	1.5	0.2	2.9	0.0	6.4	8.2	1.8	1.9	0.0	2.3	2.4	0.1	3.4
	9556.0	-0.1	-0.2	-0.3	-0.1	1.9	-0.6	0.2	0.2	0.0	1.9	-0.3	4.9	6.8	1.9	1.4	-0.7	1.9	1.6	-0.3	2.1
	9779.9	0.0	-0.1	-0.2	-0.1	2.1	-1.3	1.1	1.1	0.0	2.0	0.2	4.8	7.4	2.6	1.9	-1.3	2.5	2.8	0.3	2.3
	10082.0	-0.1	0.0	-0.7	-0.7	0.2	-2.1	-0.2	-0.2	0.0	2.8	-0.1	4.2	6.4	2.2	0.3	-2.4	1.6	1.5	-0.1	2.8
	10524.0	0.0	0.2	0.0	-0.2	-0.7	-0.8	-2.3	-2.3	0.0	-0.1	0.2	4.1	5.2	1.1	0.8	-1.6	0.2	0.2	-0.1	1.1
	10839.0	1.2	1.8	2.0	0.2	-0.4	1.4	-2.0	-1.1	0.9	3.5	3.1	5.3	6.9	1.6	-4.3	1.9	-0.1	0.3	0.5	1.8
	11121.0	0.3	2.5	3.0	0.5	-1.5	-0.2	-2.0	-1.5	0.5	0.4	2.7	6.3	7.8	1.5	-2.2	0.3	-0.2	0.5	0.7	0.4
	11648.0	0.1	0.7	0.8	0.1	-0.6	0.7	-3.7	-2.0	1.7	6.7	1.5	7.8	8.5	0.7	-11.8	1.1	0.7	1.8	1.1	1.2
	11948.0	0.0	1.3	2.0	0.7	-6.0	-4.2	-3.1	-2.7	0.4	1.9	1.6	8.6	12.5	3.9	-7.1	-4.4	-0.7	0.1	0.8	2.3
	12224.0	0.0	0.1	0.6	0.5	-4.3	-2.2	-3.2	-2.6	0.6	5.2	0.1	9.5	12.8	3.3	-8.1	-2.6	0.9	1.3	0.4	3.0
	12444.0	0.2	3.2	3.1	-0.1	-12.2	-8.9	0.1	0.1	0.0	0.0	2.9	10.0	12.4	2.4	-8.0	-8.1	-0.5	-0.6	-0.1	9.5

