Encinitas-Solana Beach Coastal Storm Damage Reduction Project

San Diego County, California

Appendix M

Mitigation Strategy

U.S. Army Corps of Engineers
Los Angeles District

December 2012

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1 INTRODUCTION

The Los Angeles District of the U.S. Army Corps of Engineers (USACE) is conducting a Feasibility Study for a coastal storm damage reduction project in the cities of Encinitas and Solana Beach, San Diego County, California. Potential impacts to rocky reef habitats off shore of Solana Beach have been predicted to require mitigation. The purpose of this document is to describe the process used by the USACE to determine the acreage of rocky reef mitigation that may be required for this project. No impacts to surf grass are predicted for any of the action alternatives. If surf grass mitigation is required it will be performed as described in **Appendix H**.

2 FUNCTIONAL ASSESSMENT

The Functional Assessment is used to provide a quantitative valuation of existing and mitigation features to support a mitigation functional equivalent to offset unavoidable losses to rocky reef habitat resulting from the Project.

USACE guidance for establishing mitigation requirements in the Civil Works Program is provided in ER 1105-2-100. USACE planning policy is clear on the use of functional habitat evaluation assessment or functional assessments (FA): “Mitigation planning objectives are clearly written statements that prescribe specific actions to be taken to avoid and minimize adverse impacts, and identifies specific amounts (units of measurement, e.g., habitat units) of compensation required to replace or substitute for remaining, significant unavoidable losses” [ER 1105-2-100, App C, Paragraph C-3.b (13) 22 April 2000] and “habitat-based evaluation methodologies…shall be used to describe and evaluate ecological resources and impacts” [ER 1105-2-100, App C, Paragraph C-3.d (5)]

This guidance requires that USACE not use standardized ratios, but instead a scientific-based approach through the use of habitat evaluation through functional assessment (FA).

Following consultations with resource agencies in March 2012, USACE decided to proceed with a process based, in part, on the National Oceanic and Atmospheric Administration (NOAA) mitigation calculator (King & Price, 2004). USACE also assembled a panel to assist in populating the mitigation calculator. That process is described below.

This process was chosen because it allows for a structured procedure tailored to the project site, it allows for a quantified assessment of mitigation, and it results in a written documentation of the determination process.

Reef habitat mitigation shall consist of shallow-water, mid-water, or deep-water reef. Shallow water reef would be for any surfgrass mitigation, mid-water reef would be located inshore of the existing kelp beds, and deep-water reef would be located offshore of the existing kelp beds. The mid-water reef would be the first priority as it is most like the reef being impacted and is thus closer to an in-kind mitigation. However, deep-water reef mitigation may be required.

Separate mitigation requirements were established for each reef type. Each of the three reef types have differing locations and characteristics that result in different functional values.

3 NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) MITIGATION CALCULATOR

The FA is based in part on the NMFS Wetland Mitigation Ratio Calculator (King and Price, 2004). This use of the mitigation ratio calculator was adopted following recommendations made by NMFS and CDF&G during a conference call on 1 March 2012. This mitigation ratio calculator represents a systematic, peer-reviewed approach to the calculation of a mitigation ratio for wetlands. The calculator is heavily dependent on best professional judgment, but it is tailored to the specific study area and project.

The calculator uses the following parameters and formula to estimate a mitigation ratio:

A: The level of wetland function provided per acre at the mitigation site prior to the mitigation project, expressed as a percentage of the per acre value of the original wetland. Values for this parameter ranged from 0 to 1. A value of 0 means that the mitigation site prior to mitigation had no wetland functions; e.g. the mitigation is constructed on a parking lot. A value of 1 means that the mitigation site has the same wetland functions as the original wetland; e.g. the mitigation is constructed on a fully functioning wetland.

B: The maximum level of wetland function each acre of mitigation is expected to attain, if it is successful, expressed as a percentage of the per acre value of the original wetland. Values for this parameter ranged from 0 to 1. A value of 0 means that the mitigation site is expected to achieve none of the wetlands functions of the original wetland. A value of 1 means that the mitigation site is expected to achieve the same wetland functions as the original wetland.

C: The number of years after construction that the mitigation project is expected to achieve maximum function. This parameter is measured in years and is not bound by the calculation. The expert panel chose to use whole years for this parameter due to uncertainties in predicting design and construction time as well as time to reach maximum function.

D: The number of years before destruction of the original wetland that the mitigation project begins to generate mitigation values (negative values represent delayed compensation). This parameter is measured in years and is not bound by the calculation. The expert panel chose to use whole years for this parameter due to uncertainties in predicting design and construction time as well as development time.

E: The percent likelihood that the mitigation project will fail and provide none of the anticipated benefits (with mitigation failure, wetland values at the mitigation site return to level A). Values for this parameter ranged from 0 to 1. A value of 0 means that the mitigation site will fail and provide none of the anticipated benefits; e.g. the mitigation does not function as designed. A value of 1 means that the mitigation site provides all of the expected benefits; e.g. the mitigation functions as designed.

L: The percent difference in expected wetland values based on differences in landscape context of the mitigation site when compared with the impacted wetland (positive values represent enhanced landscape context at mitigation site). Values for this parameter ranged from -1 to +1. A value of 0 means that the mitigation site has the same landscape context as the impacted wetland; e.g. in kind mitigation. A value of -1 means that the mitigation site has none of the landscape context of the impacted wetland. A value of +1 means that the mitigation site has none of the landscape context of the impacted wetland, but is enhanced relative to the impacted wetland.

r : The discount rate used for comparing values that accrue at different times at their present value (tables provide estimates based on discount rates of 0%, 5%, and 10%). EC 1105-2-100 Paragraph E-36 c.(1) states that: "Ecosystem restoration outputs are not discounted, but should be computed on an average annual basis, taking into consideration that the outputs achieved are likely to vary over time." The above excerpt is in the Ecosystem Restoration appendix of the ER. HQ policy interpretation is that it applies to impact analysis and mitigation planning as well as ecosystem restoration. USACE will instead separately apply an average annualized habitat evaluation using software developed and certified by the Institute for Water Resources (IWR). A value of 0 will be used in the calculator.

Tmax: The time horizon used in the analysis. (Using the OMB recommended discount rate of r=7% comparisons of value beyond about t=75 years are of negligible significance). This parameter is measured in years and is not bound by the calculation. The time horizon used for this calculation is 50 years, which is the life of the project.

R: Under the circumstances described above, the discrete time equation that can be used to solve for the appropriate mitigation ratio is as follows:

$$R = \frac{\sum_{t=0}^{T_{\max}} (1+r)^{-t}}{\left(B(1-E)(1+L)-A\right)\left[\sum_{t=-D}^{C-D} \frac{(t+D)}{C(1+r)^{t}} + \sum_{C-D+1}^{T_{\max}} (1+r)^{-t}\right]}$$

Each parameter was assigned a value by a panel of experts identified in the following table. Rationale for the assigned value is provided below. The expert panel, other than discussed above, was not restricted in its assignment of values, including the number of significant figures. The calculation was carried out in a spreadsheet application provided by the NMFS. **Table 5.1-1** shows calculated functional equivalents for low, high, average, and USACE-selected values for each variable.

