Malibu Creek Ecosystem Restoration Project

Los Angeles and Ventura Counties, California

Appendix E

Economics

U.S. Army Corps of Engineers
Los Angeles District

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this Economic Appendix is to document the results of the economic analysis conducted for the Malibu Creek (Rindge Dam) Ecosystem Restoration Feasibility Study (Feasibility Study). The removal of Rindge Dam has been under study by the United States Army Corps of Engineers (Corps) since 2004. The focus of this appendix is to present the cost effectiveness and incremental cost analysis (CE/ICA) of ecosystem restoration alternatives along Malibu Creek, including options for removal of the dam as well as removal of upstream barriers. The results of the CE/ICA identify Best Buy alternatives, and support the identification of the National Ecosystem Restoration (NER) Plan and selection of the Recommended Plan.

A baseline conditions report for the Feasibility Study was previously prepared in 2007. This report assessed flood risks in the study area along Malibu Creek. Results of this analysis are summarized in this appendix, but have not been updated due to the focus of this study on ecosystem restoration rather than flood risk management.

1.2 Guidance and References

The principal controlling guidance of the analysis comes from the U.S. Army Corps of Engineers' (USACE) *Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook,* with specific guidance from Appendix D, Economic and Social Considerations. Evaluation of alternatives has been completed in accordance with *IWR Report #95-R-1, Evaluation of Environmental Investments Procedures Manual, Interim: Cost Effectiveness and Incremental Cost Analyses, May 1995*. Benefits and costs for plan formulation, comparison and evaluation of alternatives were calculated at FY 2016 price levels utilizing a discount rate of 3.125 percent, a base year of 2026, and a 50-year period of analysis. Benefits and costs for the NER Plan and Locally Preferred Plan have been updated to FY 2020 price levels and the current Federal discount rate of 2.75%.

1.3 Study Area

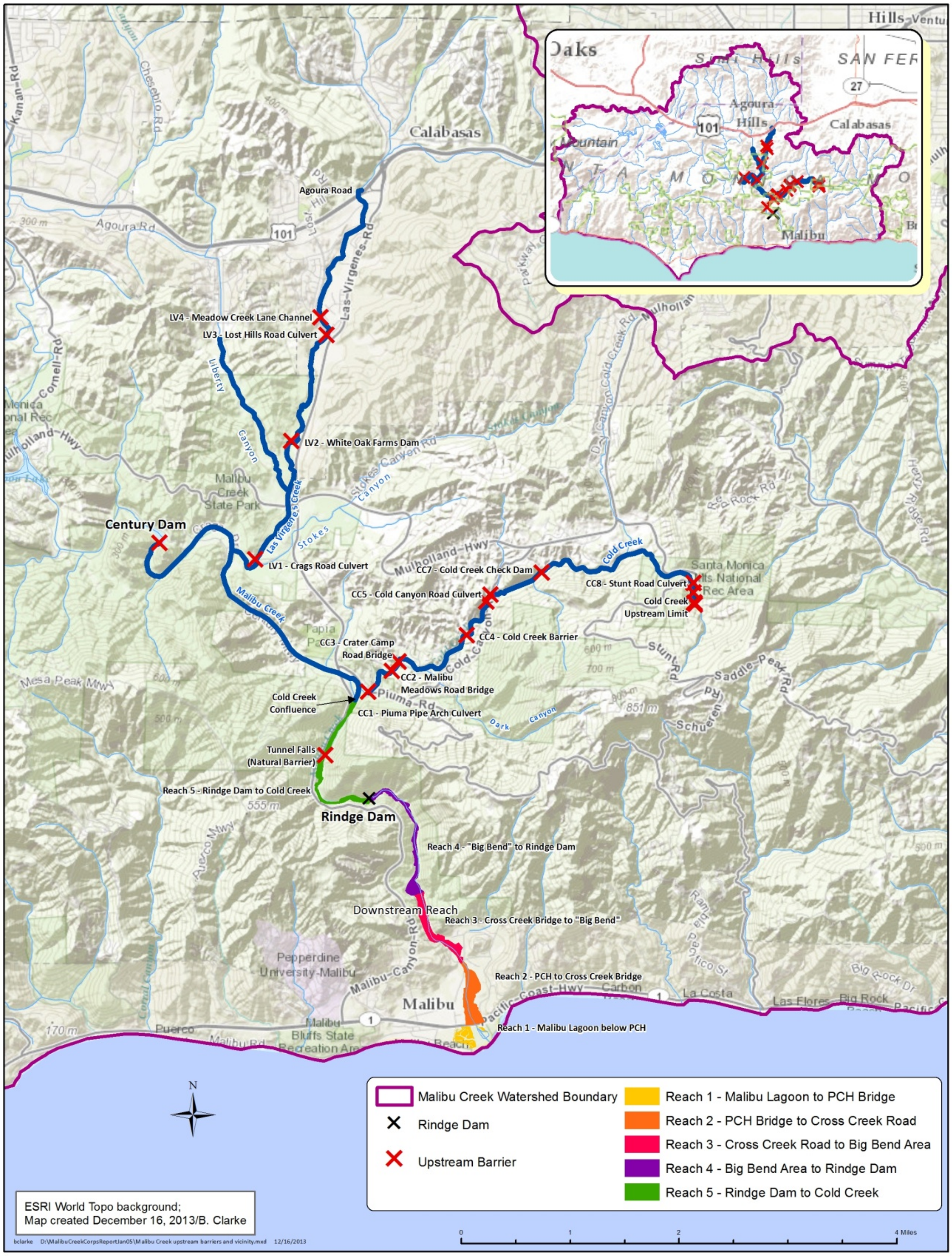
1.3.1 Location & Description

The Malibu Creek watershed is located approximately 30 miles (mi) west of downtown Los Angeles, California (**Figure 1.3-1**). Approximately two-thirds of the watershed is located in northwestern Los Angeles County and the remaining one-third is in southeastern Ventura County. The watershed drainage area is approximately 110 square miles and includes areas of the Santa Monica Mountains and Simi Hills. Elevations in the watershed range from over 3,100 ft (ft) at Sandstone Peak in Ventura County to sea level at Santa Monica Bay (**Figure 1.3-2**). It is the largest coastal watershed in the Santa Monica Mountains, and is encompassed by one of the largest areas of protected open space left in southern California (SMMNRA).

Malibu Creek itself is approximately 10 miles in length and runs from Malibu Lake to Malibu Lagoon. Major tributaries of Malibu Creek include Cold Creek and Las Virgenes Creek. Stokes Creek and Liberty Canyon Creek are tributaries to Las Virgenes Creek, while Dark Canyon Creek is tributary to Cold Creek. Malibu Canyon Road/Las Virgenes Road forms the primary north/south route through the watershed and generally parallels Malibu Creek in the lower portion of the watershed, and Las Virgenes Creek from Mulholland Highway to Highway 101.

Figure 1.3-1: Malibu Creek Watershed Location Map

Figure 1.3-2: Malibu Watershed & Detailed Study Area



1.3.2 Land Use

Over two-thirds of the watershed is currently undeveloped, and projected to remain that way for the 50-year period of analysis, with one-third of that - over 30 square miles - protected as open space by state, Federal, and other agencies. 12.84 square miles of that area is the Malibu Creek State Park, managed by the California Department of Parks and Recreation. The park boundary extends from Malibu Lagoon, along Malibu Creek and several tributaries within and outside of the project area.

The watershed includes the cities of Malibu, Calabasas and Westlake Village and other areas that have been modified by residential development, reservoirs, and agricultural operations. 40 square miles of the watershed is projected to be developed with no more than one dwelling per 20 acres, therefore future changes to the intensity of discharge and timeframe for delivery of storm runoff to Malibu Creek and tributaries is not expected to change over the period of analysis. Other areas within the watershed are unlikely to experience land use changes based on existing topography that is comprised of a combination of steep slopes, ridgelines, and existing stringent coastal restrictions on development.

The riparian corridor remains largely undeveloped and within protected areas. Development is located in the lower portion of Malibu Creek and Malibu Lagoon in the City of Malibu and the Serra Retreat community, the lower portion of Cold Creek is encompassed by low density residential development, and the upper reaches of Las Virgenes Creek is within the City of Calabasas, near Highway 101.

Rindge Dam is located approximately three miles from the mouth of Malibu Creek. The dam is a concrete arch structure 102 feet in height with an arc length of 140 feet at its crest (excluding the spillway and bedrock outcrop), and 80 feet at its base. The spillway is a concrete apron located adjacent to the arch in a bedrock outcrop along the left abutment.

The dam is located in a steep narrow canyon gorge that is difficult to access from the only thoroughfare, Malibu Canyon/Las Virgenes Road. The reservoir, though essentially filled with sediment by the mid-1940s, continued to serve as a water supply district for the Malibu community into the early 1960s. The dam was decommissioned in 1967. The property was purchased by the State of California Department of Parks and Recreation and is now part of Malibu Creek State Park. No reservoir currently exists behind Rindge Dam and the sediment impounded behind the dam has filled to the crest of the dam, about 100 feet above the elevation of the original streambed.

Malibu Lagoon is a brackish water estuarine lagoon located below the Pacific Coast Highway Bridge, connecting the creek to the Santa Monica Bay portion of the Pacific Ocean. It is approximately 33 acres in its present form with recent restoration work completed on a portion of the lagoon. The shoreline is a mix of public and private use, with residences located immediately upcoast of Surfrider Beach, and a mix of commercial and residential use downcoast of the beach and Malibu Pier.