Table 3 Depth of Deposition between Target Years, continued

		Alternative 1 Future Without Project					Alternative 2 Full Dam Removal-Mechanical Removal					Alternative 3 Full Dam Removal-Natural Transport					Alternative 4 Full Dam Removal-Mechanical Removal with Natural Transport				
		Sediment Deposition (ft)					Sediment Deposition (ft)					Sediment Deposition (ft)					Sediment Deposition (ft)				
Reach	Station	Year 1	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 10 to Yr 50	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 10 to Yr 50	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 10 to Yr 50
Big Bend to Rindge Dam	12689.0	-0.2	-1.7	-2.5	-0.8	0.0	-2.7	0.0	0.0	0.0	0.0	0.0	9.8	10.7	0.9	-9.7	-2.7	0.0	0.0	0.0	0.0
	12999.0	0.1	-1.7	-1.8	-0.1	-1.0	-2.7	0.6	0.4	-0.2	-0.4	0.0	7.3	8.0	0.7	-11.5	-2.7	0.0	0.0	0.0	0.0
	13373.0	1.9	-0.5	-3.4	-2.9	-1.2	-2.7	0.0	0.0	0.0	0.0	6.5	4.9	3.7	-1.2	-12.9	-2.7	0.0	0.0	0.0	0.0
	13647.0	-1.6	-1.2	-1.2	0.0	0.0	-2.8	0.0	0.0	0.0	0.0	-1.5	8.9	1.5	-7.4	-2.8	-2.8	0.0	0.0	0.0	0.0
	13907.0	-0.9	-1.9	-1.9	0.0	0.0	-2.8	0.0	0.0	0.0	0.0	-1.2	1.0	-0.9	-1.9	-0.7	-2.8	0.0	0.0	0.0	0.0
	14129.0	0.1	-0.1	-1.6	-1.5	-1.3	-2.8	1.2	0.7	-0.5	-0.7	0.4	3.4	-0.7	-4.1	-2.5	-2.8	0.3	0.7	0.3	-0.6
	14394.0	0.4	3.0	1.8	-1.2	-5.0	-2.8	4.6	4.6	0.0	-1.1	6.8	-3.6	-9.2	-5.6	2.1	-2.8	3.8	4.3	0.4	-0.6
	14559.0	0.0	1.9	-1.1	-3.0	-1.7	-2.8	0.5	0.4	-0.1	-0.4	4.1	4.9	-2.9	-7.8	0.2	-2.8	1.5	0.8	-0.7	-0.8
	14747.0	0.1	-1.9	-2.9	-1.0	0.0	-2.8	0.0	0.0	0.0	0.0	7.0	7.9	-8.4	-16.3	-1.4	-2.8	0.0	0.0	0.0	0.0
	14985.0	-0.5	-2.4	-2.4	0.0	0.0	-2.9	0.0	0.0	0.0	0.0	3.6	6.6	-6.5	-13.1	0.0	-2.9	0.0	0.0	0.0	0.0
	15196.0	-0.3	-2.6	-2.6	0.0	0.0	-2.9	0.0	0.0	0.0	0.0	6.4	8.6	-9.3	-17.9	0.0	-2.9	0.0	0.0	0.0	0.0
	15512.0	-0.4	-2.5	-2.5	0.0	0.0	-2.9	0.0	0.0	0.0	0.0	5.1	0.1	-8.0	-8.1	0.0	-2.9	0.0	0.0	0.0	0.0
	15662.0	-0.4	-2.5	-2.5	0.0	0.0	-2.9	0.0	0.0	0.0	0.0	6.4	6.5	-3.4	-9.9	-2.0	-2.9	0.0	0.0	0.0	0.0
	15764.0	-0.2	-2.7	-2.7	0.0	0.0	-2.9	0.0	0.0	0.0	0.6	13.3	-5.3	-15.7	-10.4	1.0	-2.9	0.1	0.1	0.0	0.1
	15859.0	-0.1	-2.8	-2.8	0.0	0.0	-2.9	0.0	0.0	0.0	0.0	17.0	-3.8	-15.4	-11.6	-4.5	-2.9	0.0	0.0	0.0	0.0
	15990.0	5.6	-3.4	-3.9	-0.5	-1.1	-1.7	2.8	3.1	0.3	1.6	24.7	-11.2	-21.9	-10.7	0.3	-2.9	3.8	6.0	2.2	0.0
	16092.0	-2.9	0.0	0.0	0.0	0.0	-2.9	0.0	0.0	0.0	0.0	32.1	-12.0	-24.8	-12.8	-10.3	-2.9	0.0	0.0	0.0	0.0
Rindge Dam to Cold Creek	16201.0	0.0	0.0	0.0	0.0	0.0	-19.2	-66.8	-66.8	0.0	1.5	-55.1	-18.5	-28.4	-9.9	-3.5	-24.2	-61.7	-61.8	-0.1	1.6
	16326.0	-5.7	-3.2	-2.8	0.4	0.5	-27.2	-61.5	-61.0	0.5	-0.5	-50.4	-22.7	-38.3	-15.6	-3.6	-41.5	-47.4	-48.2	-0.8	1.1
	16409.0	-5.3	-2.8	-2.9	-0.1	0.5	-26.5	-63.3	-63.0	0.3	3.0	-39.6	-38.6	-47.3	-8.7	-4.3	-32.2	-55.1	-54.1	1.0	-0.1
	16503.0	-3.6	-4.2	-3.8	0.4	0.7	-27.7	-58.3	-58.3	0.0	0.0	-28.8	-43.3	-56.4	-13.1	-4.2	-33.6	-52.3	-52.4	-0.1	0.0
	16704.0	-0.8	-5.4	-6.6	-1.2	0.3	-26.3	-51.3	-50.8	0.5	-0.6	-16.9	-63.5	-62.9	0.6	-2.4	-32.2	-46.1	-46.1	0.0	0.0
	16943.0	-0.4	-4.9	-5.2	-0.3	0.9	-28.6	-52.5	-52.5	0.0	0.0	-4.9	-57.1	-69.2	-12.1	-1.8	-34.8	-38.0	-38.2	-0.1	0.1
	17143.0	-0.3	-5.7	-7.3	-1.6	0.5	-26.7	-39.6	-39.6	0.0	0.0	-1.0	-59.5	-67.8	-8.3	-1.0	-32.8	-34.0	-34.1	-0.1	0.0
	17389.0	1.0	-1.9	-3.4	-1.5	1.2	-30.1	-27.8	-27.8	0.0	0.0	0.9	-48.3	-60.4	-12.1	-0.6	-33.7	-24.2	-24.2	0.0	0.0
	17674.0	1.0	-0.7	-2.0	-1.3	0.9	-22.6	-26.3	-26.3	0.0	0.0	1.6	-36.8	-52.6	-15.8	0.0	-28.3	-20.6	-20.6	0.0	0.0
	18118.0	0.7	0.5	-1.3	-1.8	2.0	-36.2	0.0	0.0	0.0	0.0	0.7	-29.4	-39.0	-9.6	0.0	-36.2	0.0	0.0	0.0	0.0
	18376.0	0.1	1.2	0.2	-1.0	1.2	-22.0	-0.3	-0.3	0.0	0.0	0.3	-23.0	-32.5	-9.5	0.0	-22.0	-0.3	-0.3	0.0	0.0
	18648.0	0.2	0.4	0.8	0.4	3.4	-18.3	0.0	0.0	0.0	0.0	0.8	-11.3	-21.4	-10.1	0.0	-18.3	0.0	0.0	0.0	0.0
	18901.0	0.9	1.1	0.1	-1.0	1.8	-9.1	0.0	0.0	0.0	0.0	1.1	-4.5	-17.0	-12.5	-0.2	-9.1	0.0	0.0	0.0	0.0
	19374.0	2.3	2.7	4.6	1.9	3.6	-1.7	0.7	0.7	0.0	-0.5	3.2	0.6	-5.6	-6.2	-7.4	-1.8	0.6	1.4	0.8	-0.4
	19769.0	0.8	1.8	2.1	0.3	0.8	-2.2	-0.6	0.3	0.9	-0.7	1.5	-0.7	-6.9	-6.2	-4.5	-1.7	-1.0	-0.3	0.8	-0.3
	20271.0	0.1	0.9	2.8	1.9	2.9	-9.8	-0.1	-0.1	0.0	0.0	-0.6	1.3	-3.1	-4.4	-6.2	-9.8	0.0	0.0	0.0	0.0
	20499.0	0.1	-6.7	-7.9	-1.2	0.2	-9.8	0.0	-0.1	-0.1	0.0	1.1	-8.6	-11.0	-2.4	0.0	-9.8	0.0	0.0	0.0	0.0
	21000.0	-2.4	-7.4	-7.4	0.0	0.0	-9.8	0.0	0.0	0.0	0.0	-9.8	0.0	0.0	0.0	0.0	-9.8	0.0	0.0	0.0	0.0
	21256.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21588.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21928.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	22233.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 3 Depth of Deposition between Target Years, continued

