WETLAND HABITAT AND HYDROLOGY MONITORING PLAN
FOR THE
SAN ELIJO LAGOON RESTORATION PROJECT

Prepared for:

Nature Collective

Prepared by:

AECOM
Nordby Biological Consulting
and
Moffatt & Nichol

In Collaboration with
Nature Collective

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LIST OF ACRONYMS AND ABBREVIATIONS

AA	assessment area
ADCP	Acoustic Doppler Current Profiler
AOU	American Ornithologists' Union
CAD	computer-aided design
Caltrans	California Department of Transportation
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
cm	centimeter(s)
CNPS	California Native Plant Society
Corps	U.S. Army Corps of Engineers
CRAM	California Rapid Assessment Method
CWA	Clean Water Act
CWMW	California Wetlands Monitoring Workgroup
DEM	Digital Elevation Model
ES	effect size
FEMA	Federal Emergency Management Agency
fps	feet per second
GIS	geographic information system
GPS	global positioning system
I-5	Interstate 5
LTMP	Long-Term Management Plan
m	meter(s)
m^2	square meter(s)
M&N	Moffatt & Nichol
mm	millimeter(s)
NAD 83	North American Datum of 1983
NAVD	North American Vertical Datum
NAVD88	North American Vertical Datum of 1988
NCTD	North County Transit District
NDVI	Normalized Difference Vegetation Index
NIR	Near Infrared
PEP	plant establishment period
ppm	parts per million
RTK GPS	real time kinematic global positioning system
RWQCB	Regional Water Quality Control Board
SELRP	San Elijo Lagoon Restoration Project
TIF	tidal inundation frequency
TKN	Total Kjendahl Nitrogen

TN	Total Nitrogen
TOC	Total Organic Carbon
UAV	Unmanned Aerial Vehicle
UCSB	University of California, Santa Barbara
USFWS	U.S. Fish and Wildlife Service

1. INTRODUCTION

The San Elijo Lagoon Restoration Project (SELRP) seeks to restore tidal influence to San Elijo Lagoon and enhance freshwater fluvial flows out of the lagoon. This will, in turn, enhance the physical and biological functions that have been degraded over the years. The SELRP has modified the channels and habitats throughout the 960-acre lagoon (Figures 1-1 and 1-2), which is owned and managed by the California Department of Fish and Wildlife (CDFW), County of San Diego Parks and Recreation Department, and Nature Collective (formerly the San Elijo Lagoon Conservancy). These modifications are expected to improve lagoon habitats that support sensitive coastal wetland plant and animal species. Restoration activities within each of the three lagoon basins (i.e., west basin between Coast Highway 101 and North County Transit District [NCTD] tracks; central basin between NCTD tracks and Interstate-5 [I-5]; east basin east of I-5) have been completed sooner than the anticipated 3-year timeline.

The SELRP is being implemented by Nature Collective and the California Department of Transportation (Caltrans) as identified in the Public Works Plan/Transportation and Resource Enhancement Program to address comprehensive, system-wide infrastructure improvements in the north coast corridor of San Diego County.

1.1 PROJECT COMPONENTS

The components of the SELRP included restoration of San Elijo Lagoon as well as placement of dredged material from the lagoon onto nearby beaches (i.e., Cardiff State Beach and Fletcher Cove). Offshore disposal of dredged materials was proposed at a nearby placement site, referred to as SO-6, used for prior regional beach nourishment projects but was ultimately not implemented as part of the overall project. Restoration focused on enhancing and expanding the existing channel network, with the exception of the overdredge pit area and a main channel connection in the central basin, to minimize impacts to existing habitat in the lagoon.

Several on-site features utilized for material disposal are unique to the SELRP, including an overdredge pit, transitional areas, nesting sites, and mounds, which are described herein. The overdredge pit is located in the central basin and has provided on-site disposal of fine material removed from cuts throughout the lagoon basins, primarily through hydraulic dredging of channels. Additional on-site disposal opportunities also focused on areas that were already disturbed and/or at higher elevation within the lagoon. Reuse of dredged material was incorporated into two transitional areas (central and east basins) and within the nesting area (central basin). Transitional areas augmented existing higher elevation areas such as the former CDFW dike in the east basin to provide additional refugia to species under future sea level rise conditions. The nesting site area was created within the footprint of a former sewage settling pond and capped with sandy

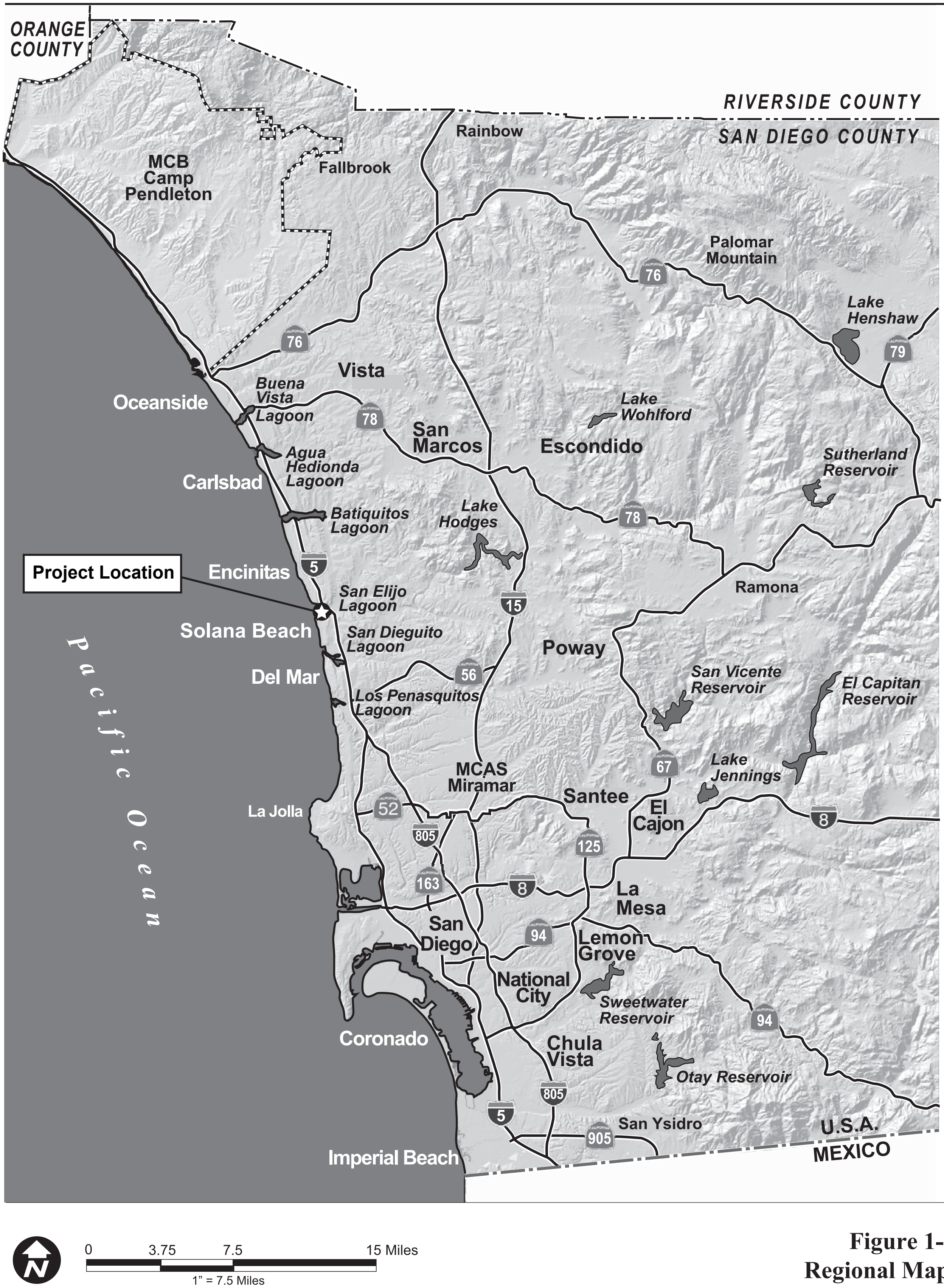
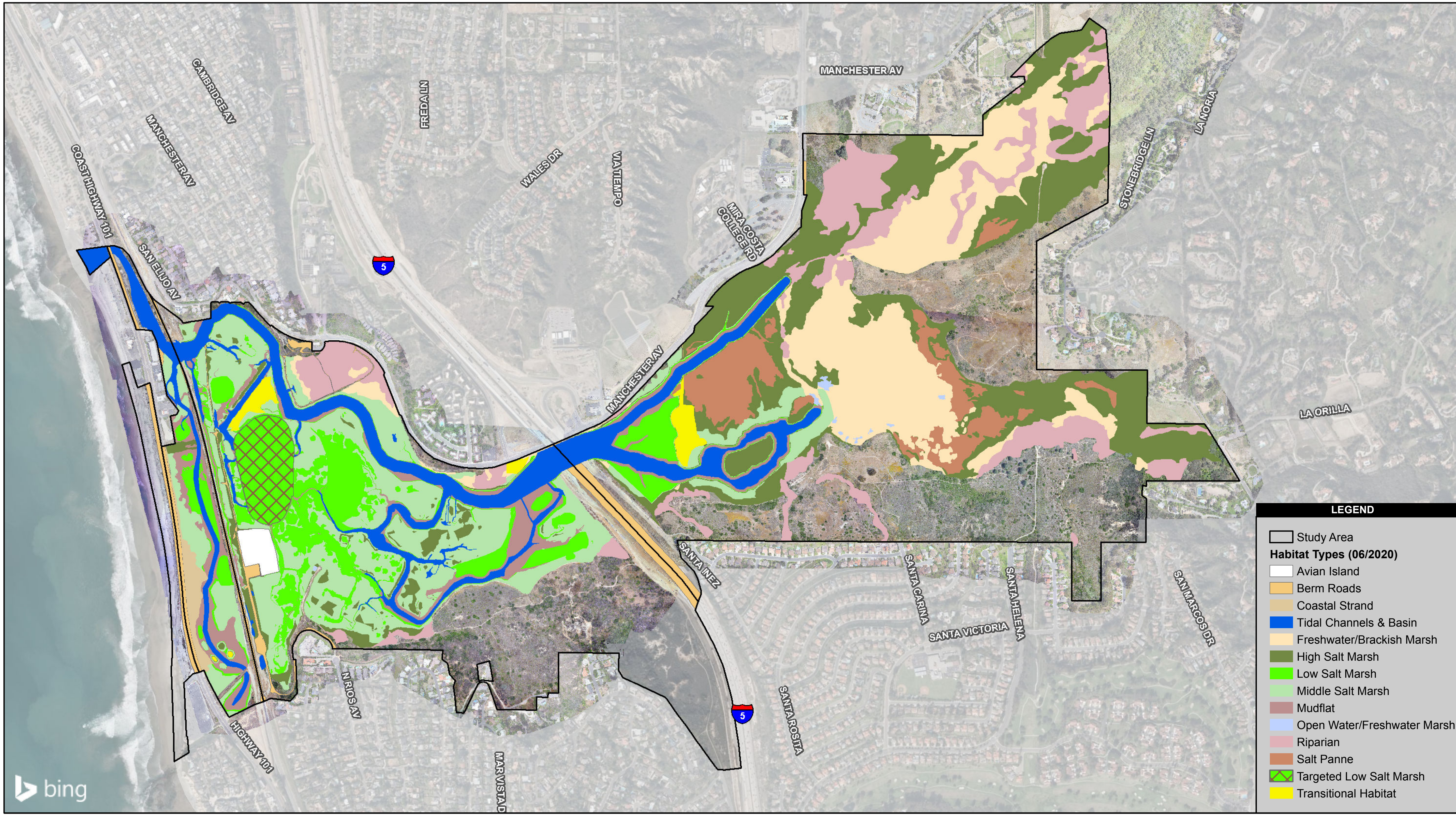