"Values for variables A, B, E, L, and r are percentages. The range for these variables are 0 to 1. Variable C is the number of years and varies from 0 to the number of years that the mitigation project is expected to achieve maximum function. Variable D is the number of years before destruction of the original wetland that the mitigation project begins to generate mitigation values (negative values represent delayed compensation). Values may be positive or negative. Tmax is the time horizon for the project. The lifetime of this project is 50 years."

4 EXPERT PANEL

The expert panel consisted of the following technical experts:

Larry Smith, U.S. Army Corps of Engineers (USACE)
Bryant Chesney, National Marine Fisheries Service (NMFS)
Jon Avery, U.S. Fish and Wildlife Service (USFWS)
Bill Paznokas, California Department of Fish and Game (CDF&G)
John Dixon, California Coastal Commission (CCC)
Keith Merkel, Merkel & Associates, Inc.

5 PANEL RECOMMENDATIONS

The panel specifically addressed mid-water reef mitigation in detail. The values for deep water reefs were discussed in lesser detail as this is seen as unlikely and is considered to be out of kind mitigation. Values for this scenario were developed by the USACE, keeping the discussion with the panel in mind when assigning values. The values for the shallow water (surf grass) reef were determined in a similar fashion.

5.1 NOAA Mitigation Calculator

A: The panel identified a consensus range of 0 – 0.23. The average value proposed by the panel is 0.106. The calculator assumes that the impact site retains no habitat value. It is, in essence, converted into a parking lot. The impacted area, for this project, however will retain some habitat value as it will be converted from rocky reef to sandy bottom habitat. Conversely, the mitigation area will be converted from sandy bottom habitat to rocky reef. Forcing the calculator to take this into the calculation requires that either A=0, the rationale for some panel members scoring this parameter, or that B be given a correspondingly higher value.

B: Near shore reefs are very diverse and artificial reefs colonize rapidly and with a high functional value. The panel agreed on a value of 1 for this variable.

C: The panel identified a consensus range of 5 – 7 with an average value of 6. Near shore reefs generally show rapid colonization, although it does take time to reach "full development".

D: The panel agreed on a value of -4 for this variable and USACE will use that value for its calculation. This value is based on a two-year delay to determine long-term rocky reef losses and an additional two-year period to identify acreage of rocky reef losses, design, contract, and build the mitigation reef. The mitigation reef would be in place and beginning to function four years after sand placement.

E: The panel identified a consensus range of 0 – 0.5. The mitigation reef is a feature of the project and any mitigation reef built would have some benefit. The variable is defined as will "provide none of the anticipated benefits". However, there was some doubt as to whether USACE could build a large enough mitigation site or build a site that would meet its objectives. The first is mostly a funding concern. Should mitigation be greater than estimated would USACE be able to obtain additional funding to enlarge the mitigation site. The second is based on an unknown mitigation site design and mitigation site features. Is the bottom of a character suitable for building an artificial reef, are the reef materials of a size and weight to be stable in the near shore environment. This project will include funding for mitigation plus a sizable contingency fund should our estimated impact be low. Additionally, the technology for artificial reef construction is a proven technology that is relatively simple compared to other kinds of mitigation commonly evaluated using the calculator (salt water marsh, eelgrass, etc.).

L: The panel agreed on a value of -0.1 for this variable and USACE will use that value for its calculation. This value is based on the fact that the mitigation site is in slightly deeper water than the impacted site and is likely to have slightly different habitat values.

r: EC 1105-2-100 Paragraph E-36 c.(1) states that: "Ecosystem restoration outputs are not discounted, but should be computed on an average annual basis, taking into consideration that the outputs achieved are likely to vary over time." The above excerpt is in the Ecosystem Restoration appendix of the ER. HQ policy interpretation is that it applies to impact analysis and mitigation planning as well as ecosystem restoration. USACE will instead separately apply an average annualized habitat evaluation using software developed and certified by the Institute for Water Resources (IWR). A value of 0 will be used in the calculator.

Tmax: The time horizon used for this calculation is 50 years, which is the life of the project.

Table 5.1-1 Summary of Recommended Values

	A	B	C	D	E	L	r	Tmax	R
Low	0	1	5	-4	0	-0.1	0	50	1.35
High	0.23	1	7	-4	0.5	-0.1	0	50	5.58
Average	0.106	1	6	-4	0.26	-0.1	0	50	2.18
Average*	0.106	1	6	-4	0	-0.1	0	50	1.54
*Confidence of success high									

6 MID WATER MITIGATION REEF

6.1 NOAA Mitigation Calculator

A = 0.106

The panel identified a consensus range of 0 – 0.23 and an average value of 0.106. The calculator assumes that the impact site retains no habitat value. It is, in essence, converted into a parking lot. The impacted area, for this project, will retain some habitat value as it will be converted from rocky reef to sandy bottom habitat. Conversely, the mitigation area will be converted from sandy bottom habitat to rocky reef. Forcing the calculator to take this into the calculation requires that either A=0 or that B be given a correspondingly higher value. USACE has decided to use a value of 0.106, the average value proposed by the panel, for this variable for its calculation.

B = 1

Near shore reefs are very diverse and artificial reefs colonize rapidly and with a high functional value. The panel agreed on a value of 1 for this variable and USACE will use that value for its calculation.

C = 6

The panel identified a consensus range of 5 – 7 with an average value of 6. Near shore reefs generally show rapid colonization, although it does take time to reach "full development". USACE has decided to use the average value of 6 for its calculation as being a conservative estimator of this function.

D = -4

The panel agreed on a value of -4 for this variable and USACE will use that value for its calculation. This value is based on a two-year delay to determine long-term rocky reef losses and an additional two-year period to identify acreage of rocky reef losses, design, contract, and build the mitigation reef. The mitigation reef would be in place and beginning to function four years after sand placement.

E = 0.1

The panel identified a consensus range of 0 – 0.5 with an average value of 0.26. The mitigation reef is a feature of the project and any mitigation reef built would have some benefit. The variable is defined as will "provide none of the anticipated benefits". However, there remains some doubt as to whether USACE could build a large enough mitigation site or build a site that would meet its objectives. The first is mostly a funding concern. Should mitigation be greater than estimated would USACE be able to obtain additional funding to enlarge the mitigation site. The second is based on an unknown mitigation site design and mitigation site features. Is the bottom of a character suitable for building an artificial reef, are the reef materials of a size and weight to be stable in the near shore environment. USACE has decided to go with a value of 0.1 because this project will include funding for mitigation plus a sizable contingency fund should our estimated impact be low. Additionally, the technology for artificial reef construction is a proven technology that is relatively simple compared to other kinds of mitigation commonly evaluated using the calculator (salt water marsh, eelgrass, etc.). The contingency funding is also available to either enlarge the mitigation site or make additions to the initial site should post-construction monitoring show that the reef is not fully functional. Adding a large measure of uncertainty only compounds this contingency unnecessarily driving up costs. The Corps has chosen to address uncertainty in the mitigation by incorporating a contingency fund into the project. Addressing uncertainty by increasing the value of this parameter increases the size of the mitigation site without reducing the risk of failure.