1.3.3 Demographics

The watershed includes the cities of Malibu, Calabasas and Westlake Village. Development is located in the lower portion of Malibu Creek and Malibu Lagoon in the City of Malibu and the Serra Retreat community. The lower portion of Cold Creek is encompassed by low density residential development, and the upper reaches of Las Virgenes Creek are within the City of Calabasas, near Highway 101.

Based upon U.S. Census data, the City of Malibu had a population of 12,777 as of July 2018. This is only a 1.1% increase from the April 2010 population of 12,634. The city population is predominantly white (nearly 93%). The white, non-Hispanic population was nearly 85% in Malibu, relative to only 26% for Los Angeles County and 37% for the State of California.

Malibu is a highly affluent community. The median household income over the period 2014-2018 was $147,934, compared to $64,251 for Los Angeles County and $71,228 for California. According to Zillow.com, the median home value as of January 2020 in Malibu was $2.23 million, vs. $644,200 in Los Angeles County and $561,300 for California.

1.3.4 *Employment & Economy*

Per the 2010 U.S. Census, the top two employment categories within the City include Management, Business & Financial occupations (27%) and Education, Legal, Community Service, Arts, and Media occupations (25%). These percentages are substantially higher than County and State ratios, which are more heavily concentrated in Sales & Office and Service occupations.

The City's top employer is HRL Laboratories. Pepperdine University is a major employer in the area, although the City's boundaries were drawn to exclude the University when it was incorporated in 1972.

Recreation and tourism are important to the local economy. Malibu's beaches include Surfrider Beach, Zuma Beach, Malibu Beach, Topanga Beach, Point Dume Beach, County Line, and Dan Blocker Beach. Local parks include Malibu Bluffs Park, Trancas Canyon Park, Las Flores Creek Park, and Legacy Park, with neighboring parks Malibu Creek State Park, Leo Carrillo State Beach and Park, Point Mugu State Park, and the Santa Monica Mountains National Recreation Area, and neighboring state beach Robert H. Meyer Memorial State Beach.

2.0 Problems & Opportunities

2.1 Flood Risks

As noted, a flood risk analysis was conducted for the Study Area in 2007. Due to the focus of this Feasibility Study on ecosystem restoration, this analysis has not been updated, but is summarized below.

The primary area of potential flooding is outlined by the 0.2 annual chance of exceedance (ACE) event (or "500-year") floodplain shown in **Figure 2.1-1**.

Figure 2.1-1: 0.2% ACE (500-Year) Floodplain

A site survey of floodplain properties was conducted in 2005. The number of parcels in the 0.2% ACE floodplain was 137 of which 95 have improvements. It is worth noting that the floodplain includes a highly affluent community of Malibu. Residential structures in this area are generally of excellent constructional quality and many are quite large reflecting the high values per structure. Commercial structures at risk include various retail establishments. The total depreciated replacement value of property in the floodplain (2007 price levels) is estimated at about $116 million.

A risk-based analysis was used to evaluate without project flood damages in the study area utilizing the HEC-FDA computer program. Key input parameters for this program include the structure inventory, hydrologic and hydraulic parameters, including water surface profiles, exceedance probability/discharge relationships with uncertainty, and stage/discharge relationships with uncertainty. Damages were estimated for both existing and future year conditions. Most of the expected flood damages are to residential housing and commercial buildings.

Based upon the results of the flood damage analysis completed in 2007, equivalent annual damages to structures and contents were estimated at about $1,145,000. The equivalent annual damages are significant given the small number of structures in the floodplain. The flood damages for the without project conditions increase over time due to increased sedimentation in Malibu Creek. However, because there is limited land available for development and most of this land is zoned low density, future housing growth in the damage area is assumed to be minimal. Correspondingly (as noted earlier) future changes in hydrology are expected to be minimal. Therefore, the expected annual damage value is not expected to increase due to future development. Equivalent annual damages/costs for cleanup, temporary housing/relocation costs, and private vehicle damages are estimated at about $90,000. These damages/costs represent less than 8 percent of total equivalent annual damages.

Table 2.1-1 Equivalent Annual Damages (FY 2007 Price Levels)

Malibu Creek Equivalent Annual Damages ($1,000s) (FY 2007 Price Levels, 3.125% Discount Rate)	
Category	**EAD**
Structure & Content	$ 1,152
Clean-Up	$ 34
Emergency/Temporary Housing	$ 4
Vehicles	$ 52
Total	$ 1,242

As noted, as the focus of this study is on ecosystem restoration, a decision was made to not update the flood risk assessment. However, a planning constraint was identified that for all ecosystem restoration alternatives considered for implementation, it would be verified that such alternatives will not negatively impact existing flood risks in the study area, or if such impacts are identified, mitigation measures will be proposed to maintain the existing level of flood protection. These analyses were conducted by Engineering Division based upon evaluation of engineering parameters. Utilization of the HEC-FDA program to perform a risk based evaluation of with vs. without project performance, long term risk, or conditional non-exceedance probabilities was not conducted.

2.2 Ecosystem Restoration

The following describes problems and opportunities in the Study Area and were used to develop the study objectives and constraints.

Problem 1: Reduction of natural sediment delivery during storms to reaches of Malibu Creek and tributaries, the Malibu Lagoon, Pacific Ocean shoreline, and nearshore environments for over 90 years due to the construction of several water supply and recreational dams in the watershed.

Problem 2: Loss of connectivity to good-to-excellent quality aquatic spawning and rearing habitat for migratory species, and disturbances to adjacent riparian habitat due to the construction of Rindge Dam and other upstream road crossings and small dams, isolating reaches of Malibu Creek and tributaries in the watershed.

Problem 3: Disruption to historic migratory paths for mammals due to the construction of Rindge Dam and other upstream road crossings and small dams, forcing mammals to use roads as bypasses, resulting in increased fatalities due to road strikes.

Problem 4: Changes to the natural creek slope in the vicinity of Rindge Dam as a result of dam construction and associated sediment deposition have lowered base flow velocities, altering vegetation types and raising water temperatures, adversely affecting the aquatic habitat quality by adding stressors to native species.

Problem 5: The Rindge Dam spillway and surrounding creek slopes have become an attraction for young adults who use the bottom of the spillway and nearby high ground as a springboard for jumping into the large pool at the base of the dam. There are concerns regarding both the safety of the young adults and the disturbance to the pool's critical habitat that support steelhead and other species.

Opportunity 1: Provide for a more natural sediment transport regime in the vicinity of Rindge Dam and along reaches downstream of Malibu Creek to the shoreline.

Opportunity 2: Reconnect the aquatic corridor to provide access to additional spawning and rearing habitat to a variety of aquatic species, including the Pacific lamprey, arroyo chub, southwestern pond turtle, and the federally endangered southern California steelhead, among others.

Opportunity 3: Restore riparian habitat connectivity along Malibu Creek and tributaries, from the Pacific Ocean to the upper watershed, to include restoration of migratory corridors for mammals.

Opportunity 4: Allow for transport of Rindge Dam impounded sediment to nourish downstream shoreline and nearshore habitats that would have naturally benefited from this material without the dam in-place.

Opportunity 5: Decrease potential for human disturbances to aquatic species that utilize the pool habitat at the base of Rindge Dam.

3.0 Planning Objectives & Constraints

The following summarizes planning objectives and constraints. Please refer to the Main report for additional details.

Objective 1: Establish a more natural sediment transport regime from the watershed to the Southern California shoreline in the vicinity of Malibu Creek within the next several decades;

Objective 2: Reestablish habitat connectivity along Malibu Creek and tributaries in the next several decades to restore migratory access to former upstream spawning areas for indigenous aquatic species and allow for safe passage for terrestrial species from the Pacific Ocean to the watershed and broader Santa Monica Mountains National Recreation Area; and

Objective 3: Restore aquatic habitat of sufficient quality along Malibu Creek and tributaries to sustain or enhance indigenous populations of aquatic species within the next several decades.

Constraint 1: Maintain downstream baseline condition levels of flood protection to avoid increases to flood risk at residences within the Serra Retreat community and businesses in the City of Malibu.

Constraint 2: Avoid or minimize adverse impacts to existing aquatic, riparian, lagoon and coastal habitats and species downstream of barriers considered in this study.

Constraint 3: Minimize detrimental impacts to existing water quality parameters in the lower portion of Malibu Creek.

Constraint 4: Avoid modification to ongoing seasonal freshwater discharges from Tapia Water Reclamation Facility into Malibu Creek above Rindge Dam.

4.0 Without Project Conditions

Key assumptions relating to future without project conditions for the ecosystem within the Study Area are documented in the Main Report. Some of these include:

- Barriers are assumed to remain in the future without project condition.
- Rindge Dam has essentially reached its storage capacity for long-term sediment impoundment and will not impound and retain additional sediment based on the amount of infilling that has already occurred behind the dam.
- Although Rindge Dam is now 90 years old, the dam arch and spillway are assumed to remain intact in the future without project condition.
- The lower reaches of Malibu Creek will remain a perennial (year-round) system due to the assumption that discharges from a water treatment facility several miles above Rindge Dam will continue for the 50-year period of analysis.
- Aquatic and riparian habitat along Malibu Creek and tributaries will remain relatively the same. It is expected that some areas will experience additional increase in percent coverage of exotics and invasives if other management measures are not implemented.
- Malibu Lagoon is assumed to remain relatively stable in the mix of current habitats.
- The shoreline is expected to remain fairly stable and a similar mix of habitat and bottom substrates in the future without project condition.
- Climate change and sea level rise is not expected to significantly alter the lagoon or the shoreline boundary, but will likely increase risk of damages to structures and infrastructure along the shoreline.