Figure 1-1
Regional Map

P:\2009\09080064_SELRP_EIR\5.0 Graphics (Non-CAD)\5.4 Proj_Graphics\Figures\Fig1 rmap.ai dbrady 1/9/14



Source: SANDAG 2012; Moffatt & Nichol 2020; AECOM.

1,100 550 0 1,100 Feet

Scale: 1:13,200; 1 inch = 1,100 feet

Figure 1-2
Proposed Habitat Distribution

Path: P:_6058\60582908_SELRP_ConPh2\900-CAD-GIS\920 GIS\map_docs\mxd\Report\HMMP\Proposed Habitat Distribution_July2020.mxd, 7/24/2020, paul.moreno

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material. Mounds were constructed in the southern end of the west basin by side-casting material to create areas of varying elevation. Recreational trail improvements were also included in the project design, including the construction of two pedestrian bridges that connect trails to the Nature Center in the central basin.

1.2 PURPOSE

The purpose of this Wetland Habitat and Hydrology Monitoring Plan (Plan) is to describe the pre-construction, construction, and post-construction monitoring of physical and biological variables that will be used to determine success of the SELRP. Other monitoring has been conducted for the project but is not addressed in this Plan (e.g., construction compliance). This Plan was developed in compliance with the requirements set forth in relevant conditions within project permits and approvals provided by the California Coastal Commission (CCC), U.S. Army Corps of Engineers (Corps), U.S. Fish and Wildlife Service (USFWS), and Regional Water Quality Control Board (RWQCB), including:

- CCC: Coastal Development Permit (#6-16-0275-A1) – Special Condition #1
- Corps: Clean Water Act (CWA) Section 404 Permit (#SPL-2009-00575-MG) – Special Conditions #6, #7, and #36
- USFWS: Biological Opinion for the SELRP (FWS-SDG-09B0046-17F0616) – Conservation Measures #8 and #23
- RWQCB: CWA Section 401 Certification (#R9-2016-0111) – Monitoring Requirement I

This Plan identifies monitoring methods and performance standards to assess project success. It is intended to cover the first 10 years post-construction or until success criteria are met. Once success criteria have been met, monitoring frequency will be reevaluated and may be reduced.

Following completion of this first phase of monitoring, a Long-Term Management Plan (LTMP) will be implemented for the life of the project, defined as a minimum of 50 years. Therefore, the LTMP will detail monitoring methodology for an approximate 40-year period, given it will be implemented after project success criteria are met, which is anticipated to occur within the first 10 years of monitoring. Information gathered during implementation of this Plan will be used to inform the LTMP.

This Plan focuses on the lagoon, defined as the tidal inlet (at the west end) to the eastern boundary of the east basin. The project also included materials placement on nearby beaches. The primary source of material for placement was sand excavated from within the lagoon. Due to the relatively discrete boundary and resource concerns, as well as the different timeline (placement was completed in July 2018), monitoring for marine resources is addressed in a separate Marine

Ecosystem Monitoring, Adaptive Management, and Mitigation Plan (Merkel & Associates 2018). Monitoring of the shoreline and nearshore marine habitats is being conducted as identified in that monitoring plan prepared as a stand-alone document. In addition, monitoring related to construction compliance, such as environmental impact avoidance and minimization measures, is not discussed in this Plan.

1.3 MONITORING PLAN FRAMEWORK

This Plan has been designed and organized around 13 broad physical and biological variables in order to measure the success of the SELRP, consistent with approval conditions of the CCC Coastal Development Permit. Some of these variables are also monitoring requirements of the USFWS Biological Opinion. In addition to these variables, this Plan also describes wetland function monitoring being conducted to satisfy approval conditions of the RWQCB CWA Section 401 Certification, as well as eelgrass and *Caulerpa* monitoring being conducted to satisfy Corps CWA Section 404 Permit and the USFWS Biological Opinion conditions. The chapters herein describe the metrics that will be used to monitor each variable. Variables associated with each agency requirement to be monitored include the following:

- Physical – CCC
    - Topography
    - Bathymetry
    - Tidal Elevation
    - Water Quality
    - Sediments
- Biological – CCC
    - Habitat Areas
    - Vegetation (also USFWS)
    - Benthic Invertebrates
    - Fish
    - Birds
- Wetland Function – RWQCB
- Eelgrass – Corps
- *Caulerpa* – Corps/USFWS

The analytical approach for variables and process for determining overall project success are described in Chapter 2. Each of the 13 broad physical and biological variables is discussed in Chapters 3 through 15. The discussion for the variables in each of the chapters is divided into two sections: methods and performance standards. The methods section first describes “how” data will be collected and then discusses “when” data will be collected. The performance standard section describes how a variable can meet its performance standard in a given year.

1.4 LONG-TERM MONITORING AND MANAGEMENT PLAN

An LTMP shall be developed in consultation with the CCC and appropriate resource agencies to provide an overall framework to guide long-term future conditions in the lagoon in anticipation of future sea level rise and climatic or other changes that may impact the lagoon and its ecology. The LTMP shall include documentation of sea level rise, sediment dynamics, and overall health of San Elijo Lagoon to allow for adaptive management, as needed. The LTMP will be implemented after performance standards are met and shall include triggers for implementing adaptive management options as appropriate, including if sea level rise is found to outpace current projections over the life of the project.

The LTMP will be developed following the first 5 years post-construction and completed prior to the end of the initial post-construction monitoring period defined in this Plan. Data collected during the first 5 years will provide information that will be used to refine monitoring methods for the long-term post-construction monitoring. After this time period, variables will have been monitored and compared to performance standards, which will provide valuable data and lessons learned that can be used to develop the LTMP.

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2. ANALYTICAL APPROACH AND REPORTING

Each variable to be monitored within the lagoon will be evaluated against specific performance standards. Success of the SELRP will be contingent on meeting performance standards of the aforementioned 13 broad-level variables. The performance standards generally fall into two categories: relative or absolute. The discussion herein describes each standard and the analytical framework for each as well as the process for determining overall project success. Additional detail is provided as needed within individual chapters in this report.

2.1 RELATIVE PERFORMANCE STANDARDS

Relative performance standards are used when the variables being measured will be compared to similar information being collected at reference wetlands within the region. Relative performance standards are being used to meet the requirements of the CCC Coastal Development Permit. The SELRP approach to relative performance standards will be based on the monitoring program developed for the San Dieguito Lagoon Restoration Project. The key source of information for reference wetlands that will be used for relative standards identified in this Plan are the data being collected by the University of California, Santa Barbara (UCSB) biologists under contract to the CCC for monitoring the success of the San Dieguito Lagoon Restoration Project. Where applicable, monitoring at San Elijo Lagoon uses consistent methodologies for comparison of data to reference wetlands, including Mugu Lagoon, Carpinteria Salt Marsh, and Tijuana Estuary. These reference wetlands are generally regarded as acceptable lagoons for which success of a restoration lagoon project can be gauged.

