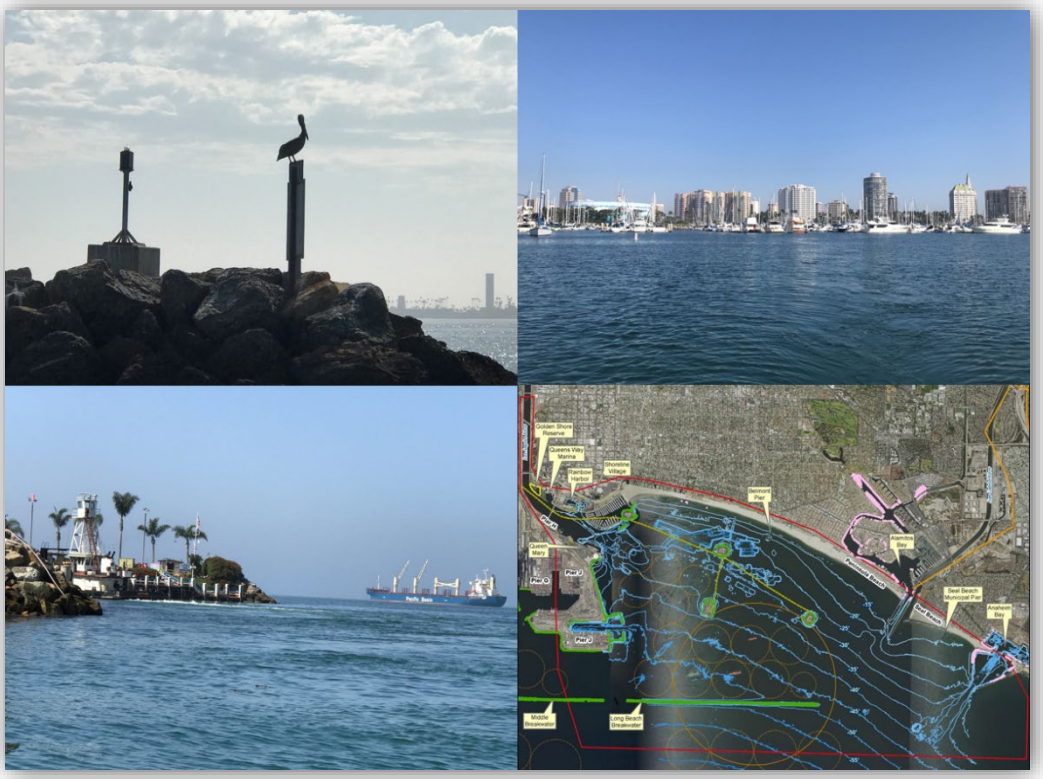
DRAFT INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT/ ENVIRONMENTAL IMPACT REPORT (EIS/EIR)

APPENDIX F: MONITORING AND ADAPTIVE MANAGEMENT PLAN

EAST SAN PEDRO BAY
ECOSYSTEM RESTORATION STUDY
Long Beach, California

November 2019



US Army Corps of Engineers ®

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1 INTRODUCTION

The U.S. Army Corps of Engineers, Los Angeles District (Corps) in partnership with the City of Long Beach (City), has developed plan alternatives for aquatic ecosystem restoration in East San Pedro Bay. This document outlines the feasibility level Monitoring and Adaptive Management Plan (MAMP) for the East San Pedro Bay Ecosystem Restoration Study (study) in Long Beach, California. This MAMP identifies and describes the monitoring and adaptive management activities proposed and estimates the costs and durations for each project alternative.

This MAMP reflects a level of detail consistent with the Draft Integrated Feasibility Report (IFR). The general purpose of the MAMP is to provide a systematic approach for improving resource management outcomes and a structured process for recommending decisions, with an emphasis on uncertainty about resources response to management actions and the value of reducing that uncertainty to improve management.

More specifically, this MAMP will establish:

- a framework for effective monitoring, assessment of monitoring data, and establishment of project performance standards in the areas of habitat restoration;
- a process for decision-making related to implementation of adaptive management activities in the project area;
- suggested adaptive management actions if the monitoring demonstrates that restoration measures are not achieving established performance standards; and
- estimated cost and duration of monitoring and adaptive management measures.

This plan will be reviewed and revised as needed during the Pre-construction, Engineering, and Design (PED) phase as specific design details are made available. It will adhere to requirements in the Implementation Guidance for Section 11616 of the Water Resources Development Act of 2016 (WRDA 2016), Completion of Ecosystem Restoration Projects, and apply the adaptive management guidelines provided in Fischenich and Vogt (2012).

1.1 STATUTORY BASIS FOR MONITORING AND ADAPTIVE MANAGEMENT

Section 1161 of WRDA 2016 amended Section 2039 of WRDA 2007 to specify information required to be included in monitoring plans for ecosystem restoration projects, and to direct when non-Federal operation and maintenance responsibilities of these projects may cease.

Section 2039 of WRDA (2007) directs the Secretary of the Army to ensure that, when conducting a feasibility study for a project (or component of a project) for ecosystem restoration, the recommended project includes a plan for monitoring the success of the ecosystem restoration. The monitoring plan must include a description of the types and number of restoration activities to be carried out, the physical actions to be undertaken to achieve project objectives, functions and values that will result from the restoration plan, monitoring activities to be carried out, criteria for ecosystem restoration success, estimated cost and duration of the monitoring, and a contingency plan (adaptive management plan) for taking corrective actions in cases in which monitoring demonstrates restoration measures are not achieving ecological success in accordance with criteria described in the monitoring plan. The monitoring plan will also specify that monitoring shall continue until such time as the Secretary determines success criteria are met. Monitoring within 10 years of completion of project construction is a cost shared project cost. Any additional monitoring beyond 10 years is a non-federal responsibility.