Based upon an assessment of the existing and projected future without project conditions, an evaluation of the projected habitat quantity and quality was conducted. Please refer to the Main Report for a description of the model used to quantify habitat values and benefits.

The metric used to quantify habitat values is the Habitat Unit (HU). HUs reflect both the size and value/quality of habitat in the Study Area. **Table 2.2-1** shows projected HUs in the Study Area. HUs are broken down by reach, with reaches designated with “CC” indicating reaches along Cold Creek, and reaches designated “LV” indicating reaches along Los Virgenes Creek. For each, the reach corresponds with the area of benefit that could be realized be removal of the dam or barrier. For example, LV1 represents the area between upstream barriers LV1 to LV2, which would provide ecosystem restoration benefits from the removal of the LV1 barrier. For Rindge dam, the area of benefit includes Malibu Creek mainstream reaches, Malibu Creek to Century Dam, Cold Creek up to the first barrier (CC1) and Los Virgenes Creek up to the first barrier (LV1). As shown in **Table 2.2-1**, habitat values are projected to be mostly stable over the period of analysis.

Table 2.2-1: Without Project AAHUs

Malibu Creek Feasibility Study Without Project Projected Habitat Units					
Reach	Year 0	Year 1	Year 10	Year 50	AAHUs
Rindge Dam	252	251	247	251	249
LV1	93	93	93	93	93
LV2	50	50	50	50	50
LV3	5	5	5	5	5
LV4	39	39	39	39	39
CC1	15	15	15	15	15
CC2	5	5	5	5	5
CC3	54	54	54	54	54
CC5	100	100	100	100	100
CC8	10	10	10	10	10
Total	623	622	618	622	620

5.0 Analysis of Ecosystem Restoration Alternatives

The primary objective is the Malibu Creek Feasibility Study is to restore the ecosystem. The primary ecosystem restoration alternatives developed for this study include options for removing Rindge Dam, and removal of barriers along creeks upstream of Rindge Dam.

5.1 Dam Removal Alternatives

5.1.1 Description of Alternatives

Alternative 2

Alternative 2 options address the mechanical removal of the impounded sediment behind Rindge Dam concurrent with removal of the dam arch. This alternative relies on the use of one to several upland storage sites for the impounded sediment, transported by trucks, in addition to placement of about 35% of the impounded sediment along the Malibu Creek shoreline at one or several sites using various means of transport. Alternative 2 dam removal options include:

- Alt 2A: Rindge Dam arch & spillway removal – shoreline/upland sediment placement
- Alt 2C: Rindge Dam arch removal – shoreline/upland sediment placement

Alternative 3

Alternative 3 options include allowances for metered natural transport of the Rindge Dam impounded sediment over decades. The mature vegetation and top layer of coarse material would be removed from the impounded sediment area to allow storm flow access to the more erodible deposits of mostly sands, silts and clays below. The dam arch would be removed in 5-foot increments to allow for a controlled range of sediment volumes to be transported naturally downstream during storms. These alternatives also include measures to address flood risk management impacts associated with natural sediment components.

- Alt 3A: Rindge Dam arch & spillway removal – natural sediment transport – downstream flood risk mgmt
- Alt 3C: Rindge Dam arch removal – natural sediment transport – downstream flood risk mgmt

<u>Alternative 4</u>

Alternative 4 options includes all the measures of the Alternative 2 scenarios, with the additional consideration of allowing for metered natural sediment transport to occur during the removal of the Rindge Dam concrete arch. An additional 5-foot increment of the arch would be cut and removed prior to each wet season during the 8-year construction timeframe, allowing for a metered portion of the total volume of impounded sediment to be transported downstream if storms of sufficient magnitude occur prior to the next dry season sediment removal operation. These alternatives also include measures to address flood risk management impacts associated with natural sediment components.

- Alt 4A: Rindge Dam arch and spillway removal - natural sediment transport & shoreline/upland placement – downstream flood risk mitigation.
- Alt 4C: Rindge Dam arch removal - natural sediment transport & shoreline/upland placement – downstream flood risk mitigation.

For each of Alternatives 2A, 2C, 4A, and 4C two options were evaluated. The first (e.g., Alternative 2A1) is based upon placement of sand material mechanically removed from the dam along the shoreline downcoast of Malibu Pier, and the second (e.g., Alternative 2A2) is based upon nearshore placement. Alternative 3A and 3C do not include these options since material would be transported naturally downstream during storm events.

5.1.2 Cost for Dam Removal Alternatives

The cost estimates which follow were developed by the Los Angeles District Cost Engineering Section. Costs include Total Project First Costs, interest during construction (IDC), investment costs, annualized investment costs, operation, maintenance, repair and rehabilitation costs (OMRR&R), and total average annual costs (**Table 5.1-1**). Costs are based upon FY 2016 price levels and were annualized applying a Federal discount rate of 3.125%. IDC was calculated based upon the estimated periods of construction for each alternative (7-8 years for Alternatives 2a, 2c, 4a, and 4c, and 4 years for Alternatives 3a and 3c). As shown in **Table 5.1-1**, Total First Costs range from approximately $111 million to $176 million. Alternatives 3a and 3c are substantially lower in cost than the other dam removal alternatives.

5.1.3 Benefits for Dam Removal Alternatives

A modified habitat evaluation approach was used to calculate habitat units (HU) for Rindge Dam and the reaches upstream of Rindge Dam over the 50 year period of analysis. The mean of the HU values over the 50-year period were determined to derive Average Annual Habitat Units (AAHUs). **Table 5.1-2** presents the net gain in average annual habitat units (AAHUs) for each dam removal alternative. AAHUs were calculated utilizing the IWR Planning Suite Annualizer and differ slightly from the values presented in the Main Report due to rounding. As shown below, Alternatives 3A and 3C actually show negative habitat values relative to without project conditions (please refer to the Main Report for details/explanation). Alternatives 2A and 2C provide the greatest gains in habitat value.

Table 5.1-1: Costs for Dam Removal Alternatives (FY 2016 Price Levels, 3.125% Discount Rate)

	DAM REMOVAL OPTIONS									
	2A1	2A2	2C1	2C2	3A	3C	4A1	4A2	4C1	4C2
	Entire Dam Removal		Dam Arch Removal		Entire Dam Removal	Dam Arch Removal	Entire Dam Removal		Dam Arch Removal, Retain Spillway	
	Mechanical Transport		Mechanical Transport		Natural Transport	Natural Transport	Mechanical & Natural Transport		Mechanical & Natural Transport	
	Beach Placement	Nearshore Placement	Beach Placement	Nearshore Placement	No Placement Rqd.	No Placement Rqd.	Beach Placement	Nearshore Placement	Beach Placement	Nearshore Placement
Dam Removal										
General Requirements	$40,898,477	$46,508,157	$40,898,477	$46,508,157	$28,145,715	$28,145,715	$46,505,527	$52,884,275	$46,505,527	$52,884,275
Rindge Dam - Arch Demolition	$4,860,263	$4,860,263	$4,860,263	$4,860,263	$5,683,372	$5,683,372	$5,526,589	$5,526,589	$5,526,589	$5,526,589
Rindge Dam - Spillway Demolition	$1,911,445	$1,911,445	$0	$0	$2,235,158	$0	$2,173,498	$2,173,498	$0	$0
Sediment Removal	$63,789,727	$66,765,321	$63,789,727	$66,765,321	$19,599,808	$19,599,808	$65,359,170	$67,251,937	$65,359,170	$67,251,937
Malibu Canyon Road Repair	$355,317	$355,317	$355,317	$355,317	$415,492	$415,492	$404,030	$404,030	$404,030	$404,030
Floodwalls	$0	$0	$0	$0	$17,943,519	$17,943,519	$9,002,310	$9,002,310	$9,002,310	$9,002,310
Biological Resources Monitoring	$5,582,232	$5,005,136	$5,582,232	$5,005,136	$17,175,250	$17,175,250	$7,085,814	$6,429,600	$7,085,814	$6,429,600
Monitoring & Adaptive Mgt.	$1,803,704	$1,663,584	$1,803,704	$1,663,584	$1,864,700	$1,864,700	$2,050,986	$1,891,656	$2,050,986	$1,891,656
Cultural Resources	$1,815,360	$1,439,640	$1,815,360	$1,439,640	$2,146,000	$2,146,000	$2,189,730	$2,583,120	$2,189,730	$2,583,120
Total Construction Cost	$121,016,525	$128,508,863	$119,105,080	$126,597,418	$95,209,014	$92,973,856	$140,297,654	$148,147,015	$138,124,156	$145,973,517
Lands and Damages	$1,202,500	$1,202,500	$1,202,500	$1,202,500	$1,660,000	$1,660,000	$1,202,500	$1,202,500	$1,202,500	$1,202,500
PED	$18,152,479	$19,276,329	$17,865,762	$18,989,613	$12,213,018	$11,926,302	$18,507,350	$19,542,798	$18,220,633	$19,256,081
Construction Mgt.	$8,108,107	$8,610,094	$7,980,040	$8,482,027	$5,455,148	$5,327,081	$8,266,616	$8,729,116	$8,138,550	$8,601,049
TOTAL FIRST COST	$148,479,611	$157,597,787	$146,153,383	$155,271,558	$114,537,181	$111,887,239	$168,274,120	$177,621,429	$165,685,838	$175,033,147
Interest During Construction	$16,991,815	$20,863,933	$16,725,604	$20,555,970	$7,191,126	$7,024,752	$19,257,073	$23,514,807	$18,960,873	$23,172,152
INVESTMENT COST	$165,471,426	$178,461,719	$162,878,987	$175,827,528	$121,728,307	$118,911,991	$187,531,193	$201,136,236	$184,646,711	$198,205,299
Annualized Investment	$6,584,597	$7,101,519	$6,481,436	$6,996,697	$4,843,929	$4,731,859	$7,462,420	$8,003,805	$7,347,638	$7,887,175
OMRR&R	$31,200	$31,200	$24,200	$24,200	$53,400	$46,400	$53,400	$53,400	$46,400	$46,400
TOTAL ANNUAL COST	$6,615,797	$7,132,719	$6,505,636	$7,020,897	$4,897,329	$4,778,259	$7,515,820	$8,057,205	$7,394,038	$7,933,575
AAHUs	46.2	46.2	46.2	46.2	-22.3	-22.3	35.5	35.5	35.5	35.5