Relative Performance Standards for the SELRP are summarized in Table 2-1 and include the following:

***Spartina* Canopy Architecture**. The restored wetland shall have a canopy architecture that is similar in distribution to the reference sites, with an equivalent proportion of stems over 3 feet tall (see Section 7.2 for details).

Water Quality. Water quality variables shall be similar to reference wetlands (see Chapter 8 for details).

Benthic Invertebrates. The total densities and number of species of macro-invertebrates shall be similar to the densities and number of species in similar habitats in the reference wetlands (see Chapter 9 for details).

Fish. The total densities and number of species of fish shall be similar to the densities and number of species in similar habitats in the reference wetlands. Metrics will be analyzed separately for main channels versus tidal creeks (see Chapter 11 for details).

2.1.1 Reference Wetlands

The SELRP follows the rationale outlined in the San Dieguito Wetlands Restoration Project for using reference wetlands. Discussion regarding reference wetlands from the San Dieguito Wetlands Restoration Project (Page et al. 2018a) is reiterated herein for context. The rationale for requiring that the value of a resource in the restored wetland be similar to that in reference wetlands is based on the belief that, to be successful, the restored wetland must provide the types and amounts of resources that occur in comparable natural wetlands in the region. Resources in natural wetlands, however, vary in space and time. Differences in physical characteristics of a wetland (e.g., soil, topography, flood regime, and/or tidal hydrology) can cause plant and animal assemblages to differ greatly among tidal wetlands while seasonal and inter-annual differences in weather, nutrient loading, and oceanographic conditions can cause the biological assemblages within tidal wetlands to fluctuate over time. Thus, comparison with reference wetlands must account for this variability.

Ideally, the biological assemblages in a successfully restored wetland should vary in a manner similar to those in the natural wetlands used for reference. Temporal variability, especially of the sort associated with weather (e.g., air temperature or rainfall) or oceanographic conditions (e.g., swell height or water temperature), can be accounted for by sampling the restored and natural reference wetlands concurrently. Concurrent monitoring of the restored and natural wetlands will help ensure that regional changes in weather and oceanographic conditions affecting the restored wetland will be reflected in the performance standards, since nearby reference wetlands will be subjected to similar conditions.

The Coastal Development Permit requires that the wetlands chosen for reference be relatively undisturbed, natural tidal wetlands within the Southern California Bight (i.e., from Point Conception to the United States/Mexico border). Relatively undisturbed wetlands have minimal human disturbance to habitats (e.g., trampling of vegetation, boating, and/or fishing). Natural wetlands are not constructed or substantially restored. Tidal wetlands are continuously open to the ocean and receive regular tidal inundation. After evaluating more than 40 wetlands within the Southern California Bight, three wetlands Tijuana River Estuary, Mugu Lagoon, and Carpinteria Salt Marsh were chosen by UCSB biologists as reference wetlands that best met the criteria of undisturbed, natural tidal wetlands within the Southern California Bight.

Table 2-1 Monitoring Plan Variable Summary

Chapter	Variable	Applicable Agency	Variable Type[1]	Primary Metric	Project Objective	Performance Standard
3	Topography	CCC Coastal Development Permit	Project Design Absolute	Elevation (feet)	Attain target elevations that sustain the predicted habitats	Within 10% (+/-) of habitat areas indicated in the final restoration plan by Year 5 post-construction
4	Bathymetry	CCC Coastal Development Permit	Project Design Absolute	Depth (feet)	Improve hydraulic connectivity throughout the lagoon	Habitat areas for subtidal habitat must fall within 10% of the designed habitat area targets
5	Tidal Elevation	CCC Coastal Development Permit	Project Design Absolute	Elevation (feet)	Improve tidal circulation and flushing; tidal inundation frequencies are achieved to establish habitat as designed	• Subtidal and mudflat habitat areas must be within 10% of the designed habitat area targets • Predicted seawater residence time must remain on average shorter than 7 days in the central and 9 days in the east basins, as estimated using a numerical hydrodynamic model (such as RMA) to indicate first order water quality
6	Habitat Areas	CCC Coastal Development Permit	Project Design Absolute	Acres of subtidal, intertidal mudflat, intertidal salt marsh, and transitional habitats	Attain predicted habitat acreages	Within 10% (+/-) of habitat areas indicated in the final restoration plan including 57 to 73 acres of low marsh by Year 5 post-construction
7.1	Vegetative Cover	CCC Coastal Development Permit and the USFWS Biological Opinion	Project Design Absolute	Percent cover	Attain predicted cover	Meet the 5- and 10-year absolute performance standards defined in the final restoration plan as detailed in Table 7-1 in Chapter 7 of this Plan
7.2	*Spartina* Canopy Architecture	CCC Coastal Development Permit	Relative	Cordgrass density and height	Restore impacted low salt marsh dominated by California cordgrass to pre-restoration conditions	Not significantly worse than the mean value at the lowest performing reference wetland within 5 years of monitoring following construction
7.3	Exotics	CCC Coastal Development Permit and the USFWS Biological Opinion	Project Design Absolute	Percent cover	Minimize exotic species cover	No more than 0% coverage by California Invasive Plant Council "Invasive Plant Inventory" species of "high" or "moderate" threat and no more than 5% coverage by other exotic/weed species during any year
8	Water Quality	CCC Coastal Development Permit	Relative	Dissolved oxygen	Restore habitat so water quality metrics are similar to reference wetlands	Not significantly worse than the mean value at the lowest performing reference wetland within 5 years of monitoring following construction
9	Benthic Invertebrates	CCC Coastal Development Permit	Relative	Density and number of species	Restore habitat so benthic invertebrates metrics are similar to reference wetlands	Not significantly worse than the mean value at the lowest performing reference wetland within 10 years of monitoring following construction
10	Sediments	CCC Coastal Development Permit	Not Applicable	Total kjendahl nitrogen, sediment grain size	Identify sediment issues that may be influencing the success of water quality and benthic invertebrate standards	No specific performance standard associated with this variable; collected to inform water quality and benthic invertebrate standards
11	Fish	CCC Coastal Development Permit	Relative	Density and number of species	Restore habitat so fish metrics are similar to reference wetlands	Not significantly worse than the mean value at the lowest performing reference wetland within 5 years of monitoring following construction
12.1	Breeding Marsh Birds with Focus on Light-Footed Ridgway's Rail	CCC Coastal Development Permit	Pre-Restoration Absolute	Density and number of individuals	Restore habitat so secretive marsh birds, in particular light-footed Ridgway's rail, metrics are similar to pre-restoration conditions	Within 95% or greater of pre-construction survey data (2016, 2017)
12.2	Western Snowy Plover, California Least Tern, and Waterbird Species	CCC Coastal Development Permit	Pre-Restoration Absolute	Number of individuals observed per week	Restore habitat so waterbird species are similar to pre-restoration conditions	Within 95% or greater of pre-construction survey data (2016, 2017)
12.3	Belding's Savannah Sparrow	CCC Coastal Development Permit	Pre-Restoration Absolute	Density of individuals	Restore habitat so Belding's savannah sparrow metrics are similar to pre-restoration conditions	Within 95% or greater of pre-construction survey data (2016, 2017)
13	Wetland Function (CRAM)	RWQCB CWA Section 401 Certification	Pre-Restoration Absolute	CRAM scores	Restore wetland function to pre-restoration conditions	Post-restoration greater than or equal to Baseline CRAM Attribute Score
14	Eelgrass	Corps CWA Section 404 Permit	Pre-Restoration Absolute	Spatial distribution, areal extent, vegetated cover, and turion density	Ensure eelgrass reestablishes after construction	No permanent losses of eelgrass
15	*Caulerpa*	Corps CWA Section 404 Permit and the USFWS Biological Opinion	Pre-Restoration Absolute	Species presence	Ensure *Caulerpa* is not introduced into the project site	*Caulerpa* absent from project site

CCC = California Coastal Commission; Corps = U.S. Army Corps of Engineers; CRAM = California Rapid Assessment Method; CWA = Clean Water Act; RWQCB = Regional Water Quality Control Board; USFWS = U.S. Fish and Wildlife Service
[1] See Section 2.1 for a definition of relative variables related to the San Dieguito Wetlands Restoration Project and Section 2.2 for a definition of the various absolute variables of the SELRP.

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2.1.2 Determination of Similarity

Methodology for assessing relative performance standards is based on the San Dieguito Wetlands Restoration Project (Page et al. 2018a). A requirement for the San Dieguito Wetlands Restoration Project is that the relative performance standards be "similar" to those of the reference wetlands identified for that project. The approach used for this Plan is the same as that used in the monitoring plan for the San Dieguito Wetlands Restoration Project (Page et al. 2018a).