L = -0.1

The panel agreed on a value of -0.1 for this variable and USACE will use that value for its calculation. This value is based on the fact that the mitigation site is in slightly deeper water than the impacted site and is likely to have slightly different habitat values.

r = 0

EC 1105-2-100 Paragraph E-36 c.(1) states that: "Ecosystem restoration outputs are not discounted, but should be computed on an average annual basis, taking into consideration that the outputs achieved are likely to vary over time." The above excerpt is in the Ecosystem Restoration appendix of the ER. HQ policy interpretation is that it applies to impact analysis and mitigation planning as well as ecosystem restoration. USACE will instead separately apply an average annualized habitat evaluation using software developed and certified by the Institute for Water Resources (IWR).

Tmax = 50

The time horizon used for this calculation is 50 years, which is the life of the project.

Table 6.1-1 Summary of Mid Depth Values

	A	B	C	D	E	L	r	Tmax	R
Mid Depth	0.106	1	6	-4	0.1	-0.1	0	50	1.73

6.2 Institute of Water Resources (IWR) Annualizer

Annualizing ecosystem costs and outputs is required by the USACE planning guidance. The annualizer utility, developed by the IWR, 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 NER module of the annualizer is used. This module was designed to evaluate average annual habitat values (as opposed to costs).

Assumptions used in the utility are presented here. The first assumption is that the mitigation reef assumes equal value with the impacted reef when it reaches full development. This is the same as variable B in the wetlands mitigation calculator, so it is a safe assumption. Habitat value for years 0-4 are set at 0 as this is the period between impact and construction of the mitigation reef (2 years post-construction monitoring plus two years to estimate impact acreage, design, contract, and build the mitigation reef). This is the same as variable D in the wetlands mitigation calculator. I am assuming that the time from construction of the reef to full functionality is 6 years. This corresponds to the average value identified by the panel for variable C of the wetlands mitigation calculator. An underlying assumption is that the reef develops linearly over those six years gaining 16.67% value each year. This is a conservative estimator as the Wheeler North reef gained a lot of value the first two years with slower development in the subsequent year. The annualizer uses a top value of 100, so this means an increase of 16.67 each year until full development when it reaches 100. This value is relative to the impacted reef and meets the first assumption. The mitigation sites should be outside the area of influence, so renourishment should not have a direct or indirect impact. While the mitigation sites are within the depth of closure, sands in this area from the project (which are at higher volumes than renourishment) show levels of one foot or less. High relief reefs should therefore see no effect. These are the type of reef under consideration as mitigation reefs. Once the mitigation reef reaches a value of 100 (in year 10) it stays there for the life of the project (50 years). This basically means that any variation in mitigation reef quality over time is matched by variation that the impacted reef would have experienced.

Applying the assumptions above into the annualizer yields a value of 86.0002 for average annual value. The average annual value of the impacted reef without project is assumed to be 100. Assuming that the ratio obtained from the mitigation calculator is for an average annual value of 100, multiplying that number by the ration of 100/86.0002 yields a recommended functional equivalent of 2.01:1.

6.3 Recommended Mitigation Functional equivalent

Other factors taken into consideration when setting a mitigation functional equivalent are the location of the mitigation site relative to the impact, time delay between impact and implementation of mitigation, time delay for the mitigation site to achieve full potential, functional value of the mitigation site in comparison to the impacted site, confidence that the mitigation will be built, confidence that the mitigation design will achieve mitigation goals, constructability of the mitigation, added benefits of the mitigation to the original project objectives, long-term functionality of the mitigation site, and maintenance requirements of the mitigation site.

The location of the proposed mitigation reefs are in the same general area as the impacted reefs and are show in the Integrated Report of mitigation site locations map. They are in slightly deeper water (roughly 5-10 feet deeper) and adjacent to existing rocky reef habitat. Therefore, they are expected to develop habitat similar, but not identical, to the impacted habitat. Additionally, the adjacent rocky reef habitat is expected to serve as a source for plant and animal colonization of the mitigation reef resulting in rapid initial colonization. This is not a factor in the wetland mitigation calculator, but it does add confidence to the expectation that the mitigation reef can be constructed and that it can reach maximum functionality.

Beach nourishment leads to an initial direct impact to the placement site. Over time, sand is spread through the system leading to indirect burial. The initial fill footprint for this project avoids all sensitive resources in the area (e.g. rocky reef and surf grass beds). Indirect burial, however, is expected to impact rocky reef habitat off of the Solana Beach segment for the selected alternative. Impacts are not expected off of the Encinitas segment from the selected project. Both segments were designed to avoid impacts by placing sand away from sensitive resources. Both segments were designed to minimize impacts by selecting the beach width that provides maximum benefits at minimum width. Larger beach widths than selected would result in greater protection benefits, but would also result in greater environmental impacts, greater mitigation costs, and lower net benefits.

The indirect nature of the impacts to sensitive resources also means that determination of the magnitude, or acreage, of impacts cannot be determined immediately. Nor is there sufficient confidence in the impact assessment process to construct mitigation based on estimated impacts. USACE, for that reason, chose to identify the magnitude of indirect impacts by monitoring two years after completion of the initial beach fill. This time frame was established following coordination with the National Marine Fisheries Service (NMFS) and the California Department of Fish and Game (CDFG). It is therefore, not feasible to construct the mitigation feature prior to or concurrent with the impact.

The wetlands mitigation calculator assumes that the impact is immediate and that habitat value is lost during or immediately after construction. This is not the case for this project, where impacts may actually be one to two years post construction as the placed sands are distributed through the system resulting in indirect burial of sensitive resources. A lower mitigation functional equivalent than calculated could be supported or a shorter duration used in the calculation. However, no change is proposed at this time because the difference is relatively small. Changing the delay in the calculator from four to three years results in a reduction from 1.54 to 1.48 functional equivalent.

The biota and function of a rocky reef habitat takes time to develop. As discussed above, placing the mitigation close to existing rocky reefs should allow for rapid initial colonization of the mitigation reef. Monitoring of other man-made reefs has shown a rapid initial colonization over the first one to two years followed by a slower growth to maturity. This was the rationale used in the wetlands mitigation calculator for a six-year period. Growth and development will be tracked by monitoring.

Expectations for the mitigation reefs are that they will achieve equal functionality to the impacted reefs. The mitigation reefs will be slightly deeper, but they are located in habitat close to and similar to that of the impacted reefs. The panel convened to implement the wetland mitigation calculator felt that the mitigation reef would develop to have equal functionality, a position supported by USACE. This is supported in the results of the wetland mitigation calculator.