Table 5.1-2: Benefits for Dam Removal Alternatives

Malibu Creek Feasibility Study Benefits for Dam Removal Alternatives (AAHUs)	
Alt	Gain in AAHUs
2A/2C	46.2
3A/3C	-22.3
4A/4C	35.5

5.2 Upstream Barrier Removal Alternatives

5.2.1 Description of Alternatives

This section of the analysis evaluates the removal of barriers along Malibu, Las Virgenes and Cold Creeks upstream from Rindge Dam. These partial or total aquatic barriers impede or block connectivity to good to excellent quality habitat in an additional 13 miles of creek corridors. Providing a contiguous link to upstream habitats affords steelhead and other migratory species refuge in former spawning and rearing habitat that have been completely blocked since the 1920s construction of Rindge Dam.

Habitat connectivity benefits can only be realized if the next most downstream total barrier has been addressed. Benefits for habitat connectivity in areas above Rindge Dam are dependent and contingent on restoration of habitat connectivity at the dam to allow for restored access from the ocean to these upstream Malibu Creek tributaries. The removal of 9 barriers along the creeks, including Rindge Dam, which are being evaluated. The barriers are outlined below.

LV1 - Las Virgenes Creek @ Crags Crossing
LV2 - Las Virgenes Creek at White Oak Farms Dam. Bridge
LV3 - Las Virgenes Creek at Los Hills Rd. Culvert
LV4 - Las Virgenes Creek at Meadow Creek Ln. Channel.

CC1 - Cold Creek at Piuma Box Culvert
CC2 - Cold Creek at Malibu Meadows Rd.
CC3 - Cold Creek at Crater Camp Road Bridge
CC5 - Cold Creek at Cold Canyon Road Culvert
CC8 - Cold Creek at Stunt Road Culvert

Barriers CC4, CC6 and CC7 are not included in the analysis. Mountains Restoration Trust, a non-profit organization committed to working in partnership with the community to preserve, protect, and enhance the natural resources of the Santa Monica Mountains, has removed the CC7 barrier and is in the process of removing the CC4 barrier. It is assumed that both are removed under without project conditions. Barrier CC6 is a partial natural barrier (small waterfall) that is accessible during moderate flows, and natural partial barriers are not being proposed for modifications.

5.2.2 Cost for Barrier Removal Alternatives

Table 5.2-1 presents costs for the barrier removal alternatives. The costs for the removal of LV3 and LV4 barriers have been combined since they are located just 934 feet apart from each other and aquatic connectivity cannot be achieved if only one of them is done and not the other. Also note that the costs for the barrier removal alternatives without contingency are the same irrespective of which dam removal option is implemented. However, the costs vary to a minor degree when including contingency depending on which dam removal alternative they are implemented with, due to variations in overall contingency percentages. The costs for the barrier removal alternatives shown in **Table 5.2-1** are based upon the contingencies applicable with implementation of the Alternative 2 dam removal options. The construction period for the barrier removal options range from one to four months.

Table 5.2-1: Costs for Barrier Removal Alternatives (FY 2016 Price Levels, 3.125% Discount Rate)

BARRIER REMOVAL ALTERNATIVES								
	LV1	LV2	LV3/LV4	CC1	CC2	CC3	CC5	CC8
Barrier Removal								
Biological Resources Monitoring	$55,952	$52,852	$41,320	$55,952	$46,528	$46,528	$52,852	$39,336
Monitoring & Adaptive Mgt.	$76,053	$76,053	$76,053	$76,053	$76,053	$76,053	$76,053	$76,053
Cultural Resources	$8,246	$5,915	$0	$0	$0	$0	$0	$0
Total Construction Cost	$140,251	$134,820	$117,373	$132,005	$122,581	$122,581	$128,905	$115,389
Lands and Damages	$67,500	$70,000	$625,000	$87,500	$85,000	$85,000	$66,875	$0
Relocations - Upstream Barrier Mo	$1,438,092	$741,841	$446,245	$1,855,033	$1,464,043	$1,118,102	$108,572	$1,231,506
PED	$236,752	$131,499	$84,543	$298,056	$237,994	$186,102	$35,622	$202,034
Construction Mgt.	$105,749	$58,736	$37,762	$133,132	$106,304	$83,126	$15,911	$90,242
TOTAL FIRST COST	$1,988,344	$1,136,896	$1,310,923	$2,505,725	$2,015,922	$1,594,911	$355,884	$1,639,171
Interest During Construction	$5,110	$1,460	$1,683	$9,667	$5,181	$4,099	$0	$4,212
INVESTMENT COST	$1,993,454	$1,138,356	$1,312,606	$2,515,392	$2,021,102	$1,599,009	$355,884	$1,643,383
Annualized Investment	$79,325	$45,299	$52,232	$100,095	$80,426	$63,629	$14,162	$65,395
OMRR&R	$0	$0	$10,200	$0	$0	$0	$10,200	
TOTAL ANNUAL COST	$79,325	$45,299	$62,432	$100,095	$80,426	$63,629	$24,362	$65,395
AAHUs (Dam Removal Options 2 & 4)	28.8	13.3	22.6	4.5	0.9	15.9	20.3	2.7
AAHUs (Dam Removal Option 3)	12.5	4.5	9.8	1.8	0.0	7.1	3.6	0.9

- Note: Based upon barrier removal cost estimates corresponding with Alternative 2 dam removal (contingencies). Costs without contingency are the same for barrier removal options for all of the dam removal alternatives.

5.2.3 Benefits for Barrier Removal Alternatives

Table 5.2-2 presents the net gain in average annual habitat units (AAHUs) for each barrier removal alternative. AAHUs were calculated utilizing the IWR Planning Suite Annualizer and differ slightly from the values presented in the Main Report due to rounding. As shown in **Table 5.2-2**, barrier removal benefits are higher if implemented in conjunction with dam removal Alternatives 2 and 4 than in conjunction with dam removal Alternative 3 (please refer to the Main Report for details). Removal of barriers LV1, LV4 and CC5 provide the greatest habitat benefits, while removal of LV3, CC2 and CC8 provide the least benefits. Also note that the benefits for removal of CC3 also include benefits associated with removal of CC4. Although CC4 is assumed to be removed under without project conditions, the benefits associated with the removal of CC4 are only realized with removal of the downstream barriers (through CC3). Similarly, the benefits for CC5 reflect AAHU gains realized for providing habitat connectivity upstream to CC8, as CC7 has already been removed and CC6 does not need to be removed to achieve the connectivity related benefits.

Table 5.2-2: Benefits for Barrier Removal Alternatives

Malibu Creek Feasibility Study Benefits for Barrier Removal Alternatives (AAHUs)	
Alt	**Gain in AAHUs**
With Alts 2/4	
LV1	28.8
LV2	13.3
LV3	2.2
LV4	20.4
CC1	4.5
CC2	0.9
CC3	15.9
CC5	20.3
CC8	2.7
With Alts 3	
LV1	12.5
LV2	4.5
LV3	0.9
LV4	8.9
CC1	1.8
CC2	0.0
CC3	7.1
CC5	3.6
CC8	0.9

5.3 Cost Effectiveness and Incremental Cost Analysis

5.3.1 Description of CE/ICA

Cost-effectiveness and incremental cost analyses were performed using IWR-PLAN. The CE/ICA is an evaluation tool which considers and identifies the relationship between changes in cost and changes in quantified, but not monetized, habitat benefits. The evaluation is used to identify the most cost-effective alternative plans to reach various levels of restoration output and to provide information about whether increasing levels of restoration are worth the successively added costs. The CE/ICA is a planning tool to help identify cost-effective plans which provide a certain level out habitat output at the least cost.

Functionally, the CE/ICA provides a framework for combining individual features into alternative plans. The software expedites this effort of testing each combination of features and tabulating the resulting costs and environmental benefits.