Evaluating whether a particular relative variable at San Elijo Lagoon is similar to the reference wetlands requires that the mean value for the relative variable at San Elijo Lagoon not be significantly lower than the mean value of the same relative variable at the lowest performing of the three reference wetlands. The relative performance standards will be measured and compared between lagoons using a running average, including results from the current year and up to the 3 most recent years of data, as is done for the San Dieguito Wetlands Restoration Project (Page et al. 2018a). Use of a short-term (up to 4-year) running average accounts for natural variation over time that could affect compliance of the restoration site relative to the reference wetlands. For example, invertebrate and fish populations can vary in their species composition and abundance from year to year. Given this variation, it is likely that the reference wetlands (much like San Elijo Lagoon) would not consistently meet all the relative standards in a given year. As such, comparisons during Years 1 through 3 post-construction, which will include only 1 to 3 years of data, will be interpreted with this consideration in mind.

Decisions regarding the design objectives and sampling effort for relative performance variables were made prior to initiating field surveys and were based on parameters applied in the San Dieguito Wetlands Restoration Project (Page et al. 2018a). For that project, data collected during pre-restoration monitoring (at the same reference wetlands used for this project), together with the advice of experts, were used to determine the level of sampling that would likely be needed to detect a 20% deviation from the relative performance standards (i.e., an effect size [ES] of 0.2). Sampling effort estimates were based on a common set of objectives for most statistical designs concerning power; namely that power should be ≥ 0.80 (meaning $\beta \leq 0.20$) and $\alpha \leq 0.20$.

To evaluate whether relative variables at San Elijo Lagoon are significantly lower than the same metrics at reference wetlands, the mean San Elijo Lagoon value will be compared with the mean of the lowest performing reference wetland using a two-sample one-tailed t-test, following the "floating alpha" approach used in the San Dieguito Wetlands Restoration Project (Page et al. 2018a), as described by Raimondi (2019). This approach entails setting the critical alpha level (α) for the t-test to be equal to the ES, which is calculated as the proportional difference between the means of the two wetlands (1 – [lower mean value/higher mean value]). For example, if the San Elijo Lagoon mean was 75 and the mean of the lowest performing reference wetland was 100, the ES would be 0.25 (1 – [75/100] = 0.25). Scaling the critical α for the t-test to the ES reduces the probability of committing a Type I error when the ES is small, and a Type II error when the ES is large.[1] If the ES is small, then a correspondingly small value of critical α can be used to increase the certainty that the difference between areas is, in fact, real. This is because the consequence of a Type I error (in terms of the ecological and societal value of the restoration) is minor in the event that a small proportional difference is found. By contrast, if the ES for a relative performance standard is large, then assigning a small value for critical α (e.g., 0.05) runs the risk of committing a Type II error in situations of higher than expected variance and lower statistical power. Here, the ecological and societal consequences are much more severe because the goals of the restoration will have not been met, yet the conclusion would be that they have.

The t-test results will be interpreted using the following set of rules when assessing whether the restoration or reference area meets a given relative performance standard. In these rules, critical α = ES when ES is less than or equal to 0.5, and calculated α is the p-value derived from the two-sample, one-tailed t-test invoked.

1. If calculated α ≤ ES for any α ranging from 0.000 to 0.500, then the restoration area (or reference area) will be considered to have not met that performance standard for that year (α and ES rounded to three significant figures).

2. If calculated α > ES for any ES ranging from 0.000 to 0.500, then the restoration area (or reference area) will be considered to have met that performance standard for that year (α and ES rounded to three significant figures).

3. If the ES is >0.500 and α is >0.500, then assessment for that year will be considered inconclusive (α and ES rounded to three significant figures) and the following steps will be taken:

    a. The sampling design may be revised to increase the statistical power to at least 0.80. Whether this increased sampling effort is necessary will be based on the history of the performance of the area with respect to the performance standard. For example, if the analyses were conclusive in previous periods, then a single inconclusive analysis would not be sufficient to invoke a revision of the sampling design.

    b. If needed, the revised sampling design will be implemented the following year.

[1] A Type I error would result in falsely concluding that San Elijo Lagoon is not similar to the reference wetlands when it is similar. A Type II error would result in falsely concluding that San Elijo Lagoon is similar to the reference wetlands when it is not similar.

c. If in the following year the standard is met, then the standard will be considered to have been met in the previous inconclusive year as well. If in the following year the standard is not met, then the standard will be considered to have not been met in the previous inconclusive year as well.

d. This process will continue until the standard can be rigorously assessed.

Monitoring data will be evaluated annually to determine if changes need to be made to the sampling program to bring it closer to the design objective of detecting an ES equal to or greater than 0.20 with statistical power greater than or equal to 0.80, using a critical alpha equal to or less than 0.20.

2.1.3 Relative Performance among Wetlands

To ensure that the SELRP is not held to a higher standard than the reference wetlands, the above procedure is also applied to the three reference wetlands (Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh) to evaluate whether they would have met the relative performance standards. This is done, for example, by treating Tijuana Estuary as the mitigation wetland and using the other wetlands as the three reference wetlands. San Elijo Lagoon is considered similar to the reference wetlands if the number of relative standards met by the SELRP is equal to or greater than the number of relative standards met by any of the reference wetlands. A hypothetical example using this approach is illustrated in Table 2-2 and demonstrates a scenario in which San Elijo Lagoon would meet relative standards in a given year. This approach is consistent with the San Dieguito Wetlands Restoration Project (Page et al. 2018a) and ensures that the assessment of similarity is met without the unreasonable requirement that San Elijo Lagoon outperforms Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh for every performance standard. Importantly, this approach deals realistically with the inherent variability of nature. If one of the reference wetlands were to experience an anomalous/catastrophic event that was not part of a normal natural process (e.g., sewage runoff at Tijuana Estuary), and that drove metrics to deviate significantly from the normal range of natural variability, the wetland in question would be considered for exclusion from the analysis for that year.

The SELRP CCC Coastal Development Permit also has special requirements for the Biological Communities standards, which stated that total densities and number of species of fish, and macro-invertebrates shall be similar to the densities and number of species in similar habitats in the reference wetlands within 5 years of the completion of the SELRP. The special requirements for Biological Communities will be evaluated as a subset of the relative performance standards. The approach will be identical to what is used to evaluate relative performance standards and San Elijo Lagoon must perform at least as well as the lowest performing reference wetland. A hypothetical example using this approach is illustrated in Table 2-3 and demonstrates a scenario in which San Elijo Lagoon would meet relative standards in a given year.

Table 2-2 Hypothetical Example of SELRP "Meeting" Relative Performance Standards

Relative Variable	Site Similar to Other Wetlands			
	SELRP	Tijuana Estuary	Mugu Lagoon	Carpinteria Salt Marsh
Water Quality	No	Yes	Yes	Yes
Fish Density – Main Channel	No	Yes	Yes	Yes
Fish Species Richness – Main Channel	No	Yes	Yes	Yes
Fish Density – Tidal Creek	Yes	Yes	No	Yes
Fish Species Richness – Tidal Creek	Yes	Yes	No	Yes
Invertebrate Density – Main Channel	Yes	No	Yes	Yes
Invertebrate Species Richness – Main Channel	Yes	No	Yes	Yes
Invertebrate Density – Tidal Creek	Yes	No	Yes	Yes
Invertebrate Species Richness – Tidal Creek	Yes	No	Yes	Yes
Spartina Canopy Architecture	Yes	Yes	Yes	Yes
Number of Standards Similar to Other Wetlands	7	6	8	10
Proportion of Standards Similar to Other Wetlands	0.7	0.6	0.8	1.0
Conclusion: In this example, the SELRP met equal or more standards than Tijuana Estuary, the reference site with the lowest number of standards met. Therefore, the SELRP would meet the relative standards for the given year.				

Table 2-3 Hypothetical Example of SELRP "Meeting" Biological Community Standards

Relative Variable	Site Similar to Other Wetlands			
	SELRP	Tijuana Estuary	Mugu Lagoon	Carpinteria Salt Marsh
Fish Density – Main Channel	No	Yes	Yes	Yes
Fish Species Richness – Main Channel	No	Yes	Yes	Yes
Fish Density – Tidal Creek	Yes	Yes	No	Yes
Fish Species Richness – Tidal Creek	Yes	Yes	No	Yes
Invertebrate Density – Main Channel	Yes	No	Yes	Yes
Invertebrate Species Richness – Main Channel	Yes	No	Yes	Yes
Invertebrate Density – Tidal Creek	Yes	No	Yes	Yes
Invertebrate Species Richness – Tidal Creek	Yes	No	Yes	Yes
Number of Standards Similar to Other Wetlands	6	4	6	8
Proportion of Standards Similar to Other Wetlands	0.75	0.50	0.75	1.00
Conclusion: In this example, the SELRP met equal or more standards than Tijuana Estuary, the reference site with the lowest number of standards met. Therefore, the SELRP would meet the Biological Community standards for the given year.				

2.2 ABSOLUTE PERFORMANCE STANDARDS

Absolute standards require that the variable of interest be evaluated only within San Elijo Lagoon. Absolute standards are used for monitoring variables that will not be compared to reference wetlands. Absolute performance standards for the SELRP fall into two general categories. First, there are "project design absolute performance standards" that have been developed based on the design of the SELRP in order to meet the project objectives. For example, topography or habitat cover variables have pre-determined goals based on the final design and restoration plans. Second, there are "pre-restoration absolute performance standards" that were developed based on the pre-restoration condition of the lagoon. These standards have been developed for variables that are being monitored to ensure the SELRP does not negatively impact them and to determine if post-restoration conditions are similar to pre-restoration conditions. Each of these two absolute variable types is discussed in further detail in the following subsections.