This MAMP includes all elements required by the Implementation Guidance for Section 1161 (Corps 2017) including:

- the parties responsible for carrying out the MAMP (Section 1.2);
- the rationale for monitoring (Section 2.1):
- the intended use of the monitoring data (Section 2.2);
- the monitoring of appropriate parameters and methodology (Section 2.3);
- the disposition of the information and analysis (Sections 2.4);
- documentation of habitat restoration success (Section 4.3);
- a project closeout plan (Section 4.4); and
- the cost of implementing the MAMP (Section 5.0).

1.2 ADAPTIVE MANAGEMENT TEAM

The MAMP provides the framework and guidance for an Adaptive Management Team (AMT) to review and assess monitoring results and consider and recommend adaptive management actions when ecological success is not achieved and decision criteria are triggered. The purpose of the AMT is for members to work together to make recommendations relevant to implementing the MAMP. The AMT should be composed of staff from the Corps, the City, and interested resource agencies. Although the Corps and City have coordinated with the entities that will compose the AMT in development of the Draft IFR, the AMT will be officially established during the PED phase.

The AMT will focus on the ecological function of the habitats through related management actions to maintain and provide functional marine habitat for general species and special status (threatened and endangered species) within the study area. The MAMP provides a monitoring plan and identifies triggers upon which an adaptive management action may be implemented. The AMT will review the monitoring results and advise on and recommend actions that are consistent with the project goals and reflect the current and future needs of the habitat and the species they support within the study area. Although the Corps will have final determination on all recommended adaptive management actions r. If these actions involve physical modification to the project, the cost must be agreed upon by the Sponsor.

The Corps will be responsible for ensuring that monitoring data and assessments are properly used in the adaptive management decision-making process. If the Corps determines that adaptive management actions are needed, it will coordinate with the AMT on implementation of those actions. The Corps will also be responsible for project documentation, reporting, and external communication.

Once the AMT is established, it will meet at a minimum of once per year, as scheduled by the Corps during the cost-shared monitoring period, to review the results of monitoring and assess whether study objectives are being met. If objectives are not being met, the AMT may recommend that adaptive management actions be taken in response to monitoring results as compared to decision-making triggers.

The AMT may also consider other related projects in the Southern California Bight in determining the appropriate adaptive management actions, and may consult with other recognized experts or stakeholders, as appropriate, to achieve project goals. Furthermore, any proposed changes to the adaptive management plan would need to be coordinated with and approved by Planning Corps Headquarters.

Recommendations for adaptive management should be based on monitoring data collected from current and previous years (including baseline site data). These data will inform the past and predicted response

by target species. In addition, current and potential threats to habitat establishment success can also inform appropriate adaptive management techniques or corrective actions.

1.2.1 TEAM STRUCTURE

The AMT will include representatives from the Corps, the City (non-Federal sponsor), and interested resource agencies.

1.2.1.1 U.S. ARMY CORPS OF ENGINEERS

The Corps may be represented by a Project Ecologist as well as a Project Hydrology and Hydraulics representative and a Project Geotechnical representative, as needed. Other Corps attendees may include the Project Manager, the Project Environmental Coordinator, and/or Operations and Maintenance designees, as needed.

1.2.1.2 CITY OF LONG BEACH

The City, as the non-Federal sponsor, would ultimately be responsible for all Operations, Maintenance, Repair, Replacement, and Rehabilitation activities once the Corps notifies the City of project completion. Prior to final project completion, the Corps will transfer responsibility for OMRRR of functional elements of the project to the City as they are completed. The City may be represented by a Project Engineering designee. Other City participants may include the City Manager, Director of Planning, City Engineer, Director of Public Works, or their designees.

1.2.1.3 RESOURCE AGENCIES

The AMT should also include representatives from resource agencies who would serve in an advisory capacity, to assist in evaluation of monitoring data and assessment of adaptive management needs. The agencies could include, upon their acceptance:

- U.S. Fish and Wildlife Service, Seal Beach Field Office
- California Department of Fish and Wildlife, South Coast Region 5
- California Regional Water Quality Control Board, Los Angeles Region
- United States Geological Survey, Western Ecological Research Center

Additional expertise may be provided by other entities and stakeholders with knowledge of the Southern California Bight ecosystem, hydrology, and wildlife species, at the discretion of the primary AMT participants.

1.3 PROJECT OBJECTIVES

In accordance with specific authorizations, prior reports, and collaborative interactions with the City and other stakeholders, the Corps has defined the study's primary restoration objective as follows: Restore six selected aquatic habitat types historically present in San Pedro Bay (kelp reef, rocky reef, eelgrass, oyster beds, sandy emergent islands, and coastal wetlands) to sufficient quality and quantity to support diverse resident and migratory species within the bay during the period of analysis.

The following sub-objectives have been identified to achieve the primary restoration objective:

a. Increase the extent (total area) of complex aquatic habitats within the study area.

b. Increase the complexity of aquatic habitat types and the diversity of organisms utilizing these habitat types within the study area.

c. Increase the overall connectivity of complex aquatic habitat types within the study area by facilitating movement of species between habitat nodes (to support and enhance existing food webs).

Meeting the requirements for these sub-objectives will improve aquatic ecosystem physical structure and function within the study area, increase biodiversity and/or biomass of associated species within these aquatic habitats, and enhance the ecosystem value of the Southern California Bight.

Expanded habitat areas that could support larger and more diverse populations of native species would further promote the sustainability and resiliency of restored ecosystems/habitats within the project area to sea level rise and coastal storm disturbance. Establishing multiple nodes of similar habitat types would provide further resiliency in the event that one is damaged or degraded.

1.4 RESTORATION ACTIONS

The project development team performed a thorough plan formulation process to identify potential management measures and restoration actions that address the project objectives. Many alternatives for habitat restoration in ESPB were considered, evaluated, and screened in producing a final array of alternatives. Three alternatives remain under consideration: Alternatives 2, 4A, and 8. Each alternative includes creation or enhancement of at least two of the six target habitats.