Cost Effectiveness Analysis

When there is no monetary measure of benefits but project outcomes can be described and quantified in some dimension, cost effectiveness analysis can be used to assist on the decision making process. Cost effectiveness analysis seeks to answer the question: given an adequately described objective, what is the least-costly way of attaining the objective? A plan is considered cost effective if it provides a given level of output for the least cost. Cost effectiveness analysis was used to identify the least cost solution for each level of environmental output being considered.

The cost effectiveness analysis is the first step in the CE/ICA, and compares the Average Annual Habitat Units (AAHUs) potentially achieved by each alternative to the cost of each alternative to generate a “cost per AAHU.” This cost provides a means to compare the cost-effectiveness of each plan. The three criteria used for identifying non-cost effective plans or combinations include (1) the same level of output could be produced by another plan at less cost; (2) a larger output level could be produced at the same cost; or (3) a larger output level could be produced at the least cost. Cost-effectiveness is one of the criteria by which all plans are judged and plays a role in the selection of the National Ecosystem Restoration (NER) Plan. Non-cost effective combinations of plans are dropped from further consideration.

Incremental Cost Analysis

Incremental cost analysis compares the additional costs to the additional outputs of an alternative. It is a tool that can assist in the plan formulation and evaluation process, rather than a dictum that drives that process. The analysis consists of examining increments of plans or project features to determine their incremental costs and incremental benefits. Increments of plans continue to be added and evaluated as long as the incremental benefits exceed the incremental costs. When the incremental costs exceed the incremental benefits, no further increments are added. Incremental analysis helps to identify and display variations in costs among different increments of restoration measures and alternative plans. Thus, it helps decision makers determine the most desirable level of output relative to costs and other decision criteria.

The incremental cost analysis portion of the CE/ICA compares the incremental costs for each additional unit of output from one cost effective plan to the next to identify “best buy” plans. The first step in developing “best buy” plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the No Action Alternative is the first incremental best buy plan. Plans that have a higher incremental cost per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans.

This process is reiterated until the lowest incremental cost per unit for the next level of output is determined. The intent of the incremental analysis is to identify successively larger plans with the smallest incremental cost per unit of incremental output.

5.3.2 Elimination of Dam Removal Alternatives 3a and 3c

Prior to completing the CE/ICA analysis it was apparent that dam removal Alternatives 3A and 3C are not cost effective and do not meet planning objectives. These alternatives have negative benefits (AAHUs were lower with these alternatives than under without project conditions), and have a total project first cost in excess of $111 million. Further, the potential benefits for the upstream barrier removal alternatives are lower if implementing these dam removal options relative to dam removal Alternatives 2 or 4. Accordingly, these alternatives were dropped from further consideration and were not included in the CE/ICA analysis.

Similar arguments can be made for dropping dam removal Alternative 4 from further consideration, as the costs for the Alternative 4 dam removal options are higher than the corresponding costs for the Alternative 2 options, and the benefits are lower. However, Alternative 4 was carried forward for the CE/ICA analysis to display the differences in efficiency with Alternative 4 vs. Alternative 2 dam removal options, with consideration of whether decision criteria other than efficiency may justify selection of a plan that includes one of the Alternative 4 dam removal options.

5.3.3 Cost Effectiveness Analysis

Inputs to the IWR Planning Suite model are shown in **Table 5.3-1**. As shown, none of the dam removal plans can be implemented with another dam removal plan, implementation of the first barrier removal plans (LV1 and CC1) both rely on implementation of one of the dam removal plans, and all upstream barrier removal plans require implementation of downstream barrier removal plans.

Table 5.3-1: Inputs to IWR Planning Suite Model (FY 2016 Price Levels, 3.125% Discount Rate)

INPUTS TO IWR PLANNING SUITE MODEL				
Name	Avg. Annual Cost ($1,000s)	Average Annual Output - AAHUs	Requirement (Dependency)	Requirement (Not Combinable With)
2A1	$6,616	46.2		2A2, 2C1, 2C2, 4A1, 4A2, 4C1, 4C2
2A2	$7,133	46.2		2A1, 2C1, 2C2, 4A1, 4A2, 4C1, 4C2
2C1	$6,506	46.2		2A1, 2A2, 2C2, 4A1, 4A2, 4C1, 4C2
2C2	$7,021	46.2		2A1, 2A2, 2C1, 4A1, 4A2, 4C1, 4C2
4A1	$7,516	35.5		2A1, 2A2, 2C1, 2C2, 4A2, 4C1, 4C2
4A2	$8,057	35.5		2A1, 2A2, 2C1, 2C2, 4A1, 4C1, 4C2
4C1	$7,394	35.5		2A1, 2A2, 2C1, 2C2, 4A1, 4A2, 4C2
4C2	$7,934	35.5		2A1, 2A2, 2C1, 2C2, 4A1, 4A2, 4C1
LV1	$79	28.8	One of: 2A1, 2A2, 2C1, 2C2, 4A1, 4A2, 4C1, 4C2	
LV2	$45	13.3	LV1	
LV3/LV4	$62	22.6	LV2	
CC1	$100	4.5	One of: 2A1, 2A2, 2C1, 2C2, 4A1, 4A2, 4C1, 4C2	
CC2	$80	0.9	CC1	
CC3	$64	15.9	CC2	
CC5	$24	20.3	CC3	
CC8	$65	2.7	CC5	

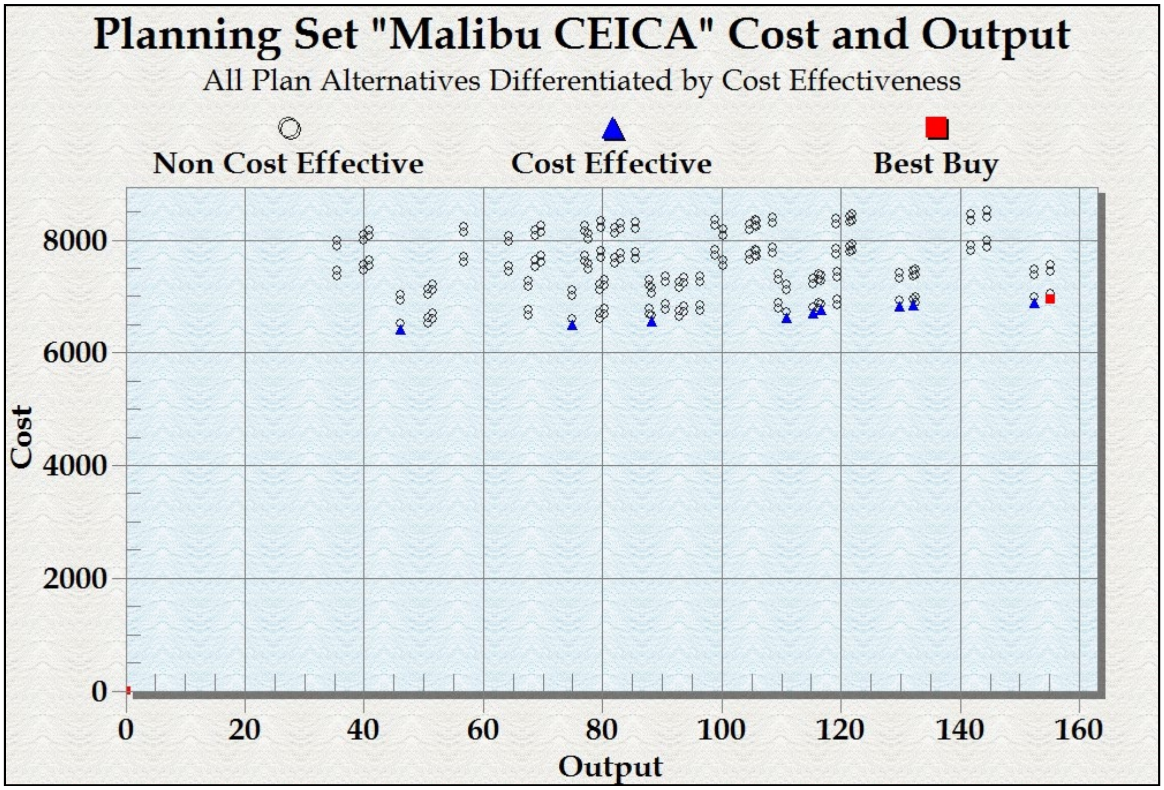
Based upon these model inputs, there are 192 possible plan combinations (not including the No Action Plan). Of these plans, there are 10 cost effective action plans. **Table 5.3-2** and **Figure 5.3-1** show the results of the cost effectiveness analysis. As shown, the total first cost for the cost effective action plans range from $146 million to $158 million. All of the cost effective plans include dam removal Alternative 2C1, which includes dam arch removal, mechanical transport, with trucking of sand material downcoast for shoreline placement and trucking of remaining material to a landfill. This dam removal alternative is the most cost effective, as it provides the same benefits as the other Alternative 2 options and greater benefits than Alternative 4 options, but at a lower cost. Implementation of dam removal Alternative 2C1 by itself is the first cost effective action plan.

The remaining cost effective action plans including incremental additions of barrier removals, with the largest cost effective plan including all of the proposed barrier removals. The output for the cost effective plans range from 46.2 AAHUs for the plan that only includes dam removal Alternative 2C1, to 155.2 for the plan that also includes all of the barrier removals. The plans that were not cost effective are displayed in **Figure 5.3-1** as circles. These non-cost-effective plans all include one of the dam removal plans other than Alternative 2C1.