2.2.1 Project Design Absolute Performance Standards

The SELRP was designed to increase tidal influence to San Elijo Lagoon and enhance freshwater fluvial flows out of the lagoon. To achieve this objective, targets were set for topography, bathymetry, and tidal elevations standards during the design phase of the SELRP. These targets were developed to achieve habitat area and vegetation cover targets that would minimize impacts to sensitive avian species. Project design absolute performance standards are being used to meet the requirements of the CCC Coastal Development Permit and the USFWS Biological Opinion. Project design absolute performance standards are summarized in Table 2-1 and include the following:

Topography. Total habitat areas shall not vary by more than 10% from designed habitat distribution.

Bathymetry. Habitat areas for subtidal habitat must fall within 10% of the designed habitat area targets as they are directly related to bathymetry.

Tidal Elevation. Habitat areas must fall within 10% of the designed habitat area targets in response to tidal inundation frequency (TIF). In addition, predicted seawater residence time must remain on average shorter than 7 days in the central and 9 days in the east basins, as estimated using a numerical hydrodynamic model (such as RMA) to indicate first order water quality.

Habitat Areas. The area of different habitats shall not vary by more than 10% from the areas indicated in the final restoration plan, including 57 to 73 acres of low marsh.

Vegetative Cover. Vegetative cover shall be equal to or greater than the absolute cover standards identified in the final restoration plan as detailed in Section 7.1.2.

Exotics. Exotic cover shall not exceed 0% coverage by species identified by the California Invasive Plant Council "Invasive Plant Inventory" or 5% coverage by other exotic/weed species.

In contrast to relative performance standards, tests of similarity are not necessary because metrics either "are" or "are not" meeting the standard. For example, the total area of low marsh within the lagoon will be quantified and that number will either be "within" or "not within" 10% of the target metric. No additional statistical analysis will be necessary. These absolute standards will be assessed annually, rather than over a temporal average.

Vegetation cover is required to meet the SELRP Wetland Restoration Plan requirements (AECOM 2017a) as defined in Table 7-1 (see Section 7.1.2) which will satisfy both USFWS and CCC requirements. Sampling of vegetation cover for the Wetland Restoration Plan will be conducted at selected transects (see Section 7.1 for further detail). Analysis to determine if vegetation cover is meeting the absolute standards identified in the Wetland Restoration Plan will include comparing mean values at transect intercepts to absolute cover standards using the "floating alpha" method, as described in Section 2.1.2. However, because the sample estimate of San Elijo Lagoon vegetative cover will be compared to a hypothetical value (the absolute standard) rather than second set of sample data, the comparison will be made using a one-sample (one-tailed) t-test rather than a two-sample (one-tailed) t-test.

2.2.2 Pre-Restoration Absolute Performance Standards

Pre-restoration absolute performance standards were developed to monitor ancillary variables to ensure the SELRP does not negatively impact special-status avian species, wetland function, and eelgrass as well as to ensure the SELRP does not introduce *Caulerpa* to the lagoon. For example, increasing light-footed Ridgway's rail (*Rallus obsoletus levipes*) (federally and state endangered) and Belding's savannah sparrow (*Passerculus sandwichensis beldingi*) (state endangered) abundance or density was not a primary objective of the SELRP. The SELRP was designed to minimize impacts to these species and ensure post-restoration abundance or density of these species is similar to pre-restoration abundance. *Caulerpa* was not present in the project areas prior to the SELRP and monitoring will be conducted after construction to ensure there is no infestation within project limits.

Pre-restoration absolute performance standards are being used to meet the requirements of the CCC Coastal Development Permit, RWQCB CWA Section 401 Certification, Corps CWA Section 404 Permit, and USFWS Biological Opinion. Pre-restoration absolute performance standards are summarized in Table 2-1 and include the following:

Breeding Marsh Birds with Focus on Light-Footed Ridgway's Rail. The abundance of breeding marsh birds, including light-footed Ridgway's rail, shall be similar or better than pre-restoration conditions.

Western Snowy Plover, California Least Tern, and Waterbird Species. The abundance of western snowy plover, California least tern, and other waterbird species shall be similar or better than pre-restoration conditions.

Belding's Savannah Sparrow. Belding's savannah sparrow population density shall be similar or better than pre-restoration conditions.

Wetland Function. California Rapid Assessment Method (CRAM) scores shall be equal to or better than pre-restoration conditions as required by the RWQCB CWA Section 401 Certification and Corps CWA Section 404 Permit.

Eelgrass. Eelgrass distribution, extent, cover, and density shall be similar to pre-restoration conditions.

Caulerpa. *Caulerpa* shall not be present within the project site.

2.2.2.1 Rationale for Using Pre-Restoration Conditions

Reference wetlands will not be used for determining success of pre-restoration absolute performance standards for several reasons. The objectives of the SELRP were not to improve variables such as the abundance or extent of light-footed Ridgway's rail, western snowy plover, California least tern, and Belding's savannah sparrow, and eelgrass. The four avian species were flourishing at San Elijo Lagoon prior to the SELRP and pre-construction data indicate these species were already in higher density at San Elijo Lagoon than other lagoons. The objective is to ensure avian numbers are similar to pre-restoration conditions, which is more conservative than comparing to reference wetlands. Ephemeral patches of eelgrass have been present within the inlet and, as with birds, the SELRP was not designed to increase distribution or abundance of this species but rather to avoid long-term impacts to the species.

In addition, the site was already functioning as a wetland unlike the San Dieguito Wetlands Restoration Project. The RWQCB CWA Section 401 Certification and Corps CWA Section 404 Permit seek to ensure wetland function is not degraded from pre-restoration conditions, and comparing CRAM scores to reference wetlands is not relevant. Finally, none of these variable types are being monitored by USCB biologists as part of the San Dieguito Wetlands Restoration Project requirements, and funding for monitoring to analyze additional relative variables is not available for the SELRP given it is not being required as mitigation for operation of a facility (i.e., San Onofre Nuclear Generating Station) like the San Dieguito Wetlands Restoration Project.

2.2.2.2 Determination of Similarity

Analysis to determine if avian density and/or abundance is meeting the pre-restoration absolute standards will include comparing mean values of each metric to a hypothetical value derived from baseline data collected during 2016 and 2017 for the SELRP. Specifically, the "floating alpha" method, as described in Section 2.1.2, will be used to determine if the mean value for these absolute variables (i.e., light-footed Ridgway's rail, western snowy plover, California least tern, Belding's savannah sparrow) at San Elijo Lagoon are equal to or greater than 75% of the pre-construction mean at 7 years post-construction, or if they are equal to or greater than 95% of the pre-construction mean 10 years post-construction. Because the benchmark is a hypothetical value rather than a sample-based estimate, a one-sample, one-tailed t-test (comparing the San Elijo Lagoon mean to absolute cover standard) would be used rather than a two-sample test. This approach will be used for avian performance variables, but not for performance variables pertaining to wetland function and eelgrass. CRAM scores do not allow for such a comparison and eelgrass values are wetland-wide estimates; thus, there are no estimates of variability about a mean value.

Similar to what is being done for relative performance standards, post-restoration mean values for light-footed Ridgway's rail, western snowy plover, California least tern, and Belding's savannah sparrow will be measured and compared annually to the 75% and 95% benchmarks described above using post-restoration 4-year running averages. Pre-restoration data were only collected in 2016 and 2017 for these species and therefore the pre-restoration baseline will be based on a 2-year running average.

The rationale for using the benchmarks of 75% of the mean pre-restoration value at 7 years post-construction and 95% of the mean pre-restoration value at 10 years post-construction is that the pre-restoration conditions for these variables were already considered acceptable and the purpose of the SELRP was not to enhance the number of these species. Nonetheless, initial restoration activities might be expected to result in temporary negative impacts to bird habitat and populations, which are expected to gradually recover over time. Hence, if the SELRP is meeting the proposed benchmarks at Years 7 and 10 post-construction, then it should be considered successful.

2.3 DETERMINING OVERALL PROJECT SUCCESS

The monitoring described in this Plan will be initiated upon completion of construction and will continue for 10 years or until overall project success criteria are met. The overarching goal of the SELRP is to protect and restore, then maintain via adaptive management, the San Elijo Lagoon ecosystem and its adjacent uplands to sustain and perpetuate native flora and fauna characteristic of Southern California, and restore and maintain estuarine and brackish marsh hydrology. Therefore, success criteria established to measure achievement of this goal are the focus of overall system success. Success for the SELRP will be achieved if relative standards and project design absolute performance standards are met for 3 consecutive years and pre-restoration absolute performance standards for avian species are met for 3 consecutive years. In addition, Wetland Function (CRAM), *Caulerpa*, and eelgrass standards must meet RWQCB CWA Section 401 Certification, the Corps CWA Section 404(b)(1) Permit, and USFWS Biological Opinion requirements. Table 2-4 demonstrates a hypothetical scenario in which the SELRP achieves overall project success within the first 10 years of monitoring.