Although the Corps has identified Alternative 4A as the Tentatively Selected Plan, the MAMP provides monitoring and adaptive management information for all alternatives in the final array. Alternatives are described in detail in Chapter 4 of the Draft IFR and a brief summary is provided in this section.

1.4.1 ALTERNATIVE 2

Near Shore Rocky Reef and Eelgrass: Five nearshore eelgrass habitat restoration areas would be created with five associated nearshore rocky reefs (i.e., shoals). The eelgrass beds would total approximately 25 acres and associated rocky reefs would total approximately 16 acres. The establishment of eelgrass habitat would require building the rocky reefs and bringing in sand from a designated borrow site to create a bench behind the reef to support growth and expansion of eelgrass.

Kelp Reefs: A total of 24 kelp reefs would be created in two locations with the same species of kelp. Twelve kelp reefs would be located adjacent to the seaward side of the breakwater and twelve would be located in open water. Each reef location would total approximately 61 acres, for a total kelp reef area of 122 acres.

1.4.2 ALTERNATIVE 4A

Near Shore Rocky Reef and Eelgrass: Six eelgrass habitat restoration areas would be created with associated near-shore rocky reefs. The eelgrass beds would total approximately 30.3 acres and the associated rocky reefs would total approximately 20 acres. The establishment of eelgrass habitat would require building the rocky reefs and bringing in sand from a designated borrow site to create a bench behind the reef to support growth and expansion of eelgrass.

Kelp Reefs: A total of 24 kelp reefs would be created in two locations with the same species of kelp. Twelve kelp reefs would be located adjacent to the seaward side of the breakwater and twelve would be located in open water. Each reef location would total approximately 61 acres, for a total kelp reef area of 122 acres.

Open Water Rocky Reefs: Two rocky reef complexes would be created in the open water. Each complex would contain several individual reefs. Each reef complex would contain approximately 14.6 acres of reef, for a total of 29.2 acres.

1.4.3 ALTERNATIVE 8

Near Shore Rocky Reef and Eelgrass: Seven eelgrass habitat restoration areas would be created with six associated near-shore rocky reefs. The eelgrass beds would total approximately 52.3 acres and associated rocky reefs would total approximately 20 acres. The establishment of eelgrass habitat would require building the rocky reefs and bringing in sand from a designated borrow site to create a bench behind the reef to support growth and expansion of eelgrass.

Kelp Reefs: A total of 24 kelp reefs would be created in two locations with the same species of kelp. Twelve kelp reefs would be located adjacent to the seaward side of the breakwater and twelve would be located in open water. Each reef location would total approximately 61 acres, for a total kelp reef area of 122 acres.

Oyster Beds: Less than one acre (0.03 acre) of oyster beds would be created at the existing Alamitos Bay jetties.

Open Water Rocky Reefs: Seven rocky reef complexes would be created in the open water. Each complex would contain several individual reefs. Each complex would total approximately 14.6 acres, for a total of 102.2 acres.

Sandy Island: A 23.8-acre sandy island would be created.

Wetlands: Two wetland areas would be created, a 10-acre wetland near the Los Angeles River and a 42.1-acre wetland near Pier J.

2 MONITORING

An effective monitoring program measures project changes over time and determines if the outcomes are consistent with project goals and objectives. Consistent, well-designed monitoring is essential to adaptive management because it allows changes in site condition to guide ongoing maintenance activities and management strategies.

The following discussion outlines a monitoring plan that will support the East San Pedro Bay Ecosystem Restoration Study Adaptive Management Program. The plan identifies the monitoring period, performance targets, monitoring design, monitoring procedures, and results and analysis. Each performance measure includes specific feature(s) to be monitored to evaluate project performance. Additional monitoring is identified as supporting information needs that will help to further understand the interrelationships of restoration features and external environmental variability and to corroborate project effects.

Overall, monitoring results will be used to evaluate the progress of habitat restoration toward meeting project objectives and sub-objectives, and to inform the need for adaptive management actions to ensure successful restoration is achieved.

2.1 RATIONALE FOR MONITORING

An adaptive management plan should be closely integrated with a well-designed monitoring program that provides information to guide management decisions. In order to be effective, monitoring should be developed with the project objectives and performance standards in mind. It should focus on the target habitats and the hydrologic and geomorphic processes that support them; it needs to track changes over time and space at a resolution that is useful to the project; and it needs to be able to distinguish between ecosystem responses that result from project implementation (i.e., management actions) and natural ecosystem variability.

According to the Corps' implementation guidance memo for WRDA (Corps 2017),

> Monitoring includes the systemic collection and analysis of data that provides information necessary to determine if the project is meeting its performance standards and to determine when ecological success has been achieved or whether adaptive management measures are necessary to ensure that the project will attain project benefits.

2.2 MONITORING PERIOD

Upon completion of construction of each phase or feature of the East San Pedro Bay Ecosystem Restoration Project, cost-shared monitoring for ecological success and adaptive management will be initiated and will continue for a period of up to ten (10) years, depending on the restoration measure, until restoration success is achieved. The monitoring and adaptive management period requirement would vary based on the data needs of the site-specific monitoring programs to assess a particular measure. Concurrent monitoring of one or more nearby reference sites with similar conditions to the desired restored habitat is recommended to differentiate changes at the restoration site that are attributable to the restoration activity versus normal environmental variability affecting the region. Any monitoring that extends beyond ten (10) years will be a requirement and cost of the non-federal sponsor.

Although WRDA 2016 allows for up to ten years of cost-shared monitoring when necessary, this plan currently anticipates that five years of monitoring will be sufficient to achieve restoration success of each

feature. However, once the Secretary determines that ecological success for a feature has been f achieved, even if this occurs in less than five years, no further monitoring will be performed. If performance criteria for project objectives have not been met within the first five years, cost-shared monitoring and adaptive management would then continue within those areas until performance criteria are met or for a maximum of five additional years, whichever is less.