Table 5.3-2: Malibu Creek CE/ICA - Cost Effective Plans

Cost Effective Plan Alternatives					
Counter	Name	Output (HU)	First Cost $1,000	AA Cost $1,000	AAC/HU
1	No Action Plan	0.0	$0	$0	
2	Dam Removal - 2C1	46.2	$146,153	$6,506	$140.8
3	DR 2C1, BR LV1	75.0	$148,142	$6,585	$87.8
4	DR 2C1, BR LV1, LV2	88.3	$149,279	$6,630	$75.1
5	DR 2C1, BR LV1, LV2, LV3/LV4	110.9	$150,590	$6,692	$60.3
6	DR 2C1, BR LV1, LV2, LV3/LV4, CC1	115.4	$153,095	$6,792	$58.9
7	DR 2C1, BR LV1, LV2, LV3/LV4, CC1, CC2	116.6	$155,111	$6,853	$58.8
8	DR 2C1, BR LV1, LV2, CC1, CC2, CC3, CC5	129.9	$155,751	$6,898	$53.1
9	DR 2C1, BR LV1, LV2, LV3/LV4, CC1, CC2, CC3	132.2	$156,706	$6,936	$52.5
10	DR 2C1, BR LV1, LV2, LV3/LV4, CC1, CC2, CC3, CC5	152.5	$157,062	$6,960	$45.6
11	DR 2C1, BR LV1, LV2, LV3/LV4, CC1, CC2, CC3, CC5, CC8	155.2	$158,701	$7,025	$45.3

Figure 5.3-1: Malibu CE/ICA Analysis – Cost & Output (All Plans)



5.3.4 Incremental Cost Analysis

The first plan Best Buy Plan is the cost effective plan that has the lowest average annual cost per AAHU. As shown on **Table 5.3-3**, the largest cost effective plan (which includes dam removal Alternative 2C1 and all of the proposed barrier removals). The average annual cost (AAC) per AAHU for this plan is $45,300, which is slightly lower than the plan with the next lowest AAC/AAHU, which does not include removal of barrier CC8. Since there are no other plans that produce greater output than this plan and this plan has the lowest AAC/AAHU, this plan would be the only Best Buy Plan based upon this analysis. Output and cost for this plan are highlighted in yellow on **Table 5.3-3**.

5.3.5 Incremental Cost Analysis – Barriers Only

As noted in the prior section, plans that included all of the barrier removal alternatives had the lowest AAC/AAHU. This was a function of the fact that the AAC/AAHU is lower for all of the barrier removal alternatives than the most efficient dam removal alternative. In order to isolate the cost effectiveness and efficiency of the barrier removal options, a separate CEICA analysis was conducted on the barriers.

This analysis yielded a total of 23 possible plan combinations, not including the No Action Plan. Of these, 9 action plans were cost effective and 4 were Best Buy Plans (see **Table 5.3-3** and **Table 5.3-4** and **Figure 5.3-2** and **Figure 5.3-3**).

Table 5.3-3: Malibu Creek CE/ICA - Cost Effective Plans (Barriers Only)

Cost Effective Plans - Barriers Only					
Counter	Name	Output (HU)	First Cost $1,000	AA Cost $1,000	AAC/HU
1	No Action Plan	0.0	$0	$0	
2	LV1	28.8	$1,988	$79	$2.8
3	LV1, LV2	42.1	$3,125	$125	$3.0
4	LV1, LV2, LV3/LV4	64.7	$4,436	$187	$2.9
5	LV1, LV2, LV3/LV4, CC1	69.2	$6,942	$287	$4.1
6	LV1, CC1, CC2, CC3, CC5	70.4	$8,461	$348	$4.9
7	LV1, LV2, CC1, CC2, CC3, CC5	83.7	$9,598	$393	$4.7
8	LV1, LV2, LV3/LV4, CC1, CC2, CC3	86.0	$10,553	$431	$5.0
9	LV1, LV2, LV3/LV4, CC1, CC2, CC3, CC5	106.3	$10,909	$456	$4.3
10	LV1, LV2, LV3/LV4, CC1, CC2, CC3, CC5, CC8	109.0	$12,548	$521	$4.8

Figure 5.3-2: Malibu CE/ICA – Cost & Output (Barriers Only)

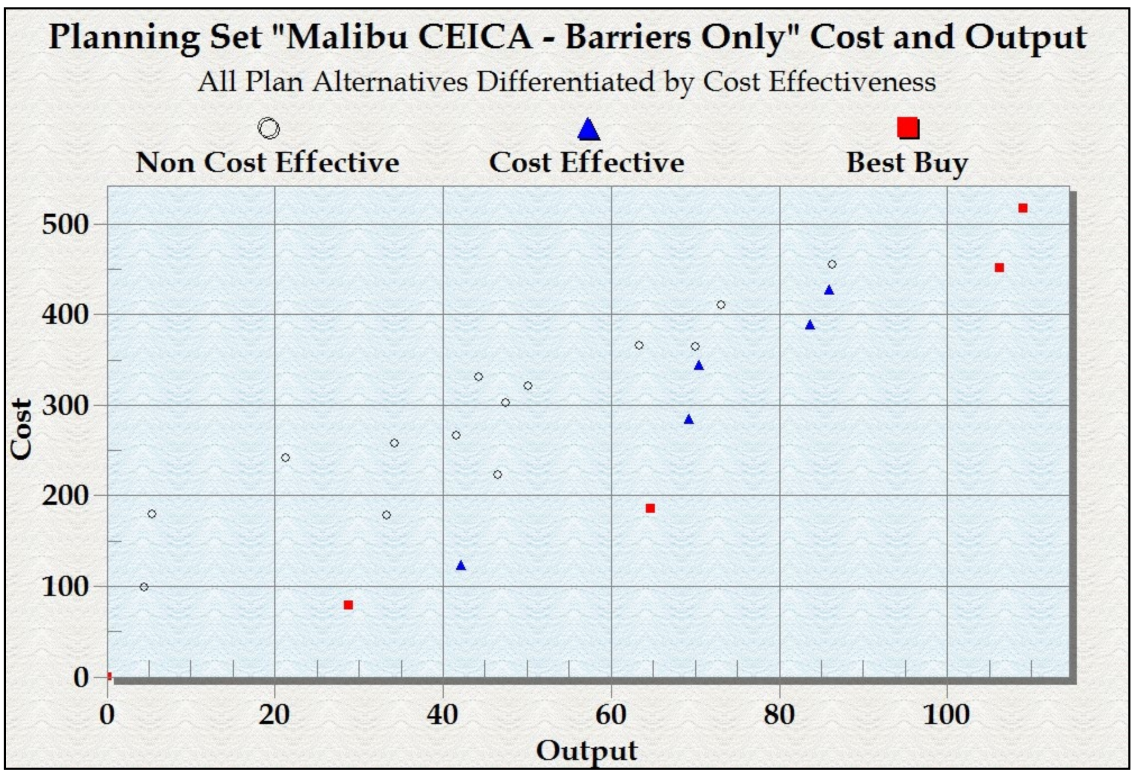
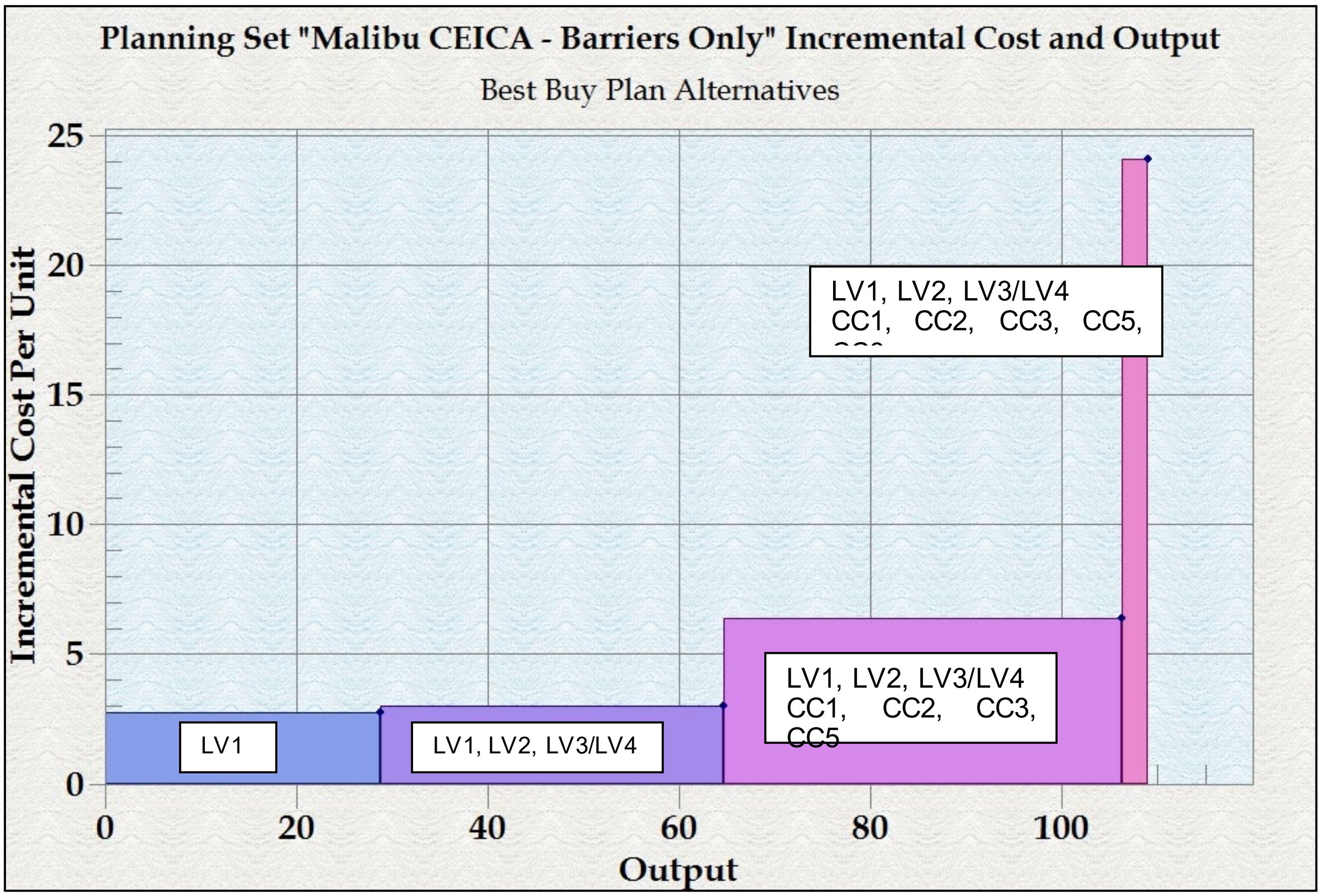