This project is a Feasibility Study authorized by Congress. The result will be a project specifically authorized and funded by Congress (assuming that it moves forward). Construction costs include the cost of mitigation based on impact estimates and including a contingency amount should that impact estimate be low when compared to actual impacts or should adjustments be required to the mitigation reef. The latter would increase the mitigation requirements and costs. However, mitigation will be a project component of the authorized project and it will be funded, if the project is funded. There is no scenario that would result in project construction without mitigation construction. The panel was not so sure and thus rated this factor lower in the wetlands mitigation calculator.

Building artificial reefs is a proven technique. Factors contributing to success or failure are relatively well known. Techniques are fairly standard and utilize standard types of construction equipment and readily available building materials.

Building mitigation rocky reefs is a relatively simple process. Construction requires the identification of an area with suitable substrate, sizing of rock to ensure that the reef is stable in the shallow water environment, and accurate placement of the selected building material. Construction methods have been standardized and have been used over a long time not only for the construction of artificial reefs, but also for the construction for shore and harbor protection structures (i.e. jetties, breakwaters, shoreline protection). Confidence in the constructability of the mitigation reef is high. This is particularly true when compared to the construction of wetland mitigation features in salt and fresh water systems.

Artificial reefs have been shown to be functional over long periods of time, times equivalent to the project duration of fifty years. Once built, reefs are rapidly colonized and tend to remain valuable habitat. There is variation over time, similar to natural reefs, but artificial reefs tend to remain high quality habitat over long periods of time. Other types of wetland mitigation, perhaps experience problems with this characteristic, which often result in higher mitigation functional equivalents for projects impacting riparian wetlands or coastal marsh wetlands. Incremental impacts from nearby development could undermine mitigation features resulting in short term development prior to failure. This is not seen as a problem faced by artificial reefs, particularly reefs placed in the open ocean and not within enclosed bays and/or estuaries.
Artificial reefs do not require long-term maintenance. Once established they are self-supporting. Maintenance in the forms of watering, additional plantings, reconstruction of eroded or damaged features are not required for artificial reefs.

Based on the panel's application of the wetland mitigation calculator, proposed USACE modifications to the wetland mitigation calculator variables, and the qualitative discussion above, USACE proposes to implement a mitigation plan that addresses impacts to rocky reef habitat by the creation of mid-depth, artificial rocky reef habitat on 2:1 functional equivalent.

These additional factors support the calculated functional equivalent. The major loss in value is temporal due to the time delay between impact during initial sand placement and identification of impacts, design, and construction of mitigation reefs. This time delay is unavoidable as it is very difficult to identify indirect impacts[1] in such a dynamic environment. It also reflects the resource agency viewpoint that mitigation may be more difficult than anticipated.

7 DEEP WATER MITIGATION REEF

7.1 NOAA Mitigation Calculator

A = 0.106

The panel identified a consensus range of 0 – 0.23 and an average value of 0.106. The calculator assumes that the impact site retains no habitat value. It is, in essence, converted into a parking lot. The impacted area, for this project, will retain some habitat value as it will be converted from rocky reef to sandy bottom habitat. Conversely, the mitigation area will be converted from sandy bottom habitat to rocky reef. Forcing the calculator to take this into the calculation requires that either A=0 or that B be given a correspondingly higher value. USACE has decided to use a value of 0.106, the average value proposed by the panel, for this variable for its calculation.

B = 1.3

Deeper water kelp reefs have greater habitat value than a shallow water reef. There is higher productivity and diversity as kelp extends protective habitat from the reef itself up the water column to the surface.

C = 7

The panel identified a consensus range of 5 – 7 with an average value of 6. Near shore reefs generally show rapid colonization, although it does take time to reach "full development". USACE has decided to use the average value of 6 for the shallow water reef for its calculation as being a conservative estimator of this function. Kelp generally takes a longer time to develop, so we have elected to go with the high end of the range, or 7 for this variable.

D = -4

The panel agreed on a value of -4 for this variable and USACE will use that value for its calculation. This value is based on a two-year delay to determine long-term rocky reef losses and an additional two-year period to identify acreage of rocky reef losses, design, contract, and build the mitigation reef. The mitigation reef would be in place and beginning to function four years after sand placement. This value is based on the schedule, so there is no change when considering a deep water mitigation site.

[1] The project was designed to avoid direct impacts to rocky reef and surf grass habitats. Placement sites were limited to areas that lacked these resources. However, natural littoral transport processes are expected to result in movement of the placed sand indirectly burying rocky reef habitat in Solana Beach. No indirect burial of surf grass is predicted for the project. Indirect burial of rocky reef is not predicted for Encinitas. Natural processes at the site results in burial and uncoverage of low relief reefs. Monitoring will be required to determine if reef burial is a result of indirect burial by the project or natural movement of sand.

E = 0.1

The panel identified a consensus range of 0 – 0.5 with an average value of 0.26. The mitigation reef is a feature of the project and any mitigation reef built would have some benefit. The variable is defined as will "provide none of the anticipated benefits". However, there remains some doubt as to whether USACE could build a large enough mitigation site or build a site that would meet its objectives. The first is mostly a funding concern. Should mitigation be greater than estimated would USACE be able to obtain additional funding to enlarge the mitigation site. The second is based on an unknown mitigation site design and mitigation site features. Is the bottom of a character suitable for building an artificial reef, are the reef materials of a size and weight to be stable in the near shore environment. USACE has decided to go with a value of 0.1 because this project will include funding for mitigation plus a sizable contingency fund should our estimated impact be low. Additionally, the technology for artificial reef construction is a proven technology that is relatively simple compared to other kinds of mitigation commonly evaluated using the calculator (salt water marsh, eelgrass, etc.). The contingency funding is also available to either enlarge the mitigation site or make additions to the initial site should post-construction monitoring show that the reef is not fully functional. Adding a large measure of uncertainty only compounds this contingency unnecessarily driving up costs. The Corps has chosen to address uncertainty in the mitigation by incorporating a contingency fund into the project. Addressing uncertainty by increasing the value of this parameter increases the size of the mitigation site without reducing the risk of failure. Additionally, it is slightly easier to gain access to the deep water areas than the mid-depth for the construction equipment, which should reduce uncertainty. However, this change was not large enough to justify changing this parameter.

L = -0.1

The panel agreed on a value of -0.1 for this variable and USACE will use that value for its calculation. This value is based on the fact that the mitigation site is in slightly deeper water than t he impacted site and is likely to have slightly different habitat values.

r = 0

EC 1105-2-100 Paragraph E-36 c.(1) states that: "Ecosystem restoration outputs are not discounted, but should be computed on an average annual basis, taking into consideration that the outputs achieved are likely to vary over time." The above excerpt is in the Ecosystem Restoration appendix of the ER. HQ policy interpretation is that it applies to impact analysis and mitigation planning as well as ecosystem restoration. USACE will instead separately apply an average annualized habitat evaluation using software developed and certified by the Institute for Water Resources (IWR).

Tmax = 50

The time horizon used for this calculation is 50 years, which is the life of the project.