Table 2-4 Hypothetical Example Timeline of SELRP "Meeting" Overall Project Success

Permitting Agency	Variable	Year Performance Standard Met									
		1	2	3	4	5	6	7	8	9	10
CCC	Relative Performance Standards[1]	No	No	No	Yes	Yes	Yes	Yes	-	-	-
	Biological Community Standards	No	No	No	No	Yes	Yes	Yes	-	-	-
	Project Design Absolute Performance Standards										
	Topography[3]	No	No	No	No	Yes	Yes	Yes	-	-	-
	Bathymetry[3]	No	No	No	No	Yes	Yes	Yes	-	-	-
	Tidal Elevations	No	No	No	No	Yes	Yes	Yes	-	-	-
	Habitat Areas	No	No	No	No	Yes	Yes	Yes	-	-	-
	Exotic Cover	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-	-
	Pre-Restoration Absolute Performance Standards										
	Light-Footed Ridgway's Rail	No	No	No	No	No	No	Yes	Yes	Yes	-
	Western Snowy Plover/California Least Tern	No	No	Yes	Yes	Yes	-	-	-	-	-
	Belding's Savannah Sparrow	No	No	Yes	No	No	Yes	Yes	Yes		
USFWS/CCC	Vegetation Cover[2]	No	No	No	No	No	No	No	No	No	Yes
RWQCB	Wetland Function (CRAM)	No	No	No	No	Yes	-	-	-	-	-
Corps	Eelgrass	Yes	Yes	-	-	-	-	-	-	-	-
Corps/USFWS	*Caulerpa*	Yes	-	-	-	-	-	-	-	-	-

Conclusions by Year:

Year 1. *Caulerpa* standard met. Monitoring complete for this variable.
Year 2. Eelgrass standard met. Monitoring complete for this variable.
Year 3. Standards not met. Monitoring continues for all variables.
Year 4. Standards not met. Monitoring continues for all variables.
Year 5. Wetland function (CRAM) and western snowy plover and California least tern standards met. Monitoring discontinued for CRAM. Western snowy plover and California least tern standard met and monitoring may cease or be reduced for this variable. Monitoring will continue for all other variables, including vegetation cover as it relates to relative performance standards.
Year 6. Relative standards, biological community standards, and project design absolute standards not met for 3 consecutive years. Monitoring continues for remaining variables.
Year 7. Relative standards, biological community standards, and project design absolute standards met for 3 consecutive years. Monitoring may cease for these variables or may continue at a reduced frequency. Light-footed Ridgway's rail and Belding's savannah sparrow monitoring to continue.
Year 8. Belding's savannah sparrow standard met and monitoring may cease or be reduced for this variable. Light-footed Ridgway's rail monitoring to continue.
Year 9. Light-footed Ridgway's rail standard met and monitoring may cease or be reduced for this variable.
Year 10. All standards met. Project success. Transition to long-term monitoring.

CCC = California Coastal Commission; CRAM = California Rapid Assessment Method; RWQCB = Regional Water Quality Control Board; SELRP = San Elijo Lagoon Restoration Project; USFWS = U.S. Fish and Wildlife Service

[1] Not all required to be met in a given year. See Section 2.1.2 for details.

[2] Interim standards are provided in Table 7-1 (see Chapter 7) for Years 1 through 9. Should the Year 10 standards be met prior to Year 10, monitoring may cease for this variable or may continue at a reduced frequency depending on the trajectory of other variables.

[3] It is assumed site conditions would not change frequently enough to necessitate annual surveys or negate previous survey results for topography and bathymetry. Success of both of these absolute standards is tied to habitat, which is being monitored every year. Topography and bathymetry metrics will be considered met in the years between monitoring topography and bathymetry if the habitat performance standard is met. Therefore, if the topography and bathymetry standard was met during monitoring in Year 2 and Year 5 and the habitat standard was also met in Year 2 through Year 5, topography and bathymetry would be considered met during Year 2 through Year 5.

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Performance standards are anticipated to be met within 10 years, with some anticipated to be met in much less time. Specific metrics have established interim performance standards as well, such as vegetation. In general, metrics are anticipated to be met relatively sequentially, with the physical metrics like topography and tidal elevation meeting performance standards first, followed by vegetation and habitat, then finally by metrics such as avian use and specific species support.

Monitoring will continue until relative standards and project design absolute performance standards are met for 3 consecutive years. Once these standards have been met, monitoring may cease for these variables or may continue at a reduced frequency for variables related to pre-restoration (i.e., avian) absolute standards. This will be evaluated after relative standards and project design absolute performance standards are met for 3 consecutive years. For example, it is possible that vegetation cover would need to be monitored until pre-restoration (i.e., avian) absolute standards are met. It should also be noted that topography and bathymetry metrics will not be monitored annually as they are not anticipated to change frequently enough to require annual surveys. Success of both of these absolute standards is tied to habitat, which is being monitored every year. Topography and bathymetry metrics will be considered met in the years between monitoring topography and bathymetry if the habitat performance standard is met. Therefore, if the topography and bathymetry standard was met during monitoring in Year 2 and Year 5 and the habitat standard was also met in Year 2 through Year 5, topography and bathymetry would be considered met during Year 2 through Year 5.

Overall success of pre-restoration absolute performance standards for avian species will be evaluated independently from relative standards and project design absolute performance standards. For example, if avian standards are met for 3 consecutive years prior to relative standards and project design absolute performance standards then performance standards will be considered met for avian species. At this point, monitoring may cease for avian standards or may continue at a reduced frequency.

This Plan is unique in that it is meant to be an all-inclusive monitoring plan to address the various permit requirements. Several variables are being monitored to meet specific permit requirements and were not intended to be monitored long term to gauge overall project success. These variables include vegetation cover as it relates to the absolute cover standards identified in the final restoration plan as defined in Table 7-1 of Chapter 7 of this Plan; Wetland Function (CRAM), *Caulerpa*, and eelgrass. These variables will be monitored until they meet their individual performance standards but will not continue to be monitored after their performance standards have been met.

Adaptive management will be an integral part of the monitoring approach throughout the post-restoration monitoring period. Nature Collective y, as the project proponent and non-profit land trust organization responsible for the lagoon as a whole, has a proactive approach to managing the lagoon. Most metrics will be quantitatively assessed annually, and qualitatively assessed more frequently. Nature Collective staff and Project Restoration Biologists will be frequently on-site and monitoring the lagoon during various ongoing efforts, and will integrate qualitative assessments into their regular activities. If post-restoration specific variables do not trend toward success as anticipated, adaptive management strategies will be discussed and identified for implementation. Specific potential adaptive management actions, minimum assessment frequencies, and quantitative adaptive management triggers are identified in detail in Chapter 16. Adaptive management will be required if an individual performance standard is not met or is not trending toward success.

2.4 REPORTING

A baseline report will be prepared to describe results of pre-construction monitoring conducted for each performance variable. The report will define baseline results that will be used for determining success of each of the monitoring variables. Although relative monitoring variables will be compared to reference wetlands post-restoration, baseline information will be used to assess pre-restoration conditions for these variables, which will help identify trends in the data sets and inform adaptive management decisions in future years.

Annual reports will be submitted to the CCC, USFWS, and appropriate resource agencies that document the methods and results of this Plan. Annual reports will be submitted by August 1 for each year of monitoring and will be prepared beginning the first year after completion and submittal of the as-built report for each basin. Reports will be cumulative, summarizing previous results, and will be specific to metrics being monitored that year (e.g., water quality and tidal elevation may not be monitored in all locations if construction is ongoing). Annual reporting described herein will also satisfy the reporting requirement of the final restoration plan. Each annual report will include, at a minimum:

- Photographs from fixed locations to document the condition of the restoration
- Discussion of each monitoring variable results from annual monitoring efforts
- Recommended modifications to monitor variables, if necessary
- A performance evaluation section where results are compared in relation to interim and final performance standards for each specific agency success determination
- Adaptive management recommendations, if necessary

Within each annual report, a performance evaluation section will also be included incorporating qualitative observations as well as quantitative results in an evaluation of the status of the success of the restoration effort at the system level. This section will summarize the status of each metric in terms of interim and final performance standards, and provide discussion indicating whether quantitative performance standards not yet met are affecting lagoon function and overall restoration success based on specific agency requirements.

Annual reporting will continue as needed until Year 10 post-construction. Reporting after Year 10 post-construction will be described in the LTMP. At the completion of the 10-year monitoring period, a final monitoring report will be prepared and submitted to the CCC. This final report will discuss the results through Year 10 post-construction and provide an evaluation of whether the restoration project met each of the goals, objectives, and performance standards approved in this Plan. If the final report indicates that the restoration project has not met performance standards, Nature Collective will submit a revised or supplemental restoration program to identify adaptive management actions to be taken for those portions of the original plan that did not meet the approved performance standards. The approved final, revised restoration plan will follow procedures and reporting requirements as outlined in this Plan.