		Alternative 1 Future Without Project					Alternative 2 Full Dam Removal-Mechanical Removal					Alternative 3 Full Dam Removal-Natural Transport					Alternative 4 Full Dam Removal-Mechanical Removal with Natural Transport				
		Sediment Deposition (ft)					Sediment Deposition (ft)					Sediment Deposition (ft)					Sediment Deposition (ft)				
Reach	Station	Year 1	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 10 to Yr 50	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 10 to Yr 50	Yr 1	Yr 1 to Yr 5	Yr 1 to Yr 10	Yr 5 to Yr 10	Yr 10 to Yr 50
Rindge Dam to Cold Creek	22781.0	0.4	0.7	1.2	0.5	-1.2	1.1	0.0	0.9	0.9	-1.3	0.2	0.8	1.4	0.6	-1.2	1.2	0.0	0.9	0.9	-1.3
	23198.0	-3.8	-2.1	-5.9	-3.8	0.0	-9.6	0.0	-0.1	-0.1	0.0	-5.5	-0.5	-4.2	-3.7	0.0	-9.5	-0.1	-0.2	-0.1	0.0
	23661.0	-2.1	-6.5	-6.6	-0.1	0.0	-8.6	0.0	-0.1	-0.1	0.0	-5.3	-3.3	-3.3	0.0	0.0	-8.6	0.0	0.0	0.0	0.0
	24000.0	-0.5	-6.4	-7.4	-1.0	0.1	-6.4	-0.9	-1.2	-0.3	-0.2	-1.1	-5.9	-6.8	-0.9	0.1	-6.4	-0.9	-1.2	-0.3	-0.2
	24500.0	-0.2	-1.0	-0.8	0.2	-0.6	-0.3	-1.4	-2.0	-0.6	0.1	-0.2	-1.1	-0.8	0.3	-0.5	-0.5	-1.3	-1.8	-0.5	0.1

This page was intentionally left blank for duplex printing.

APPENDIX J3

Aquatic Habitat Quality Data
Taken from: Abramson and Grimmer (2005)

This page was intentionally left blank for duplex printing.