Table 7.1-1 Summary of Deep Water Values

	A	B	C	D	E	L	r	Tmax	R
Deep Water	0.106	1.3	7	-4	0.1	-0.1	0	50	1.30

7.2 IWR Annualizer

Annualizing ecosystem costs and outputs is required by the USACE planning guidance. The annualizer utility, developed by the IWR, 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 NER module of the annualizer is used. This module was designed to evaluate average annual habitat values (as opposed to costs).

Assumptions used in the utility are presented here. The first assumption is that the mitigation reef assumes equal value with the impacted reef when it reaches full development. This is the same as variable B in the wetlands mitigation calculator, so it is a safe assumption. Habitat value for years 0-4 are set at 0 as this is the period between impact and construction of the mitigation reef (2 years post-construction monitoring plus two years to estimate impact acreage, design, contract, and build the mitigation reef). This is the same as variable D in the wetlands mitigation calculator. I am assuming that the time from construction of the reef to full functionality is 7 years. This corresponds to the average value identified by the panel for variable C of the wetlands mitigation calculator. An underlying assumption is that the reef develops linearly over those six years gaining 14.29% value each year. This is a conservative estimator as the Wheeler North reef gained a lot of value the first two years with slower development in the subsequent year. The annualizer uses a top value of 100, so this means an increase of 14.29 each year until full development when it reaches 100. This value is relative to the impacted reef and meets the first assumption. The mitigation sites should be outside the area of influence as well as the depth of closure, so renourishment should not have a direct or indirect impact. Once the mitigation reef reaches a value of 100 (in year 11) it stays there for the life of the project (50 years). This basically means that any variation in mitigation reef quality over time is matched by variation that the impacted reef would have experienced.

Applying the assumptions above into the annualizer yields a value of 85.0006 for average annual value. The average annual value of the impacted reef without project is assumed to be 100. Assuming that the functional equivalent obtained from the mitigation calculator is for an average annual value of 100, multiplying that number by the ration of 100/85.0006 yields a recommended mitigation functional equivalent of 1.53:1.

7.3 Recommended Mitigation Functional Equivalent

Other factors taken into consideration when setting a mitigation functional equivalent are the location of the mitigation site relative to the impact, time delay between impact and implementation of mitigation, time delay for the mitigation site to achieve full potential, functional value of the mitigation site in comparison to the impacted site, confidence that the mitigation will be built, confidence that the mitigation design will achieve mitigation goals, constructability of the mitigation, added benefits of the mitigation to the original project objectives, long-term functionality of the mitigation site, and maintenance requirements of the mitigation site.

The location of the proposed mitigation reefs are in the same general area as the impacted reefs. They are somewhat farther offshore than the mid-depth reef sites. They are in deeper water (roughly 30 feet deeper), but are adjacent to existing rocky reef, kelp habitat. Therefore, they are expected to develop richer, kelp habitat similar, compared to the impacted habitat. Additionally, the adjacent rocky reef habitat is expected to serve as a source for plant and animal colonization of the mitigation reef resulting in rapid initial colonization. This is not a factor in the wetland mitigation calculator, but it does add confidence to the expectation that the mitigation reef can be constructed and that it can reach maximum functionality.

Beach nourishment leads to an initial direct impact to the placement site. Over time, sand is spread through the system leading to indirect burial. The initial fill footprint for this project avoids all sensitive resources in the area (e.g. rocky reef and surf grass beds). Indirect burial, however, is expected to impact rocky reef habitat off of the Solana Beach segment for the selected alternative. Impacts are not expected off of the Encinitas segment from the selected project. Both segments were designed to avoid impacts by placing sand away from sensitive resources. Both segments were designed to minimize impacts by selecting the beach width that provides maximum benefits at minimum width. Larger beach widths than selected would result in greater protection benefits, but would also result in greater environmental impacts, greater mitigation costs, and lower net benefits.

The indirect nature of the impacts to sensitive resources also means that determination of the magnitude, or acreage, of impacts cannot be determined immediately. Nor is there sufficient confidence in the impact assessment process to construct mitigation based on estimated impacts. USACE, for that reason, chose to identify the magnitude of indirect impacts by monitoring two years after completion of the initial beach fill. This time frame was established following consultation with the National Marine Fisheries Service (NMFS) and the California Department of Fish and Game (CDFG). It is therefore, not feasible to construct the mitigation feature prior to or concurrent with the impact.

The wetlands mitigation calculator assumes that the impact is immediate and that habitat value is lost during or immediately after construction. This is not the case for this project, where impacts may actually be one to two years post construction as the placed sands are distributed through the system resulting in indirect burial of sensitive resources. A lower mitigation functional equivalent than calculated could be supported or a shorter duration used in the calculation. However, no change is proposed at this time because the difference is relatively small. Changing the delay in the calculator from four to three years results in a reduction from 1.48 to 1.42 functional equivalent.

Rocky reef habitat takes time to develop. As discussed above, placing the mitigation close to existing rocky reefs should allow for rapid initial colonization of the mitigation reef. Monitoring of other man-made reefs has shown a rapid initial colonization over the first one to two years followed by a slower growth to maturity. This was the rationale used in the wetlands mitigation calculator for a six-year period. Growth and development will be tracked by monitoring.

Expectations for the mitigation reefs are that they will achieve equal functionality to the impacted reefs. The mitigation reefs will be slightly deeper, but they are located in habitat close to and similar to that of the impacted reefs. The panel convened to implement the wetland mitigation calculator felt that the mitigation reef would develop to have equal functionality, a position supported by USACE. This is supported in the results of the wetland mitigation calculator.

This project is a Feasibility Study authorized by Congress. The result will be a project specifically authorized and funded by Congress (assuming that it moves forward). Construction costs include the cost of mitigation based on impact estimates and including a contingency amount should that impact estimate be low when compared to actual impacts. The latter would increase the mitigation requirements and costs. However, mitigation will be a project component of the authorized project and it will be funded, if the project is funded. There is no scenario that would result in project construction without mitigation construction. The panel was not so sure and thus rated this factor lower in the wetlands mitigation calculator.

Building artificial reefs is a proven technique. Factors contributing to success or failure are relatively well known. Techniques are fairly standard and utilize standard types of construction equipment and readily available building materials.

Building mitigation rocky reefs is a relatively simple process. Construction requires the identification of an area with suitable substrate, sizing of rock to ensure that the reef is stable in the shallow water environment, and accurate placement of the selected building material. Construction methods have been standardized and have been used over a long time not only for the construction of artificial reefs, but also for the construction for shore and harbor protection structures (i.e. jetties, breakwaters, shoreline protection). Confidence in the constructability of the mitigation reef is high. This is particularly true when compared to the construction of wetland mitigation features in salt and fresh water systems. Additionally, it is slightly easier to gain access to the deep water areas than the mid-depth for the construction equipment, which should reduce uncertainty.