If the performance targets cannot be met within the ten-year period of cost-shared monitoring allowed by law, any additional monitoring and management will be a non-Federal responsibility. Monitoring Approach

This section describes the general approach to monitoring habitat condition of each habitat type being considered in the project alternatives. The desired outcome presented for each habitat describes target condition that would indicate successful restoration and satisfy project objectives. The performance measure for each habitat type is an approximate measurement of desired outcome. Specific interim performance standards (i.e., annual standards for each project year) should be defined prior to project initiation but are not fully outlined here.

2.2.1 HABITAT TYPE 1: KELP REEF (ALL ALTERNATIVES)

Desired Outcome: The desired outcome is to both increase the size and lateral extent of existing giant kelp beds and create new beds within the project area to a target size of five (5) acres that contain a medium-to-dense canopy at the water's surface during the peak annual growth period.

Performance Measure: Kelp must adhere to at least 50 percent of the initial rock placement area with medium-to-dense canopy on the water's surface (50–75 percent coverage) in each habitat node where kelp habitat is expected to occur (e.g., open water or breakwater zones).

Monitoring Procedures: Kelp reefs will be monitored quarterly during the performance period using true-color or multi-spectral aerial imagery taken from a small plane or drone. Methods and protocols will adhere to those provided in the Central Region Kelp Survey Consortium (CRKSC) which requires quarterly synoptic monitoring of kelp. The CRKSC was formed in 2003 and consists of various ocean dischargers that monitor kelp along the coast of the Southern California Bight. The images will be used to delineate and digitize the specific locations of the kelp and to measure both total lateral area (i.e., surface area of the water) that is covered by kelp and surface canopy density. Quarterly images will be used to capture seasonal maximums as well as variability during the year that may be due to project activities, disturbances, and/or seasonal variation.

A reference reef will also be imaged and measured during each monitoring period. The reference reef will be a disparate portion of the existing kelp coverage along the Long Beach Breakwater that will not be impacted by restoration activities (i.e., this reference site will be a kelp bed at the breakwater that is not contiguous with the bed to be expanded by the project)". Reference sites are areas that are physically and biologically similar to the area being restored (according to pre-determined characteristics) but that do not require restoration (Kennedy and Sanford, 1999; Beck et al., 2011; zu Ermgassen et al., 2012; Baggett et al., 2014). These sites provide a benchmark of how much progress is needed to achieve adequate restoration progress and help control for effects of broad scale natural disturbances when assessing restoration progress. The differences between the restoration project site(s) and the matched reference site(s) are expected to be relatively large before restoration and increasingly small after restoration.

Reference sites can also provide information on the effect of naturally occurring disturbances and expectation with respect to natural variability.

The rationale for requiring that the value of a resource be similar to that on natural reefs is based on the requirement that to be successful the restoration reef must provide the types and amounts of resources that occur on natural reefs. One way to help ensure that this will be the case is to select reference reefs that are close to and physically similar to the restoration reef. The premise here is that nearby reefs with similar physical characteristics should support similar biota, which should fluctuate similarly over time. Temporal variability, especially of the sort associated with changes in oceanographic conditions, can be accounted for more easily by sampling the experimental and natural reference reefs concurrently. Concurrent monitoring of the natural reefs will help ensure that regional changes in oceanographic conditions affecting the restored reef will be reflected in the performance criteria, because nearby natural reefs will be subjected to similar changes in oceanographic conditions. Although portions of the Long Beach breakwater are targeted for restoration by increasing the coverage of existing kelp, some areas of the breakwater will not receive additional rock and would be appropriate to serve as a reference site.

In addition to the quantitative monitoring, biological communities and reef production would be qualitatively monitored during Years 3 and 5 by underwater survey.

2.2.2 HABITAT TYPE 2: EELGRASS (ALL ATERNATIVES)

Desired outcome: The desired outcome is to increase the extent (acreage) of eelgrass within the nearshore zone by a minimum extent of 20 acres within the nearshore areas targeted for restoration

Performance Measure: Eelgrass covers at least 85 percent of the initial transplant area with the portion of vegetated cover at least 80 percent of that at the reference site(s).

Monitoring Procedures: The eelgrass beds will be monitored annually using a combination of field survey and visual or acoustic remote sensing methods (e.g., aerial imagery or side-scan sonar) consistent with the California Eelgrass Mitigation Policy and Implementing Guidelines (National Marine Fisheries Service 2014). Parameters that would be assessed are spatial distribution, areal extent, percent vegetated cover, and the turion (shoot) density. Other monitoring parameters would include qualitative assessment of localized wave action and water circulation patterns at restored bed sites. Monitoring will be conducted during the peak growing period for eelgrass, which is typically March through October for southern California. A reference population of established eelgrass within the nearshore zone of the study area will also be imaged and measured during each monitoring period. Adaptive management results will indicate if more than one reference site in an alternative location will be needed.

2.2.3 HABITAT TYPE 3: ROCKY REEF (ALL ALTERNATIVES; OPEN WATER ROCKY REEFS ONLY ALTERNATIVE 4A AND 8)

Desired outcome: The desired outcome is to increase the extent of submerged hard substrate within the study area where rocky reef habitat is expected to occur (e.g., nearshore and open water zones), by a minimum of 16 acre for Alternative 2, 49 acres for Alternative 4A or 122 acres for Alternative 8.

Performance Measure: The area of exposed rocky reef substrate is sustained at 90 to 100 percent of the implementation area.

Monitoring Procedures: The rocky reef will be monitored during Years 1, 3, and 5 using acoustic survey (e.g., side-scan or multi-bean sonar). The surface area of rocky reef will be digitized from the images to

provide estimates of total coverage. As a monitoring option, biological communities and reef production would be qualitatively monitored during Years 3 and 5 by underwater survey. In addition, underwater diver surveys of the kelp reef will be used to assess condition and inform corrective actions.