Table 5.3-4: Malibu Creek CE/ICA - Best Buy Plans (Barriers Only)

Best Buy Plans - Barriers Only							
Counter	Name	Output (HU)	AA Cost $1,000	AAC/HU	Increm. Output (HU)	Increm. AA Cost	Increm. AA Cost/HU
1	No Action Plan	0.0	$0				
2	LV1	28.8	$79	$2.8	28.8	$79	$2.8
3	LV1, LV2, LV3/LV4	64.7	$187	$2.9	35.9	$108	$3.0
4	LV1, LV2, LV3/LV4, CC1, CC2, CC3, CC5	106.3	$456	$4.3	41.6	$269	$6.5
5	LV1, LV2, LV3/LV4, CC1, CC2, CC3, CC5, CC8	109.0	$521	$4.8	2.7	$65	$24.2

Figure 5.3-3: Malibu CE/ICA - Incremental Costs (Barriers Only)



The analysis above shows that when isolate the CE/ICA on the barriers only, there are 4 Best Buy action alternatives. These include:

- LV1
- LV1, LV2, LV3/LV4
- LV1, LV2, LV3/LV4, CC1, CC2, CC3, CC5
- LV1, LV2, LV3/LV4, CC1, CC2, CC3, CC5, CC8

Figure 5.3-2 shows that the incremental costs per incremental AAHU are very similar for the first two Best Buy plans. The Incremental AAC/AAHU for the third Best Buy Plan is about 115% higher than the first two Best Buy Plans. Finally, the incremental AAC/AAHU for the largest Best Buy Plan (which includes all barrier removal plans) is 275% higher than the third Best Buy Plan, and is more than 8 times higher than the incremental AAC/AAHU for the first two Best Buy Plans. This analysis indicates that the barrier removal plans on Cold Creek are less efficient in providing output than those on Los Virgenes Creek, and the removal of the CC8 barrier on Cold Creek in particular is less efficient than the removal of other barriers. As a component of the largest plan, however, removal of CC8 is part of the largest Best Buy Plan.

5.4 <u>Decision Criteria – NER Plan</u>

The NER Plan selection is significantly influenced by the results of the CE/ICA. Generally, one of the best buy plans should be considered the NER plan as it reflects the results of the analysis of both the output and costs of the alternatives. The decision whether to select successively larger scale best buy plans, is whether the incremental output is deemed to be worth the incremental costs.

The results of the analysis indicate that Alternative 2C1 is clearly the best dam removal alternative in terms of cost efficiency. In order to gain the additional environmental outputs associated with upstream barrier removals, this alternative must be combined with those plans. In turn, each upstream barrier removal plan is dependent upon removal of downstream barriers.

The CE/ICA analysis that included the barrier removal plans with the dam removal plans showed that there is only one Best Buy Plan. This plan includes dam removal Alternative 2C1 as well as all of the proposed barrier removal options.

However, in order to isolate the efficiency of the barrier alternatives, the CEICA analysis was redone with just the barrier removal alternatives. This analysis showed that there are 4 combinations of barrier removal plans that are Best Buy Plans. Barrier removal alternatives along Los Virgenes are more efficient at producing output than those along Cold Creek. The removal of the most upstream barrier along Cold Creek (CC8) is substantially less efficient than the other barrier removal plans. Given these results, the Project Delivery Team determined that the benefits/output from removal of the CC8 barrier was not "worth it" and therefore should not be considered part of the NER Plan (along with dam removal Alternative 2C1 and removal of the other barriers).

The Main Report has identified the NER Plan as including Rindge Dam arch removal (retaining the spillway) with mechanical transport and upstream barrier removal (excluding Barrier CC8). This alternative is identified as Alternative 2D1. The sand material would be placed along the Malibu shoreline. The remaining material would be trucked to Calabasas Landfill. The NER Plan also includes removal or modification of eight upstream barriers. The impounded sediment behind the dam would be mechanically removed and transported at the same rate that the dam is lowered. The total construction timeframe is estimated to be 7 years. Small fish passage barriers upstream along Las Virgenes and Cold Creek tributaries would also be removed to provide access to additional good to excellent quality aquatic habitat.

5.5 Locally Preferred Plan

The Non-Federal Sponsor has expressed a preference for a different plan than the NER Plan – Alternative 2B2. This plan includes removal of the same barriers as the NER Plan. The primary differences are: 1) Alternative 2B2 includes removal of the entire dam, including the spillway, while Alternative 2D1 does not include spillway removal; and 2) Under Alternative 2B2, impounded sand sediment is trucked to Ventura Harbor and transported via barge for near-shore placement, while under Alternative 2D1, the sediment is placed on the shoreline downcoast of Malibu pier. The Locally Preferred Plan is the Recommended Plan. The period of construction for this plan is estimated at 8 years.

5.6 Summary of Benefits & Costs – NER Plan & LPP (Recommended Plan)

Table 5.6-1 summarizes the benefits and costs for the NER Plan (Alternative 2D1) and LPP (Alternative 2B2). As noted, the LPP is the Recommended Plan. Total costs have been updated to FY 2020 price levels, and average annual costs have been computed applying the current Federal discount rate of 2.75%.

Table 5.6-1: Benefit/Cost Summary for NER Plan and LPP (FY 2020 Price Levels, 2.75% Discount Rate)

NER Plan & LPP Summary of Benefits & Costs ($1,000s) FY 2020 Price Levels, 2.75% Discount Rate		
Costs & Benefits	**NER Plan (2D1)**	**LPP (2B2)**
NER Costs		
Construction Costs	$171,822	$182,217
PED	$60,805	$65,356
Construction Management	$11,226	$10,224
LERRD	$12,362	$12,151
Total First Cost	**$256,215**	**$269,948**
Interest During Construction	$25,625	$31,192
Investment Cost	$281,840	$301,140
Annualized Investment Cost	$10,440	$11,155
OMRR&R	$63	$52
Total Annual Costs	**$10,502**	**$11,207**
NER Benefits		
AAHUs	**152.5**	**152.5**
Annual Cost/AAHU	**$68.9**	**$73.5**

As shown above, the output of the NER Plan and LPP are the same, while the costs for the LPP are higher due to the additional costs for dam spillway removal and nearshore placement.

Summary of Flood Risk Considerations – NER Plan and LPP

As noted earlier in this appendix, one of the constraints and considerations of the study was that the proposed ER alternatives should not increase flood risks. Hydrologic and hydraulic engineering analyses were conducted to verify that water surface elevations (WSE's) did not increase with proposed restoration measures in place. Based upon this analysis, it was determined that dam removal Alternatives 3 and 4 would result in increased WSEs (due to natural transport of material rather than entirely mechanical transport), and therefore floodwalls were designed to mitigate for the increased risk, and these costs were included in the cost estimates for these alternatives (see **Table 5.1-1**).

The H&H analysis did show a potential increase in water surface elevations under the NER and LPP dam removal options (Alternative 2). However, the area of potential impact is small, representing a less than one-half mile segment of the creek, and the level of detail in the H&H modeling was insufficient to confirm that there would be an increase in flood risk. Additional modeling is necessary to confirm if there would be increased flood risks and if so, the geographic extent of flooding and increased flood depths. This analysis will be conducted in the pre-construction engineering and design phase (PED). Should an increase in risk be identified, an evaluation will then be conducted of potential mitigation measures.