Artificial reefs have been shown to be functional over long periods of time, times equivalent to the project duration of fifty years. Once built, reefs are rapidly colonized and tend to remain valuable habitat. There is variation over time, similar to natural reefs, but artificial reefs tend to remain high quality habitat over long periods of time. Other types of wetland mitigation, perhaps experience problems with this characteristic, which often result in higher mitigation functional equivalents for projects impacting riparian wetlands or coastal marsh wetlands. Incremental impacts from nearby development could undermine mitigation features resulting in short term development prior to failure. This is not seen as a problem faced by artificial reefs, particularly reefs placed in the open ocean and not within enclosed bays and/or estuaries.

Artificial reefs do not require maintenance. Once established they are self-supporting. Maintenance in the forms of watering, additional plantings, reconstruction of eroded or damaged features are not required for artificial reefs.

Based on the panel's application of the wetland mitigation calculator, proposed USACE' modifications to the wetland mitigation calculator variables, and the qualitative discussion above, USACE proposes to implement a mitigation plan that addresses impacts to rocky reef habitat by the creation of shallow, artificial rocky reef habitat on 1.5:1 functional equivalent.

8 SHALLOW WATER (SURF GRASS) MITIGATION REEF

8.1 NOAA Mitigation Calculator

A = 0.106

The panel identified a consensus range of 0 – 0.23 and an average value of 0.106. The calculator assumes that the impact site retains no habitat value. It is, in essence, converted into a parking lot. The impacted area, for this project, will retain some habitat value as it will be converted from rocky reef to sandy bottom habitat. Conversely, the mitigation area will be converted from sandy bottom habitat to rocky reef. Forcing the calculator to take this into the calculation requires that either A=0 or that B be given a correspondingly higher value. USACE has decided to use a value of 0.106, the average value proposed by the panel, for this variable for its calculation.

B = 1

Near shore reefs are very diverse and artificial reefs colonize rapidly and with a high functional value. The panel agreed on a value of 1 for this variable and USACE will use that value for its calculation.

C = 7

The panel identified a consensus range of 5 – 7 with an average value of 6. Near shore reefs generally show rapid colonization, although it does take time to reach "full development". Surf grass develops rather more slowly. USACE has decided to use the high value of 7 for its calculation as being a conservative estimator of this function.

D = -4

The panel agreed on a value of -4 for this variable and USACE will use that value for its calculation. This value is based on a two-year delay to determine long-term rocky reef losses and an additional two-year period to identify acreage of rocky reef losses, design, contract, and build the mitigation reef. The mitigation reef would be in place and beginning to function four years after sand placement.

E = 0.26

The panel identified a consensus range of 0 – 0.5 with an average value of 0.26. The mitigation reef is a feature of the project and any mitigation reef built would have some benefit. The variable is defined as will "provide none of the anticipated benefits". However, there remains some doubt as to whether USACE could build a large enough mitigation site or build a site that would meet its objectives. The first is mostly a funding concern. Should mitigation be greater than estimated would USACE be able to obtain additional funding to enlarge the mitigation site. The second is based on an unknown mitigation site design and mitigation site features. Is the bottom of a character suitable for building an artificial reef, are the reef materials of a size and weight to be stable in the near shore environment. USACE has decided to go with a value of 0.26 because this project will include funding for mitigation plus a sizable contingency fund should our estimated impact be low. Additionally, the technology for artificial reef construction is a proven technology that is relatively simple compared to other kinds of mitigation commonly evaluated using the calculator (salt water marsh, eelgrass, etc.). The contingency funding is also available to either enlarge the mitigation site or make additions to the initial site should post-construction monitoring show that the reef is not fully functional. Adding a large measure of uncertainty only compounds this contingency unnecessarily driving up costs. The Corps has chosen to address uncertainty in the mitigation by incorporating a contingency fund into the project. Addressing uncertainty by increasing the value of this parameter increases the size of the mitigation site without reducing the risk of failure. Surf grass restoration, however, is not certain, so a higher uncertainty value is used in this case. Should surf grass restoration fail, it would be replaced by kelp transplants that have a high confidence level.

L = -0.1

The panel agreed on a value of -0.1 for this variable and USACE will use that value for its calculation. This value is based on the fact that the mitigation site is in the same water depth as the impacted site and is likely to have similar habitat values.

r = 0

EC 1105-2-100 Paragraph E-36 c.(1) states that: "Ecosystem restoration outputs are not discounted, but should be computed on an average annual basis, taking into consideration that the outputs achieved are likely to vary over time." The above excerpt is in the Ecosystem Restoration appendix of the ER. HQ policy interpretation is that it applies to impact analysis and mitigation planning as well as ecosystem restoration. USACE will instead separately apply an average annualized habitat evaluation using software developed and certified by the Institute for Water Resources (IWR).

Tmax = 50

The time horizon used for this calculation is 50 years, which is the life of the project.

Table 8.1-1 Summary of Shallow Water Values

	A	B	C	D	E	L	r	Tmax	R
Shallow Water	0.106	1	7	-4	0.26	-0.1	0	50	2.19

8.2 Institute of Water Resources (IWR) Annualizer

Annualizing ecosystem costs and outputs is required by the USACE planning guidance. The annualizer utility, developed by the IWR, 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 NER module of the annualizer is used. This module was designed to evaluate average annual habitat values (as opposed to costs).

Assumptions used in the utility are presented here. The first assumption is that the mitigation reef assumes equal value with the impacted reef when it reaches full development. This is the same as variable B in the wetlands mitigation calculator, so it is a safe assumption. Habitat value for years 0-4 are set at 0 as this is the period between impact and construction of the mitigation reef (2 years post-construction monitoring plus two years to estimate impact acreage, design, contract, and build the mitigation reef). This is the same as variable D in the wetlands mitigation calculator. I am assuming that the time from construction of the reef to full functionality is 7 years. This corresponds to the average value identified by the panel for variable C of the wetlands mitigation calculator. An underlying assumption is that the reef develops linearly over those six years gaining 14.29% value each year. This is a conservative estimator as the Wheeler North reef gained a lot of value the first two years with slower development in the subsequent year. The annualizer uses a top value of 100, so this means an increase of 14.29 each year until full development when it reaches 100. This value is relative to the impacted reef and meets the first assumption. The mitigation sites should be outside the area of influence as well as the depth of closure, so renourishment should not have a direct or indirect impact. Once the mitigation reef reaches a value of 100 (in year 11) it stays there for the life of the project (50 years). This basically means that any variation in mitigation reef quality over time is matched by variation that the impacted reef would have experienced.

Applying the assumptions above into the annualizer yields a value of 85.0006 for average annual value. The average annual value of the impacted reef without project is assumed to be 100. Assuming that the functional equivalent obtained from the mitigation calculator is for an average annual value of 100, multiplying that number by the ration of 100/85.0006 yields a recommended mitigation functional equivalent of 2.58:1.

8.3 Recommended Mitigation Functional Equivalent

Other factors taken into consideration when setting a mitigation functional equivalent are the location of the mitigation site relative to the impact, time delay between impact and implementation of mitigation, time delay for the mitigation site to achieve full potential, functional value of the mitigation site in comparison to the impacted site, confidence that the mitigation will be built, confidence that the mitigation design will achieve mitigation goals, constructability of the mitigation, added benefits of the mitigation to the original project objectives, long-term functionality of the mitigation site, and maintenance requirements of the mitigation site.