2.2.4 HABITAT TYPE 4: OYSTER REEF (ALTERNATIVE 8 ONLY)

Desired outcomes: To (1) establish and maintain moderate to high densities and size-frequency distributions of adult native oysters that meets the prescribed performance measure for these measures, and (2) measure an increase in the area and height of an oyster reef located within at least one zone in which restoration will take place (Los Angeles River estuary or nearshore zone) over two or more consecutive years during the performance period. The density of adult oysters at a site can serve as a cumulative indicator of performance and is a recommended universal metric to use for oyster restoration monitoring (Baggett et al. 2004).

Performance Measures: A moderate to high density of oysters within the oyster reef restoration area totals at least 66 adult native oysters per square yard (55 oysters per square meter). Also, to measure a positive (or neutral) change in reef height from year to year. A neutral change in reef height will indicate the reef is able to maintain its viability.

Water quality parameters will be also monitored to ensure that ambient water conditions remain conducive to oyster reef sustainability over time (within the appropriate ranges determined by the habitat model for oyster reefs). This will help to account for temporal variability associated with changes in oceanographic conditions, as well as sudden changes in water quality to anthropogenic reasons (e.g., oil spill or other type of contamination), that could affect the achievement of performance criteria and allow the AMT to identify contributors to success or lack thereof. Specific water quality parameters to be monitored will be established during final planning phases, but are expected to include a core set of physical water quality parameters (temperature, salinity, turbidity, and dissolved oxygen), two chemical water quality parameters (nutrients and toxins), and one biological parameter (benthic macroinvertebrates).

Monitoring Procedures: Reef area dimensions, reef height, and oyster density will be based on the methods in Baggett et al (2014). Oyster reef area is the actual area (summed) of patches of living and non-living oyster shell (or other construction material with and without live oysters. The edge of the oyster reef area is defined by a continuous line where the percent coverage of substrate (either living or non-living material remaining above the sediment) is equal or greater than 25 percent.

Reef area and height will be monitored during Years 1, 3 and 5 using acoustic methods (i.e., side-scan or multi-beam sonar). Adult oyster density and will be monitored annually by divers at the end of the growing season (late summer or early fall).

Ambient water quality parameters will be monitored in the area of the oyster reefs by either data logging instruments or regularly scheduled surveys.

Construction of oyster reefs in southern California is experimental, and few efforts have been completed to date (Zacherl 2018). While there are oyster bed restoration projects in Alamitos Bay and Newport Bay, there are no oyster reefs that could be used as reference sites for this project. For all metrics, sampling should be performed at the restoration site and a control and/or natural reference site in the year prior to construction, and during post-construction monitoring (Baggett et al. 2014).

2.2.5 HABITAT TYPE 5: SANDY ISLAND (ALTERNATIVE 8 ONLY)

Desired outcome: Restore at least five (5) acres of sandy islands resulting in the creation of stable and contiguous sandy shore habitat for shore birds and other terrestrial wildlife.

Performance Measures: The total area of sandy islands should cover at least five (5) acres without evidence of active area loss due to wave erosion and depletion. The islands must each contain less than ten percent cover of native vegetation considered suitable for target wildlife and less than one percent cover of non-native vegetation.

Monitoring Procedures: The sandy islands will be monitored annually using true-color aerial imaging. The images will be used to digitize the boundaries of the islands, identify changes in perimeters from year to year, and measure each island's area. The images will also be used to estimate total vegetation cover on the islands and identify potential problem areas (i.e., areas where vegetation impedes nesting bird mobility and needs to be removed).

Biologists will conduct qualitative vegetation surveys annually outside the breeding season to identify plant species that are present on the island. This information will be used to determine if measures are required to control non-native and/or non-target vegetation. Qualitative observations of sand movement, displacement, and erosion will be made during vegetation surveys to inform adaptive management and specific corrective actions.

2.2.6 HABITAT TYPE 6: COASTAL WETLAND (ALTERNATIVE 8 ONLY)

Desired outcome: The desired outcome is to double the amount of functioning coastal wetland currently established and add at least one new location within the study area. The restored areas must contain a complex of open water, mudflat, and emergent herbaceous vegetation that is adapted to saturated soil conditions.

Performance Measure: Due to the complex nature of the coastal wetland habitat type, final performance measures will be established during final planning phases. They will include, but not necessarily be limited to vegetation cover, species diversity, and overall quality of the habitat complexes (open water, mudflat, etc.); topography (surface elevations) and bathymetry (sub-marine depths); accretion/erosion of the inlet; abundance, density, and biomass of mudflat and subtidal invertebrates; sediment grain size distribution; and bird species composition and abundance.

Monitoring Procedures: The coastal wetland areas will be monitored annually using true-color or multi-spectral aerial photography during the peak growing season for wetland vegetation (April through June). The images will be used to digitize the boundaries of the habitat complexes (open water, mudflat, etc.) and measure the areas. Imagery will also be flown in the reference area located at Golden Shore Marine Reserve.

Topography and bathymetry will be determined by topographic survey and acoustic or lead-line surveys. Wetland tidal flushing will be affected by changes in size of the inlet. The cross-sectional area of the wetland inlet(s) will be calculated during each survey (during similar tidal heights) to monitor accretion/erosion.

Mudflat and subtidal invertebrates will be surveyed annually by core tubes and/or grab samples. Individuals will be screened on 1.0-millimeter mesh screens, and identified to the lowest practical taxon. Abundance, density, and biomass in each area will be reported. Sediment grain size samples will be

collected concurrently from the upper two centimeters at each station. Grain size distribution will be determined using standard sieves or laser light diffraction methods.

Wetland vegetation complexes will be surveyed annually to assess vegetation cover, species diversity, and assess the overall quality of wetland habitat. High quality wetland habitat will be characterized by healthy vegetation that increases in cover each year, limited cover by non-native species, and presence of species that are appropriate to the target community.