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3. TOPOGRAPHY

Attainment of target elevations (i.e., topography) for proposed habitats within the lagoon is critical for restoration success since correct elevations will drive habitat establishment. Topography is a project design absolute monitoring variable and, as such, elevation will not be subject to comparisons with reference wetlands for purposes of determining success of the SELRP. Topography within San Elijo Lagoon will focus on the upper elevations within the lagoon, while bathymetry monitoring (Chapter 4) will focus more specifically on subtidal elevations. The methodology will provide for overlap of the two datasets and compilation of a complete elevational dataset for the restoration area.

Topography will be considered in combination with bathymetric data and tidal elevation data to quantify the TIF relationship for wetland habitat. The TIF of the marsh indicates the elevations being colonized by specific marsh habitats. The TIF is well understood from the literature (e.g., publications by Joy Zedler and others) and specifically at San Elijo Lagoon through field measurement. Each of these parameters is addressed herein and is analyzed in an integrated way to understand wetland habitat establishment. This physical monitoring is done to determine the pre-construction conditions of TIF for habitat at San Elijo Lagoon for comparison with the TIF for post-construction conditions. If habitat establishment at San Elijo Lagoon is different from that anticipated, then the TIF can help explain the discrepancies and may be useful to determine modifications to be made to the parameters to adaptively manage the habitat distribution on-site.

The purpose of topographic monitoring is to identify whether the lagoon experiences surface dynamics, such as sedimentation from upstream, or erosion/accretion from stormflows, tides, wind waves, combined conditions, or other factors. It is an effort to understand lagoon surface dynamics over time and space, and resulting effects on habitat. Thus, the effort must be able to capture changes over relatively small scales (within several feet horizontally and within less than 1 foot vertically), and also over time by being comparable by location. In addition, the overdredge pit was backfilled with lagoon sediment and will continue to settle over time. Topographic surveying is important to monitor pit settlement and verify its final surface elevation.

3.1 METHODS

3.1.1 Data Collection

Given the size of the restoration effort (~960 acres), difficulties with site access, the sensitivity of the site, and the unknown condition of the restored marsh plain (e.g., unstable, muddy substrate), topography will be monitored remotely, primarily using aerial imagery. Aerial imagery will be used to prepare an aerial topographic map of the site. False color aerial imagery of the three basins will be recorded by sensing Red August, Green (G), Blue (B), and Near Infrared (NIR) wavelengths digitally. This imagery will then be converted to open water, vegetated areas, and bare ground using Normalized Difference Vegetation Index (NDVI). Vegetated areas will include salt marsh vascular plants and will require ground-truthing to differentiate between habitats.

An aerial topographic map of the basins was generated from the R, G, B, and NIR digital image. Elevation contours were produced in digital computer aided design (CAD) format. A mosaic of the georeferenced digital imagery was created within the extents of the overlapping aerial imagery. This process will be done by a photogrammetrist and will produce a Digital Elevation Model (DEM) file with 1-foot contour intervals, and point data accurate to within 6 inches or less. The mapping is done to National Map Accuracy Standards that require 90% of the data to be accurate within 0.5 foot of the contour interval, and spot elevations to be accurate to within 0.25 foot of the contour interval, or within 3 inches. The resulting CAD file containing elevation contour data will then be converted to ArcGIS format for further processing and analysis. Ground control points will be used as vertical and horizontal controls for this analysis. Additionally, ground-truthing of elevations will be done using conventional ground survey methods. Ground surveys will also be used to measure the final overdredge pit elevation.

Biannual high-resolution aerial imagery will be used to look for areas of erosion and deposition via visual changes for qualitative assessment, and from changes in the DEM file. Accurate survey and monitoring control has been established, and will be reported and maintained to support monitoring. The vertical and horizontal control points will be made available so biological and physical surveys can tie into the same vertical control points.

If a severe storm event occurs, then a drone may be mobilized above the lagoon to record images and identify major topographic changes that may have occurred. These data would be useful to direct the work of a survey team to perform focused surveys of storm event effects.

3.1.2 Monitoring Frequency

Monitoring was conducted pre-construction and will continue post-construction for topography. No monitoring was conducted during construction other than to verify quantities of cut and fill for payment to the contractor.

3.1.2.1 Pre-Construction

An extensive topographic and bathymetric survey of the lagoon was conducted in 2011 by KDM Meridian, and again in August of 2017 by the same surveyor supplemented by Coastal Frontiers Corporation for more detailed bathymetry. Topography in the three basins was mapped to 1-foot contours using a combination of aerial photogrammetry and total station equipment. Water areas were surveyed using side-scan sonar mounted on small vessels. The 2011 survey was used in the design of the restoration and to determine target elevation breaks based on hydrodynamic modeling (Table 3-1).

Table 3-1 Elevations of Habitats According to Tidal Inundation Frequency Analysis (ft NAVD88)

Habitat Type	Existing Conditions in the Lagoon Pre-Construction	Proposed Elevation Ranges Post-Construction[1]	Target Elevations[2]
Subtidal	Below +2.1	Below +1.6	Below +1.6
Mudflat	+2.1 - +3.4	+1.6 - +3.2	+2.4
Low Marsh	+3.4 - + 4.1	+3.2 - +4.1	+4.1
Mid-High Marsh	+4.1 - +5.8	+4.1 - + 5.5	+5.3
Transitional	Above +5.8	Above +5.5	Above +5.8

ft NAVD88 = feet North American Vertical Datum of 1988
[1] Proposed elevation ranges are those predicted by tidal hydraulic modeling to provide the tidal inundation frequency needed for habitat establishment post-construction.
[2] Target elevations are set at the 75th percentile (upper 25%) of the range, with the exception of low marsh, which was set at a higher elevation than the high end of the range to increase probability of success in the event of construction errors, tidal muting, and/or sea level rise, due to its limited elevation range.

The 2017 survey serves as the baseline for pre-construction conditions to compare with post-construction conditions. This pre-construction topographic survey was conducted to document the topography of the lagoon immediately prior to the initiation of the restoration program. Substantial deviations from the 2011 survey were documented and incorporated into the final engineering drawings.

3.1.2.2 Post-Construction

Post-construction monitoring of site elevations and habitat establishment will determine whether target elevations have been attained. Existing elevations that are suitable for low, mid, and high salt marsh habitats, as well as wetland to upland transition zone habitat, will be actively planted and maintained. Target elevations for these habitats must be met for restoration to be successful.

Post-construction monitoring for topography will be conducted at Years 0 (i.e., immediately post-construction), 2, 5, and 10 post-construction or until overall project success criteria have been met using the same methods implemented for pre-construction topography monitoring. Any reduced frequency will be evaluated as it relates to the success of other monitoring variables. Annual monitoring for topography is not proposed as site conditions are not anticipated to change frequently enough to require annual surveys. Extreme hydraulic events such as major storms of a return interval of 100 years (as defined by the Federal Emergency Management Agency [FEMA]) would trigger the need for post-storm inspection to determine if any substantial changes were incurred as a result and, if warranted, additional monitoring to characterize impact/response in the wetland may be conducted.

Major storm flood events such as the 100-year stormflow (as defined by FEMA) will potentially trigger surveys of certain areas that may experience change. The 100-year stormflow event is estimated to be the event that could cause some measure of wetland change as shown by modeling (M&N 2012). Stormflow velocities sufficient to induce geomorphic change occur at a threshold of approximately 0.6 feet per second (fps) and higher (Hjulstrom 1935). The numerical hydrodynamic modeling done for the project shows that, for the project, this threshold is only reached during the 100-year storm in the vicinity of the I-5 bridge due to the large open lagoon area both upstream and downstream of the I-5 bridge and the resulting broad floodplain available for storm flow dispersion. The need for event-based surveys, and their scope, will be determined at the time based on the magnitude of the event. As mentioned above, a drone may be mobilized above the lagoon to identify where major topographic changes may have occurred to focus topographic surveys on areas affected by storm events.

3.2 PERFORMANCE STANDARDS

One important restoration goal of the project is for the wetland to not undergo major topographic change, such as excessive erosion or sedimentation, over time. Minor natural adjustments (e.g., shifts in the channel planform, bank steepening or flattening, development of small bars or holes) are expected and acceptable, but wholesale trends of accretion or erosion are neither acceptable nor expected. Also, topography is inextricably linked to habitat establishment, and total habitat areas shall not vary by more than 10% of the design habitat distribution according to the permit. Immediately following construction, the final topography (i.e., elevations and slopes) will be compared to target design elevations (Table 3-1). The data in Table 3-1 were developed using tidal hydraulic modeling combined with topographic mapping and habitat mapping. Tides were analyzed to develop the relationship of TIF to habitat types within the lagoon. This analysis is presented in detail in the hydraulic report by Moffatt & Nichol (M&N) in 2012 (amended in 2014). Tides for post-construction conditions included those for a fully cleared tidal inlet, and for a shoaled tidal inlet. Tidal muting occurs from shoaling, so tidal elevations vary over time depending on the date of annual inlet clearing, and during alternating spring and neap tidal cycles. The TIF relationship was based on muted tides under shoaled conditions because that condition is more common at this site than a cleared condition.