Appendix C. Aquatic Habitat Quality Data

Creek Name	Heal the Bay Reach ID	Heal the Bay Reach Description	Relevant HE Reach [a]	Weighted Pool Habitat Quality (wPHQ) [b]	Rating [c]	HE Aquatic Habitat Value Score [d]
Malibu Creek	3	Rindge Dam to Tunnel Falls	Cold Creek Confluence - Century Dam	0.793	Excellent	1.0
Malibu Creek	4	Tunnel Falls to Texas Crossing MCSP	Cold Creek Confluence - Century Dam	0.577	Good	0.75
Malibu Creek	5	Texas Crossing to Century Dam	Cold Creek Confluence - Century Dam	0.637	Good	0.75
Las Virgenes Creek	2	Crags Rd culvert xing to White Oak Farms dam	LV1 - LV2	0.716	Good	0.75
Las Virgenes Creek	3	White Oak Farms dam to Lost Hills Rd culvert xing	LV2 - LV3	0.785	Excellent	1.0
Las Virgenes Creek	4	Lost Hills Rd.bridge-Meadow Creek Ln Con channel	LV3 - LV4	0.701	Good	0.75
Las Virgenes Creek	5	Meadow Creek Ln con channel- Agoura Rd. con channel	LV4 - Agoura Road	0.554	Good	0.5*
Cold Creek	2	Piuma Rd Box culvert to Malibu Meadows Rd. Bridge	CC1 - CC2	0.699	Good	0.75
Cold Creek	3	Malibu Meadows Rd Bridge to Crater Camp Rd Bridge	CC2 - CC3	0.200	Poor	0.5*
Cold Creek	4	Crater Camp Rd Bridge to 6 ft. stepped waterfall	CC3 - CC4	0.526	Good	0.75
Cold Creek	5	6 ft. stepped waterfall to Cold Canyon Rd culvert	CC4 - CC5	0.724	Good	0.75
Cold Creek	6	Cold Canyon Rd culvert to 6 ft. waterfall	CC5 - CC7	0.555	Good	0.75
Cold Creek	7	6 ft. waterfall to 4 ft. waterfall	CC5 - CC7	0.514	Good	0.75
Cold Creek	8	4 ft. waterfall to Stunt Rd. culvert	CC7 - CC8	0.550	Good	0.75
Cold Creek	9	Perched Stunt Rd culvert-5 ft waterfall	CC8 - upstream limit	0.472	Fair	0.5
Cold Creek	10	5 ft. waterfall to 6 ft. waterfall	CC8 - upstream limit	0.570	Good	0.75
Cold Creek	11	6 ft waterfall.-7 ft. waterfall	CC8 - upstream limit	0.200	Poor	0.25
Cold Creek	12	7 ft. waterfall to 12 ft. waterfall upper limits	CC8 - upstream limit	0.200	Poor	0.25

Source: Abramson and Grimmer/ Heal the Bay, 2005.

[a]The HE reach that includes part or all of the Heal the Bay reach described.

[b]Weighted pool habitat quality (wPHQ) reflects 7 categories: pool to reach ratio, consistent flow, average pool depth, percent instream pool shelter cover, available gravel, embeddedness, and predator species observed.

[c]Rating based on the following ranges of wPHQ: Weighted Pool Habitat Quality (wPHQ) scores:

Excellent = 0.751 - 1.0
Good = 0.501 - 0.75
Fair = 0.251 - 0.50
Poor = 0 - 0.25

[d]HE score based on the following: Excellent = 1.0; Good = 0.75; Fair = 0.5; Poor = 0.25.

*TAC revised rating based on current conditions

This page was intentionally left blank for duplex printing.

APPENDIX J4

Barrier Severity Rating
Taken from: Abramson and Grimmer (2005)

This page was intentionally left blank for duplex printing.

Appendix J4 - Barrier Severity Rating

HE Barrier ID	Heal the Bay Barrier ID	TYPE	SEVERITY
Rindge Dam	2	Dam	Not passable
Tunnel Falls	9	Large waterfall	Passable high flows
Century Dam	4	Dam	Not passable
Crags Rd Culvert (LV1)	128	Stream crossing	Not passable
White Oak Farms Dam (LV2)	143	Dam	Passable high flows
Lost Hills Road Culvert (LV3)	141	Box culvert	Not passable
Meadow Creek Lane Channel (LV4)	140	Drop structure	Not passable
Agoura Road	131	Concrete channel	Not passable
Piuma Culvert (CC1)	155	Culvert	Not passable
Malibu Meadows Road Bridge (CC2)	161	Stream crossing	Passable high flows
Crater Camp Rd Bridge (CC3)	159	Stream crossing	Not passable
Cold Creek Barrier (CC4)	173	Dam	Passable moderate high flows
Cold Canyon Rd Culvert (CC5)	171	Culvert	Not passable
CC6*	172	Large waterfall	Passable high flows
Cold Creek Check Dam (CC7)	176	Dam	Passable moderate_high flows
Stunt Rd Culvert (CC8)	167	Culvert	Not passable
Cold Creek Upstream Limit	163	Large waterfall	Not passable

Source: Abramson and Grimmer/ Heal the Bay, 2005.