Bird species composition and abundance will be surveyed by biologists twice per year: once in winter and once in spring. Observations will be recorded every 30 minutes during each six-hour survey period, consistent with the survey methods at Golden Shore Marine Reserve (MBC 2003).

2.3 MONITORING PROCEDURES

This section provides additional detail about the monitoring procedures provided in Section 2.3.

Aerial Imagery: True-color and/or multi-spectral aerial imagery provide a visual assessment of the study area. True-color imagery captures light in the visible spectrum while multi-spectral imagery captures light both inside and outside of the visible spectrum. For the purposes of this project, aerial imagery should be captured from a small plane or drone. Images will be geo-referenced and ortho-rectified prior to delivery. Surface resolution of the images should be at least 0.5 foot (0.15 meter) in order to accurately assess the metrics being assessed. Commercially available satellite imagery may be used in lieu of (or in conjunction with) aerial imagery if the product meets the needs of the project.

Acoustic Surveys: Acoustic surveys use active remote sensing methods to provide a visual representation of objects and surface contours; it is effective technique for mapping bathymetry in underwater locations where light penetration is limited. Side-scan sonar is typically mounted to a submersible and multi-beam sonar is mounted to a ship on the surface of the waters. Monitoring methods for this project will be consistent with the California Eelgrass Mitigation Policy (National Marine Fisheries Service 2014).

Lead-line Surveys: Lead-line surveys can be used to measure bathymetry if acoustic surveys are not feasible. Lead-line surveys map bathymetry from the surface of the water by dropping a weighted line that measures depth at precise locations.

Oyster Density and Size-frequency: Oyster surveys will be conducted annually within the oyster reef habitat using quadrats or band transects that are established using a random or stratified random sample design. Live oyster density is a count of live oysters, including recruits, per unit area. Oyster size-frequency distributions will be recorded during surveys. Measurements of the shell height (the distance from the umbo to the distal margin of the shell) will be obtained from samples taken during surveys. Oyster samples collected from the reef should be returned to the reef when measurements are completed in order to minimize impacts to the reef and to future sampling efforts.

Water Quality: Water quality will be monitored in the area of the oyster reefs by either data logging instruments or regularly scheduled surveys. Data loggers would be placed at strategic locations throughout the study area and, if possible, relay information remotely so that information can be viewed in real-time. If data loggers are not possible, water quality data would be collected by teams on site for routine monitoring. At a minimum, water quality parameters that will be monitored include temperature, salinity, turbidity, and dissolved oxygen, all of which can be collected on-site using a handheld meter. Other recommended parameters include nutrients, toxins, and benthic macroinvertebrates, all of which will require that water samples be taken from the site and sent to a laboratory for analysis.

Vegetation Cover: Vegetation cover will be assessed annually during the peak of growing season, and will consist of permanent field monitoring plots along one or more transects. Plots will be selected within each habitat type and the distance between plots and along transects will be dependent on the project site area and variability. At a minimum, monitoring will provide percent cover of native and non-native plant species. Species composition and cover of each species will be recorded where diversity and composition data are necessary.

Vegetation Composition: Vegetation composition is a qualitative monitoring assessment that will be conducted by biologists as-needed to provide an overview of plant species that are present. If applicable, approximate cover or relative dominance of each species will be recorded. This information will be used to determine if measures are required to control non-native and/or non-target vegetation.

Vegetation Quality: Vegetation quality is a qualitative monitoring assessment that will be conducted by biologists as-needed to provide an overview of condition of the habitat as a whole. The assessment will include observations such as fitness and health of plantings, native plant species recruitment, and signs of stress. Additionally, potential soil erosion, flood damage, vandalism and intrusion, trampling, and pest problems would be qualitatively identified.

Avian Wildlife: Bird species composition and abundance will be surveyed by biologists twice per year: once in winter and once in spring. Observations will be recorded every 30 minutes during each six-hour survey period, consistent with the survey methods at Golden Shore Marine Reserve (MBC 2003).

Wildlife Surveys: A general inventory of all wildlife species observed and detected using the study area would be documented annually in coordination with vegetation monitoring. During the general inventory, station counts will be conducted for sensitive and target species including least tern, least Bell's vireo, yellow-breasted chat, and yellow warbler. Amphibian surveys may also be performed using station counts, fence arrays or pit fall traps. Presence of non-native and nuisance wildlife species will be noted.

Marine Invertebrates: Presence, density, and species composition of mudflat and subtidal invertebrates will be surveyed by excavating core tubes from soft-bottom habitats and/or grab samples from target habitats.

2.4 RESULTS AND ANALYSIS

The results of the monitoring will be provided to the AMT who will compare data to project objectives and decision-making triggers to evaluate whether the habitat restoration features are functioning as planned. The AMT will use the monitoring results to assess habitat responses to management actions, evaluate overall performance, and make recommendations as appropriate. If monitoring results show that objectives are not being met, the AMT will evaluate causes of failure and recommend adaptive management alternatives to remedy the underlying problems.

As data is gathered through monitoring, more information will be available to address uncertainties and fill information gaps. Uncertainties such as effective operational regimes, benefits generated by restored features, and accuracy of hydrologic models can be evaluated to inform adaptive management actions and future restoration needs.

3 ADAPTIVE MANAGEMENT

Adaptive management planning is a critical component of successful habitat restoration. It provides a framework for actions that will be undertaken to achieve the project objectives if the project is not performing to standards. This section outlines the adaptive management planning framework, identifies triggers for implementation, and lists sources of uncertainty that may impact the need for adaptive management actions.

The level of detail provided is based on currently available data and information developed during plan formulation as part of the Draft IFR. Uncertainties may remain concerning the exact project features, monitoring elements, and adaptive management opportunities. Uncertainties will be addressed in the PED phase, and the MAMP may be amended to incorporate additional detail as part of that phase.