The location of the proposed mitigation reefs are in the same general area as the impacted reefs and are show in the Integrated Report of mitigation site locations map. They are in slightly deeper water (roughly 5-10 feet deeper) and adjacent to existing rocky reef habitat. Therefore, they are expected to develop habitat similar, but not identical, to the impacted habitat. Additionally, the adjacent rocky reef habitat is expected to serve as a source for plant and animal colonization of the mitigation reef resulting in rapid initial colonization. This is not a factor in the wetland mitigation calculator, but it does add confidence to the expectation that the mitigation reef can be constructed and that it can reach maximum functionality.
Beach nourishment leads to an initial direct impact to the placement site. Over time, sand is spread through the system leading to indirect burial. The initial fill footprint for this project avoids all sensitive resources in the area (e.g. rocky reef and surf grass beds). Indirect burial, however, is expected to impact rocky reef habitat off of the Solana Beach segment for the selected alternative. Impacts are not expected off of the Encinitas segment from the selected project. Both segments were designed to avoid impacts by placing sand away from sensitive resources. Both segments were designed to minimize impacts by selecting the beach width that provides maximum benefits at minimum width. Larger beach widths than selected would result in greater protection benefits, but would also result in greater environmental impacts, greater mitigation costs, and lower net benefits.

The indirect nature of the impacts to sensitive resources also means that determination of the magnitude, or acreage, of impacts cannot be determined immediately. Nor is there sufficient confidence in the impact assessment process to construct mitigation based on estimated impacts. USACE, for that reason, chose to identify the magnitude of indirect impacts by monitoring two years after completion of the initial beach fill. This time frame was established following coordination with the National Marine Fisheries Service (NMFS) and the California Department of Fish and Game (CDFG). It is therefore, not feasible to construct the mitigation feature prior to or concurrent with the impact.

The wetlands mitigation calculator assumes that the impact is immediate and that habitat value is lost during or immediately after construction. This is not the case for this project, where impacts may actually be one to two years post construction as the placed sands are distributed through the system resulting in indirect burial of sensitive resources. A lower mitigation functional equivalent than calculated could be supported or a shorter duration used in the calculation. However, no change is proposed at this time because the difference is relatively small. Changing the delay in the calculator from four to three years results in a reduction from 1.54 to 1.48 functional equivalent.

The biota and function of a rocky reef habitat takes time to develop. As discussed above, placing the mitigation close to existing rocky reefs should allow for rapid initial colonization of the mitigation reef. Monitoring of other man-made reefs has shown a rapid initial colonization over the first one to two years followed by a slower growth to maturity. This was the rationale used in the wetlands mitigation calculator for a six-year period. Growth and development will be tracked by monitoring.

Expectations for the mitigation reefs are that they will achieve equal functionality to the impacted reefs. The mitigation reefs will be slightly deeper, but they are located in habitat close to and similar to that of the impacted reefs. The panel convened to implement the wetland mitigation calculator felt that the mitigation reef would develop to have equal functionality, a position supported by USACE. This is supported in the results of the wetland mitigation calculator.

This project is a Feasibility Study authorized by Congress. The result will be a project specifically authorized and funded by Congress (assuming that it moves forward). Construction costs include the cost of mitigation based on impact estimates and including a contingency amount should that impact estimate be low when compared to actual impacts or should adjustments be required to the mitigation reef. The latter would increase the mitigation requirements and costs. However, mitigation will be a project component of the authorized project and it will be funded, if the project is funded. There is no scenario that would result in project construction without mitigation construction. The panel was not so sure and thus rated this factor lower in the wetlands mitigation calculator.

Building artificial reefs is a proven technique. Factors contributing to success or failure are relatively well known. Techniques are fairly standard and utilize standard types of construction equipment and readily available building materials.

Building mitigation rocky reefs is a relatively simple process. Construction requires the identification of an area with suitable substrate, sizing of rock to ensure that the reef is stable in the shallow water environment, and accurate placement of the selected building material. Construction methods have been standardized and have been used over a long time not only for the construction of artificial reefs, but also for the construction for shore and harbor protection structures (i.e. jetties, breakwaters, shoreline protection). Confidence in the constructability of the mitigation reef is high. This is particularly true when compared to the construction of wetland mitigation features in salt and fresh water systems.

Artificial reefs have been shown to be functional over long periods of time, times equivalent to the project duration of fifty years. Once built, reefs are rapidly colonized and tend to remain valuable habitat. There is variation over time, similar to natural reefs, but artificial reefs tend to remain high quality habitat over long periods of time. Other types of wetland mitigation, perhaps experience problems with this characteristic, which often result in higher mitigation functional equivalents for projects impacting riparian wetlands or coastal marsh wetlands. Incremental impacts from nearby development could undermine mitigation features resulting in short term development prior to failure. This is not seen as a problem faced by artificial reefs, particularly reefs placed in the open ocean and not within enclosed bays and/or estuaries.

Artificial reefs do not require long-term maintenance. Once established they are self-supporting. Maintenance in the forms of watering, additional plantings, reconstruction of eroded or damaged features are not required for artificial reefs.

Based on the panel's application of the wetland mitigation calculator, proposed USACE modifications to the wetland mitigation calculator variables, and the qualitative discussion above, USACE proposes to implement a mitigation plan that addresses impacts to rocky reef habitat by the creation of mid-depth, artificial rocky reef habitat on 2.5:1 functional equivalent.

9 SUMMARY

Reef habitat mitigation shall consist of shallow water, mid depth, or deep water reef. Shallow water reef would be for any surfgrass mitigation (none currently predicted), mid depth reef would be located inshore of the existing kelp beds, and deep water reef would be located offshore of the existing kelp beds. The mid-water reef would be the first priority as it is most like the reef being impacted and is thus closer to an in-kind mitigation. However, deep water reef mitigation may be required if insufficient acreage of suitable mid depth reef is available.

The value of the contingency for mitigation construction for the NED Plan is approximately $3 million. This value represents 35% of the estimated construction costs for reef mitigation. As a fixed percentage it increases as the construction costs are increased for mitigation functional equivalents higher than those proposed in this appendix. A higher mitigation functional equivalent, owing to an increase in the uncertainty factor, therefore results in a doubled increase to projects costs due to the increase in direct construction costs and to increase to the fixed percentage contingency costs. For example, an increase in mitigation functional equivalent for mid depth reefs from 2:1 to 2.5:1 would increase contingency costs by almost $1 million. As an extreme example, $3 million is sufficient to build up to an additional 6 acres of either mid depth and deep water mitigation reefs, if all of the contingency were used to create replacement mitigation area. Use of this level of contingency funding comes with the added bonus of allowing the Corps the flexibility to modify reef that is not fully functional rather than being forced to construct new reef during initial mitigation construction. This allows the Corps the opportunity to correct for unforeseen difficulties in design and/or construction of the mitigation site rather than placing all of our funding into design and construction of a larger mitigation site. Identification of the functionality of the mitigation reef and proposed modifications would be done in consultation with members of the expert panel and their respective organizations.