*CC6 is a natural barrier (large waterfall) located within the CC5 – CC7 reach

This page was intentionally left blank for duplex printing.

APPENDIX J5

Invasive Vegetation Data
Taken from: Abramson and Grimmer (2005)

This page was intentionally left blank for duplex printing.

Appendix E. Invasive Vegetation Data

Reach	Area of Arundo donax (ft2)	Total Area of reach (ft2)	% Arundo Cover	HE Riparian % Non-Native Score [a]
Cold Creek Confluence to Century Dam	11744	11178000	0.1	1.0
Crags Road Culvert Crossing to White Oak Farms Dam (LV1 - LV2)	525	4027146	0.0	1.0
White Oak Farms Dam to Lost Hills Road Culvert (LV2 - LV3)	0	3811614	0.0	1.0
Lost Hills Road Culvert to Meadow Creek Land Channel (LV3 - LV4)	0	610392	0.0	1.0
Meadow Creek Lane Channel to Agoura Road Concrete Channel (LV4 - Agoura Road)	0	4555116	0.0	1.0
Piuma Pipe Arch Culvert to Malibu Meadows Road Bridge (CC1 - CC2)	280	1094232	0.0	1.0
Malibu Meadows Road Bridge to Crater Camp Road Bridge (CC2 - CC3)	776	336948	0.2	1.0
Crater Camp Road Bridge to Cold Creek Barrier (CC3 - CC4)	5447	2599254	0.2	1.0
Cold Creek Barrier to Cold Canyon Road Culvert (CC4 - CC5)	0	1326870	0.0	1.0
Cold Canyon Road Culvert to Cold Creek Check Dam (CC5 - CC7)	0	1678230	0.0	1.0
Cold Creek Check Dam to Stunt Road Culvert (CC7 - CC8)	649	5528664	0.0	1.0
Stunt Road Culvert to 12 foot waterfall (CC8 - upstream limit)	0	682734	0.0	1.0

Source: Abramson and Grimmer/ Heal the Bay, 2005. Data on invasive vegetation were also collected in 2002 and 2003 by the National Park Service for the Santa Monica Mountains region. The NPS data were deemed inappropriate for use in this study because they were estimations made by visual surveys from roads and trails and not a representative survey along the reaches as was conducted by Abramson and Grimmer in 2005.

[a]HE Riparian Percent Non-Native Score based on the following:

0 to 5% cover = HE score of 1.0

5 to 20% cover = HE score of 0.75

20 to 50% cover = HE score of 0.25

50 to 90% cover = HE score of 0.25

90 to 100% cover = HE score of 0

This page was intentionally left blank for duplex printing.

APPENDIX J6

Reach Information
Taken from: Abramson and Grimmer (2005)

This page was intentionally left blank for duplex printing.

Appendix F. Reach				
Rea	**Length**	**Ripari buff distance on each**	**Rea area**	**Rea are (acre**
Cold Creek Confluence to	186	30	111780	25
Crags Road Culvert Crossing to White Oak Farms	671	30	40271	9
White Oak Farms Dam to Lost Hills Road Culvert	635	30	38116	8
Lost Hills Road Culvert to Meadow Creek Land	101	30	6103	1
Meadow Creek Lane Channel to Agoura Road Concrete Channel	759	30	45551	10
Piuma Pipe Arch Culvert to Malibu Meadows Road	182	30	10942	2
Malibu Meadows Road Bridge to Crater Camp Road	56	30	3369	8
Crater Camp Road Bridge to Cold Creek Barrier	433	30	25992	6
Cold Creek Barrier to Cold Canyon Road Culvert	221	30	13268	3
Cold Canyon Road Culvert to Cold Creek Check Dam	279	30	16782	3
Cold Creek Check Dam to Stunt Road Culvert	921	30	55286	12
Stunt Road Culvert to 12 foot waterfall (CC8 -	113	30	6827	1
Source: Abramson and Grimmer/ Heal the				

This page was intentionally left blank for duplex printing.