3.1 RATIONALE FOR ADAPTIVE MANAGEMENT

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes given the identified uncertainties and unknown factors that may influence the outcome of project success. Given these uncertainties and unknown factors, adaptive management provides an organized, coherent, and documented process that suggests management actions in relation to measured project performance compared to study objectives and outcomes. The adaptive management program utilizes the results of continued monitoring to manage restoration actions in order to achieve the study objectives. Adaptive management establishes the critical feedback of information from project monitoring to inform project management and promote learning through reduced uncertainty.

The objectives of the monitoring and adaptive management program are to ensure successful habitat establishment, document maintenance and monitoring efforts, and evaluate the progress of restoration towards performance standards. Implementation of the MAMP would provide flexibility to account for changing environmental conditions. Data collected through monitoring would allow project success to be measured, though it will not alleviate all uncertainty. The MAMP provides a mechanism to evaluate the effectiveness of the restoration implemented and to implement adaptive changes, if required to realize study objectives.

3.2 SOURCES OF UNCERTAINTY

Adaptive management provides a coherent process for making decisions in the face of uncertainty. Scientific uncertainties and technological challenges are inherent with any large-scale ecosystem restoration project. Uncertainties associated with restoration of aquatic habitats within the project area include:

- correct engineering and design to fully address project objectives;
- future operation and maintenance regime required to maintain project objectives;
- ability of hydrologic models to predict project impacts and benefits;
- future availability of freshwater for restored terrestrial habitat (sandy island) due to extreme drought or other climate change issues;
- climate change variability, such as storm frequency, intensity, and timing;
- climate change effects in redistributing sand placed as part of the project;
- the long-term fate of placed material;

- projected recovery time and recruitment for benthic invertebrates; and
- other factors which are not completely within the Corps' or City's ability to predict or prevent, such as extreme weather conditions, vandalism, watershed changes, or storm surge events that may occur before the restored habitat has fully established.

Uncertainties may remain concerning specific project features, monitoring elements, and adaptive management opportunities.

3.3 DECISION MAKING PROCESS

The information generated by the monitoring program will be used by the Corps and City in consultation with the other AMT members to guide decisions on adaptive management actions that may be needed to ensure that the ecosystem restoration project achieves success. Final decisions on implementation of adaptive management actions are made by the Corps.

3.4 ADAPTIVE MANAGEMENT TRIGGERS

The adaptive management trigger is a threshold value that is used to determine whether or not corrective action is needed. It can be qualitative or quantitative and should be based on project performance standards, overall performance measures, and the level of information required to assess condition.

If results of the monitoring are poor and trigger adaptive management action, the Corps would consult with the AMT to discuss which adaptive management action is warranted. Further monitoring may be required to determine the cause of system stress and/or project failure in order to choose the appropriate adaptive management action.

3.5 ADAPTIVE MANAGEMENT ACTIONS

Adaptive management measures will be based on the results of qualitative and quantitative monitoring data. Achieving the key objectives and goals of the restoration program and establishing self-sustaining target habitats will be the focus of all adaptive management decisions.

Initial decision criteria are identified below, based on project objectives and performance measures. More specific decision criteria, based on other parameters such as hydrology, geomorphology, and vegetation dynamics will be developed during the PED phase of the project.

3.5.1 HABITAT TYPE 1: KELP REEF

Adaptive Management Trigger: Adaptive measures will be implemented if the study area is not on track to meet project goals and if reasons cannot be explained by environmental factors (i.e., are not observed in the reference area). Specifically, adaptive measures will be implemented if after three years the cover of kelp reef is less than 50 percent of the initial rock placement area with canopy density less than 50 percent, and if coverage of the reference site is greater than 50 percent of its three-year average.

Adaptive Management Tasks: Monitoring results will inform adaptive strategies or corrective actions to achieve performance criteria which will increase the resilience of kelp forest ecosystems to the stressors associated with urban environments (e.g. overfishing, sedimentation and runoff events) and global phenomena which may be associated with climate change (e.g. frequency of ENSO and large storm events).. Corrective actions may include extension of reef area, planting of additional plant matter, removal of kelp nuisance species, and/or repair of existing reef substrate.

3.5.2 HABITAT TYPE 2: EELGRASS

Adaptive Management Trigger: Adaptive measures will be implemented if the study area is not on track to meet project goals and if reasons cannot be explained by environmental factors (i.e., are not observed the reference area). Specifically, adaptive measures will be implemented if (1) after three (3) years eelgrass covers less than 85 percent of the initial transplant area, and/or (2) if the portion of vegetated cover within the eelgrass beds is less than or equal to 50 percent relative to the reference site(s).

Adaptive Management Tasks: These could include activities such as (1) remedial transplanting within the restoration eelgrass bed will be conducted in order to increase vegetative cover and survival, (2) addition of sand of or other unconsolidated material to maintain appropriate bathymetry and depth profiles, or (3) addition of material to rocky shoals if wave or circulation patterns are determined to be inhibiting eelgrass establishment and/or growth If none of these techniques are demonstrated to be successful, relocation of the restoration activities may be considered.

3.5.3 HABITAT TYPE 3: ROCKY REEF

Adaptive Management Trigger: Adaptive measures will be implemented if the area of exposed rocky reef substrate in any habitat node is less than 90 percent of the desired outcome during any survey year.

Adaptive Management Tasks: These could include activities such as (1) placement of additional hard substrate, 2) re-positioning of existing hard substrate to increase/decrease interstitial spacing, and (3) removal of nuisance species.

3.5.4 HABITAT TYPE 4: OYSTER REEF

Adaptive Management Trigger: Adaptive measures will be implemented if densities of oysters are less than 50 percent of the target densities during any two consecutive years of survey.