6.0 Regional Economic Development Analysis

6.1 Purpose

"The regional economic development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output and population."[1] The RED account displays information not analyzed in other accounts in the feasibility report that could have a "material bearing on the decision-making process."[2]

The RED account is born out of the difference in perspectives between the Federal government and local communities directly impacted by water resource planning. The Federal objective in water resource planning is contributing to national economic development and the Federal perspective is the nation as a whole. Local communities and regions directly impacted by water resource planning may consider impacts at the state, regional, or local level a more relevant measure. From the Federal perspective transferring employment opportunities and resources from one region of the nation to another to construct a water resource project does not in itself constitute national economic development and therefore regional economic impacts may not be fully captured in the national economic development (NED) account. However, from a regional or local perspective the transfer of employment opportunities and resources to construct a project in that region, as opposed to some other region of the United States, can be a significant benefit to the local economy in terms of more local employment, more local spending, and more local production. This is why the different perspectives between the Federal government and local communities impacted by water resource projects are addressed in

[1] *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies*, 1983

[2] Ibid

different accounts. The Federal perspective is addressed principally in the NED account while the regional or local perspective is addressed principally in the RED account.

6.2 Process

To perform an economic analysis from the regional perspective (RED account), several different impacts from constructing the water resource project have to be analyzed. These impacts are termed direct, indirect, and induced effects.

i) *Direct effects* are "immediate effects associated with the change in total sales for a particular industry. In other words…the proportion of the expenditure in each industry that flows to material and service providers in that region."[3] Stated simply, these are the direct impacts to employment and income due to the demand for goods and services to complete construction (e.g. construction equipment and labor). The region is typically defined by political rather than economic or geographic boundaries. Political boundaries are broken down to state and county or metropolitan area for analysis.

ii) *Indirect Effects* are changes in inter-industry purchases in response to new demand from the directly affected industries. In other words the supply of materials and services to meet the needs of the companies or individuals directly engaged in constructing the project (e.g. concrete suppliers).

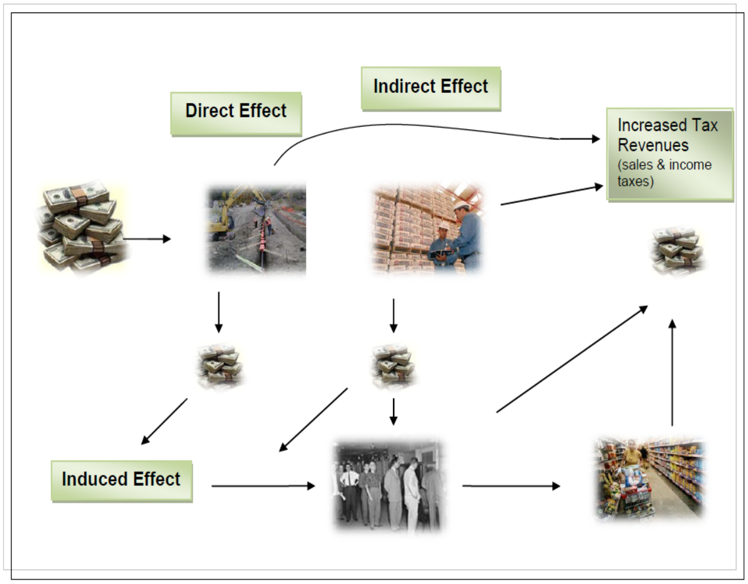
iii) *Induced effects* are "changes in spending patterns [from] increases in income to directly and indirectly affected industries."[4] Stated simply, this is the increased spending on local goods and services such as restaurants, grocery stores, hotels, and gas stations due to the direct and indirect effects of the project.

The impact from spending to construct the project is shown in **Figure 6.2-1**. First the direct effects from hiring a construction firm to complete the project are experienced, then that firm purchases supplies and services from other firms to complete the project causing indirect effects.

[3] *Regional Economic Development (RED) Procedures Handbook* 2011-RPT-01, March 2011

[4] Ibid

Figure 6.2-1: Process to Evaluate Regional Economic Development



Finally, both direct and indirect effects contribute to induced spending at local retailers, restaurants, convenience stores, etc. This leads local retailers, restaurants, convenience stores, and so on to purchase more goods and services and perhaps hire additional workers. At the same time all this cycling of dollars also leads to increased tax revenue. This cycle continues until the additional dollars are no longer in circulation in the regional economy due to leakages. Leakages occur when goods and services with value added outside of the region are purchased (e.g. purchased clothing that was manufactured in Asia or consulting services from a firm located and engaged in business activity primarily outside the region). The graphic below illustrates the concepts of direct, indirect, and induced effects.

The direct, indirect, and induced effects are estimated through multipliers, which can be thought of, figuratively, as money multiplying throughout the regional economy. A portion of the money spent on construction equipment and labor (direct effect) gets re-spent on construction supplies (indirect effect) and a portion of the money from both is re-spent on local restaurants and gas stations (induced effect). Economists have used regression analysis on historical spending data to estimate how much spending and re-spending varies when there is an economic stimulus to the region through various construction projects. This produces the “multipliers” that are applied to the initial construction spending (i.e. cost of constructing the project) to estimate the direct, indirect, and induced effects of the project studied in this feasibility report.

In addition to the regional benefits from direct, indirect, and induced spending on constructing the project there are also benefits from increased recreation demand from non-locals and tax benefits to the local and state economy from preserving property tax receipts since episodic erosion events causing property loss would be markedly reduced once the project is constructed. These are called forward linkages since they link the construction project to the regional “consumers” of the outputs from this coastal storm damage reduction project, which are decreased land loss resulting in the preservation of property tax receipts as well as increased recreational opportunities resulting in more tourist spending. This contrasts with backward linkages from the construction firm to its suppliers captured in the "money multipliers" described earlier and analyzed in this section.

6.3 Analysis

The RECONS model was used to estimate the direct, indirect, and induced effects of the NER Plan and LPP based on construction cost estimates. This model generates regional construction multipliers based on the USACE business lines (navigation, flood mitigation, water storage & supply, etc). Each business line is subdivided into numerous work activities, which improves the accuracy of the estimates for regional and national job creation, and retention and other economic measures such as income, value added, and sales. Although the project purpose is ecosystem restoration, for purposes of the RED analysis the business line profile selected was flood risk management (construction and rehabilitation of dams and spillways), given the primary expenditures are for demolition of the dam and sediment removal. **Table 5.6-1** shows that the direct expenditures for the NER Plan (Alternative 2D1) and the LPP (Alternative 2B2) are approximately $256.2 million and $269.9 million, respectively.

6.4 Results

Results are presented for the region, state, and nation. The region consists of Los Angeles-Long Beach-Anaheim Metropolitan Statistical Area (comprised of Los Angeles and Orange Counties) which includes the Malibu Creek study area. This means regional impacts that have been measured accrue within the MSA but not specifically in the City of Malibu and neighboring cities. The state-level impacts are for California and the national impacts are for the contiguous United States.

Direct impacts (effects) to employment and income due to the demand for goods and services. These contribute to additional output, additional demand for jobs, and increased value-added to goods and services within the MSA, the state of California, and the nation as shown in **Table 6.4-1**.

Based on these estimated impacts we expect about 827 full-time equivalent (FTE) jobs to be created from direct employment from constructing the NER Plan and about 871 FTE jobs from constructing the LPP, over the period of construction within the region. The NER Plan and LPP are projected to create an additional 550 and 579 additional FTE jobs, respectively, by indirect and induced effects that support or compliment that construction effort during the period of construction. The regional capture rate, which is the region's direct output as a share of total spending, is around 77%. Since most of the labor and equipment comes from within the region, we expect the capture rate to be high as shown.

Overall, the NER Plan should lead to $144 million in gross regional product (GRP) and about 1,377 full time equivalent jobs within the region through the period of construction. The impact to the state would be of greater magnitude although less relative importance due to the large size of the California economy. Approximately $191 million in GRP and about 1,747 jobs would be created state-wide.

The LPP should lead to $152 million in gross regional product (GRP) and about 1,451 full time equivalent jobs within the region over the period of construction. Approximately $201 million in GRP and about 1,840 jobs would be supported state-wide.

Table 6.4-1: Regional Economic Development Impacts for NER Plan and LPP

NER PLAN - RED Analysis Summary					
Area	**Local Capture ($000)**	**Output ($000)**	**Jobs***	**Labor Income ($000)**	**Value Added ($000)**
Local					
Direct Impact		$196,245	827	$62,659	$86,496
Secondary Impact		$94,834	550	$34,163	$57,446
Total Impact	$196,245	$291,080	1377	$96,822	$143,942
State					
Direct Impact		$223,489	930	$73,597	$103,073
Secondary Impact		$152,316	816	$52,309	$87,595
Total Impact	$223,489	$375,806	1747	$125,905	$190,667
US					
Direct Impact		$242,232	984	$78,019	$109,073
Secondary Impact		$303,297	1516	$92,801	$158,636
Total Impact	$242,232	$545,529	2500	$170,820	$267,708
LPP - RED Analysis Summary					
Area	**Local Capture ($000)**	**Output ($000)**	**Jobs***	**Labor Income ($000)**	**Value Added ($000)**
Local					
Direct Impact		$206,764	871	$66,017	$91,132
Secondary Impact		$99,917	579	$35,994	$60,525
Total Impact	$206,764	$306,681	1451	$102,011	$151,657
State					
Direct Impact		$235,468	980	$77,541	$108,597
Secondary Impact		$160,480	860	$55,112	$92,290
Total Impact	$235,468	$395,949	1840	$132,654	$200,887
US					
Direct Impact		$255,216	1036	$82,201	$114,919
Secondary Impact		$319,554	1597	$97,776	$167,139
Total Impact	$255,216	$574,770	2634	$179,976	$282,057

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