Table 8.3-1 Summary of All Results

	A	B	C	D	E	L	r	Tmax	R_{calc}	$R_{Annualized}$
Mid Depth	0.106	1	6	-4	0.1	-0.1	0	50	1.73	2.0
Deep Water	0.106	1.3	7	-4	0.1	-0.1	0	50	1.30	1.5
Shallow Water	0.106	1	7	-4	0.26	-0.1	0	50	2.19	2.5

10 REFERENCES

King, Ph.D., Dennis M. and Price, M.S., Elizabeth W. 2004 Developing Defensible Wetland Mitigation Ratios: A Companion to “The Five-Step Wetland Mitigation Ratio Calculator”. NOAA, Office Conservation, Habitat Protection Division, September 30, 2004.

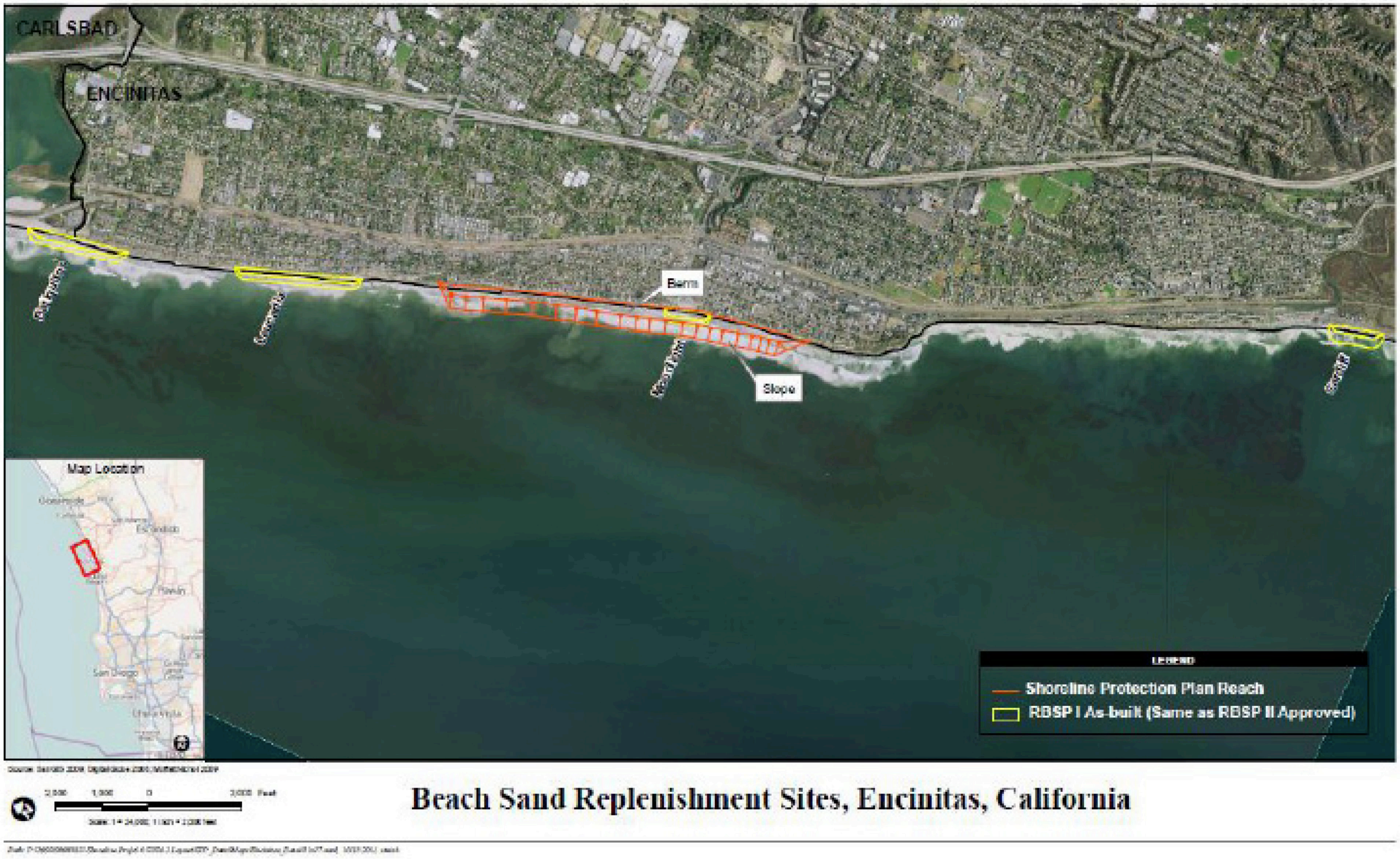

Figure 8.3-1 Encinitas Plan

Figure 8.3-2 Solana Beach Plan

Encinitas (EN)		Alternative EN - 1A: Beach Nourishment (100 ft; 5-yr cycle)	Alternative EN - 1B: Beach Nourishment (50 ft; 5-yr cycle)		Alternative EN-2A: Hybrid (100 ft; 10-yr cycle)	Alternative EN-2B: Hybrid (50 ft; 5-yr cycle)	Alternative EN -3: No Action
Initial Placement Volume (cy)	High SLR	730,000	390,000		800,000	390,000	Assumes that the continued practice of emergency permitting for seawalls along the segment would continue.
	Low SLR	680,000	340,000		700,000	340,000	
Re-Nourishment Cycle	High SLR	5-yr	5-yr		10-yr	5-yr	
	Low SLR	5-yr	5-yr		10-yr	5-yr	
Added Beach MSL Width	High SLR	100 ft	50 ft		100 ft	50 ft	
	Low SLR	100 ft	50 ft		100 ft	50 ft	
Solana Beach (SB)		**Alternative SB - 1A: Beach Nourishment (200 ft; 13-yr cycle)**	**Alternative SB - 1B: Beach Nourishment (150 ft; 10-yr cycle)**	**Alternative SB-1C: Beach Nourishment (100 ft; 10-yr cycle)**	**Alternative SB-2A: Hybrid (150 ft; 10-yr cycle)**	**Alternative SB-2B: Hybrid (100 ft; 10-yr cycle)**	**Alternative SB-3: No Action**
Initial Placement Volume (cy)	High SLR	1,620,000	790,000	540,000	790,000	540,000	Assumes that the continued practice of emergency permitting for seawalls along the segment would continue.
	Low SLR	960,000	700,000	440,000	700,000	440,000	
Re-Nourishment Cycle	High SLR	14-yr	10-yr	10-yr	10-yr	10-yr	
	Low LSR	13-yr	10-yr	10-yr	10-yr	10-yr	
Added Beach MSL Width	High SLR	300 ft	150 ft	100 ft	150 ft	100 ft	
	Low SLR	200 ft	150 ft	100 ft	150 ft	100 ft	

Table 8.3-1 Alternatives EN-1A and SB-1A constitute the NED Plan