Adaptive Management Tasks: These could include activities such as: 1) transplanting oysters from a source location and/or add oyster shell material to enhance seeding, especially during initial establishment phase of project. If oyster shell material is limited, consider using a similar type of shell that is available in the immediate area (e.g., mussel shell), 2) removal of nuisance species, and 3) re-positioning of entire oyster reef structure.

3.5.5 HABITAT TYPE 5: SANDY ISLAND

Adaptive Management Trigger: Adaptive measures will be implemented if island size is less than 90 percent of target size during any survey.

Adaptive Management Tasks: Place additional sand on or around the island, outside of the breeding season, and/or conduct remedial actions to minimize sand loss and erosion.

3.5.6 HABITAT TYPE 6: COASTAL WETLAND

Adaptive Management Trigger: Adaptive measures will be implemented if any of the following observations are made during monitoring:

1. Aerial monitoring shows low representation (less than 80 percent of target area) by any of the target habitat complexes or any of the habitat complexes are trending toward low representation.
2. Topographic and/or bathymetric monitoring shows elevations that are not suitable for the target habitat complexes or are exhibiting signs of excessive accretion or erosion.
3. Mudflat and subtidal invertebrates are not present, are present in very low numbers, or show

dramatic reduction in population size.

4. Non-native plant species cover is above five (5) percent in any habitat complex.
5. Consistent observation of any non-native species rated as invasive, noxious, or otherwise threatening to the success of the project is detected within or directly adjacent to the study area. The species would need to be observed at least once during each monitoring cycle or site visit.
6. Vegetation is not suitable for or is shifting away from the target habitat complex.

Adaptive Management Tasks: Adaptive measures may include, but are not limited to, 1) re-contouring to improve surface hydrology, 2) installing additional plant or seed material, or 3) translocating invertebrates into mudflats and subtidal zones. Monitoring (as described above for coastal wetlands) would inform which of these measures would be most effective for long-term restoration success.

4 ASSESSMENT OF PERFORMANCE

The assessment phase of the adaptive management framework describes the process by which the results of the monitoring efforts are compared to the project performance measures to identify whether or not the restoration actions have successfully fulfilled project objectives.

The results of the East San Pedro Bay monitoring program will be assessed annually through the AMT. Monitoring results will be compared to the desired project outcomes as set forth by the project performance measures. This assessment process will measure the progress of the project in relation to the stated project objectives. The AMT will compare monitoring results to decision-making triggers to evaluate project effectiveness and consider if adaptive management actions are needed.

The assessments will indicate if the habitat responses to management actions are undesirable (e.g., are moving away from restoration goals) or if the responses have met the success criteria for the project. Assessments will also inform the AMT if other factors are influencing the response that may warrant further research.

4.1 DATABASE MANAGEMENT

Database management is an important component of the monitoring plan and the overall adaptive management program. As part of the AMT, individuals with responsibility for data management activities in support of an adaptive management program (data managers) will be identified by the Corps. The data managers should collaborate with the AMT in developing a data management plan to support the adaptive management program. The data management plan should describe how and where data will be archived, data standards, data upload process and format, quality assurance and quality control procedures, metadata standards, and public data release. Storage of all data will be handled by the Corps.

Data analysis and reporting will be the responsibility of the Corps, who will provide reports for the AMT to facilitate evaluation of adaptive management needs.

4.2 DOCUMENTATION AND REPORTING

The Corps will document the monitoring results, assessments, and the results of the AMT deliberations. The Corps will produce annual reports that will measure progress towards meeting project objectives as characterized by the performance measures. Results of assessments will be used to evaluate adaptive management needs and inform decision-making.

4.3 PERFORMANCE STANDARDS

Performance standards are specific, usually quantitative performance measures used to assess project performance and the trajectory of ecological progress. They are often provided for each year of the project to ensure the project is on track to reach success by the end of the restoration maintenance and monitoring period. Ultimately, performance standards will be used to help determine when ecological success has been achieved and determine whether monitoring may cease prior to the end of the 10-year post-construction monitoring period. For this project, final and interim performance standards will be developed for each habitat type using the performance measures provided in Section 2.0 of this Plan.

4.4 CONCLUSION OF MONITORING FOR PROJECT FEATURES

Ecological success of a project feature will be confirmed when desired outcomes have been achieved, as measured by meeting or exceeding the 5-year or 10-year achievement thresholds. Once ecological success

has been documented by the District Engineer in consultation with the Federal and State resources agencies, and a determination has been made by the Division Commander that ecological success has been achieved; no further monitoring will be required specifically for adaptive management. The City will still monitor features following protocols and timelines established for routine maintenance. Ecological success will be documented through an evaluation of the predicted outcomes as measured against the actual results.

When monitoring has shown that project objectives and performance standards have been met, regular inspection and maintenance by the City would occur over the 50-year life of the project.

5 COSTS FOR IMPLEMENTATION OF MONITORING AND ADAPTIVE MANAGEMENT PROGRAMS

The costs associated with implementing the monitoring and adaptive management plan were estimated based on currently available data, methods, and comparable projects. The monitoring methods and potential adaptive management actions as described in this Plan were used as a basis for cost estimating. Because uncertainties remain as to detailed designs and adaptive management needs and opportunities, the costs estimated here will be refined in PED during the finalization of the detailed monitoring and adaptive management plans for each habitat type that is implemented.

5.1 MONITORING AND ADAPTIVE MANAGEMENT PROGRAM COSTS

Cost calculations for monitoring are displayed as a total cost including all labor and expenses. If ecological success is determined earlier than planned, some portions of the monitoring program will end early and costs will decrease accordingly. Costs for the adaptive management program are based on estimated levels of effort and potential frequency of need, and include participation in the AMT and reporting. The current total estimate for implementing the monitoring and adaptive management plan described in Sections 2.0 and 3.0 for each alternative are as follows: approximately $1.54 million for Alternative 2; approximately 2.07 million for Alternative 4A; and, approximately $3.25 million for Alternative 8.

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