Existing elevation conditions of habitat are taken from mapped habitat over elevation data. Proposed elevation ranges are those predicted by the model to provide the TIF needed for habitat establishment. For example, mudflat forms where the TIF is 40% or more, while vegetated marsh forms when the TIF is 40% or less. Vegetated marsh subdivides into low marsh with a TIF of 20% to 40%, mid-marsh with a TIF of 4% to 20%, and high marsh with a TIF less than 4%. These TIF values were derived from work by previous researchers such as Chris Nordby, Joy Zedler, and Keith Merkel. of

Target elevations were determined working with Nature Collective (Gibson, personal communication, 2011). Nature Collective recognized the need to set the elevations of the marsh above the mid-point of the range of elevations to account for variations in elevations created during construction, and for sea level rise. Nature Collective directed the design team to target elevations at the 75th percentile (upper 25%) of the range for most habitats, meaning that the target is approximately in the upper three-quarters of the established elevation range. The exception is low marsh that was set at a higher elevation than the modeled high end of the range. The modeled elevation range for low marsh is very limited (0.8 foot); within San Elijo Lagoon, the actual range of low marsh exceeds 1.0 foot of elevational difference. Therefore, a higher probability exists that it will not be successful due to construction errors, tidal muting, and/or sea level rise. To increase the probability of success, the elevation range was expanded upward on the high end to account for these factors. If colonization of low marsh is less successful than planned, the design group felt it best to err on the high side of the elevation rather than the low side. Sea level rise could benefit the site in the future if elevations are created that are slightly too high, causing low marsh to colonize larger areas in the future.

In addition, the large and segmented lagoon possesses varying tidal elevations throughout. Analysis was done for each basin (M&N 2014), and the results indicate that the central basin represents the largest area of vegetated salt marsh. It was therefore selected as the indicator for TIF for the east basin as well. By setting the target habitat elevations slightly high, the east basin will be better represented as tides do not drain as well at that location and habitats form at higher elevations. The west basin is very small and only minor grading is proposed to create a subtidal channel, so target habitat elevations are not as applicable at that location as compared to other basins.

Performance standards shall be considered met if post-construction monitoring results show no large-scale variations from the design elevations and habitat areas are within 10% of the acreage proposed. Success is determined by habitat areas and their similarity to the design (i.e., within 10%; see Chapter 6). Surveys will continue at specified intervals until the 10-year monitoring period is over to document marsh dynamics and if the marsh has reached an equilibrium for topography. In addition, surveys may occur after significant storm events occurring less than once every 100 years to document changes from post-construction and potential remedial actions. Once overall project success criteria have been met, surveys can stop altogether or be spaced out over longer timeframes (e.g., decadal). Any reduced frequency will be evaluated as it relates to the success of other monitoring variables.

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4. BATHYMETRY

Pre- and post-construction bathymetric surveys will be conducted in navigable subtidal regions included in the restoration project to document changes relative to the existing condition. Bathymetry is defined as areas of subtidal habitat that are inundated 100% of the time. Like topography, bathymetry is a project design absolute monitoring variable and will not be subject to comparisons with reference wetlands for purposes of determining success of the SELRP.

Monitoring of bathymetry will be focused on identifying obstructions to the channels from sedimentation/deposition, channel scour, and/or channel shifts. The channel network will be surveyed from downstream to upstream, including the main channel and tidal creeks.. Monitoring of bathymetry will occur at key fixed locations over time. Both longitudinal and cross-sectional profiles will be collected at regular intervals, including following episodic events such as storm flows substantial enough to cause sedimentation (i.e., the 100-year storm).

4.1 METHODS

4.1.1 <u>Data Collection</u>

Bathymetric data will be obtained using a survey-grade digital acoustic echosounder operated from a shallow-draft vessel. A real-time kinematic global positioning system (RTK GPS) base-rover set will be used to determine the horizontal position of each sounding, as well as the water surface elevation (relative to North American Vertical Datum of 1988 [NAVD88]). Speed-of-sound casts will be obtained periodically and used to adjust the raw soundings based on changes in water properties (temperature and salinity). In addition, the echosounder output will be physically verified using a standard "rod-check" procedure at the start and end of the survey day. The soundings will be corrected for draft and sound velocity, and then adjusted to the project datum.

Bathymetry will be obtained along pre-established channel-perpendicular transects spaced at a nominal interval of 100 feet. Sections are needed to see if the channel itself is changing over time. Additional data will be obtained by supplementing the pattern of data gathering to identify sites of shoaling or erosion, based on aerial photographic data. Pre-construction bathymetric methodology will be replicated each year to enable comparison over time to the pre-construction survey.

The use of pre-established survey transects will support direct comparison of the pre-construction and post-construction configuration at those locations. This approach also allows the full channel cross-section to be documented at each transect.

The soundings will be merged with the topographic data described in Chapter 3 and used to develop a DEM. As described above, the bathymetric and topographic portions of the surveys will be conducted in a manner to provide overlap between the two data sets. The bathymetric data are collected at high tide, whereas the topographic data is collected at low tide. This approach ensures full coverage to the intertidal area and provides a measure of quality control where the data overlap (two sets of measurements at the same location for comparison if the topographic survey extends below low tide and if the bathymetric data extend upland on the channel bank above low tide). The DEM will be used to evaluate post-construction changes in the restored lagoon channels.

Cross-sectional surveys will provide the following items:

- representative geometry and slope in stable reaches,
- channel profile, and
- higher resolution survey of the channel profile and cross-sections where the channel is dynamic.

4.1.2 Monitoring Frequency

Monitoring was conducted pre-construction and will continue post-construction for bathymetry at the same time intervals as topography. Monitoring was also conducted during construction to calculate dredging quantities and to verify that the design was met by the contractor. Construction monitoring was different than the type used for determining project success and is not elaborated on further in this document.

4.1.2.1 Pre-Construction

Bathymetric monitoring was done in 2011 to set the baseline condition for project design, and again in 2017 to identify site changes and verify whether the design needed to be updated, and to set the baseline for pre-construction conditions as the basis for payment for the contract, and for monitoring. The same approach was used as presented above, and by the same surveyors (KDM Meridian and Coastal Frontiers Corporation) in an effort to maintain consistency in approach and data quality over time.

4.1.2.2 Post-Construction

Like topography, post-construction monitoring for bathymetry will be conducted at Years 0 (immediately post-construction), 2, 5, and 10 post-construction or until overall project performance standards have been met. Any reduced frequency will be evaluated as it relates to the success of other monitoring variables. Annual monitoring for bathymetry is not proposed as site conditions are not anticipated to change frequently enough to require annual surveys. Extreme hydraulic events such as major storms of a return interval of 100 years (as defined by FEMA) will trigger the need for post-storm inspection, and, if warranted, additional monitoring to characterize impact/response in wetland. The 100-year stormflow event is estimated to be the event that could cause some measure of wetland change as shown by modeling (M&N 2012). Stormflow velocities sufficient to induce geomorphic change occur at a threshold of approximately 0.6 fps and higher (Hjulstrom 1935). The numerical hydrodynamic modeling done for the project shows that, for the project, this threshold is only reached during the 100-year storm in the vicinity of the I-5 bridge due to the large open lagoon area both upstream and downstream of the I-5 bridge and the resulting broad floodplain available for storm flow dispersion.

4.2 PERFORMANCE STANDARDS

Like topography, bathymetry is a project design absolute monitoring variable and will not be subject to comparisons with reference wetlands. Topography focuses on the upper elevations within the lagoon that are not inundated 100% of the time. In contrast, bathymetry is inundated 100% of the time, is at lower elevations, and is more heavily influenced by hydraulic forces in the lagoon. Bathymetry is expected to evolve beginning immediately after construction. It is expected that sediment within tidal channels will be mobile post-construction and scour and deposition within the tidal channel network will occur as a more stable equilibrium condition establishes. The immediate as-built bathymetric condition will not persist as a result of the sediment movement. Thus, there are no quantitative performance standards for bathymetry other than immediate as-built conditions.

Success of the project with respect to bathymetry will be determined based on subtidal habitat areas and channel capacity. Performance standards shall be considered met if post-construction monitoring results show no large-scale variations from the design elevations and subtidal habitat areas are within 10% of those proposed. Success is determined by subtidal habitat areas and their similarity to the design (i.e., within 10%; see Chapter 6). An additional concern with bathymetry is providing efficient hydraulic connectivity throughout the lagoon. The channels need to be sufficiently deep to provide approximately 2 feet of depth at low tide for aquatic organisms to prevent elevated temperatures from occurring. Also, the channel cross-sections need to be large enough to reduce friction and allow for tidal flow to be conveyed effectively to the inland limit of tidal influence in the east basin. Channel widths and depths were designed to provide that efficiency, as determined by hydraulic modeling (M&N 2014), while not being so large as to require dredging beyond that needed for successful function. Iterations of modeling were done to determine the optimal depth of the channels, and the elevation of -4 feet NAVD was identified as the depth providing water conveyance with some tolerance for shoaling. Therefore, the main tidal channel was designed to be at a depth of -4 feet NAVD in the center, and widened from its pre-construction condition ranging between 50 and100 feet, to between 100 and 200 feet wide in some areas.

Also, tidal elevations will be a reflection of the hydraulic efficiency of the channel network. Monitoring tides will indicate problems with bathymetry that might need to be addressed. Finally, habitat mapping will indicate changes in bathymetric function, with changes in subtidal habitat areas indicating expansion of bathymetric function and vice versa.

5. TIDAL ELEVATION

Tidal elevation is a project design absolute monitoring variable and will not be subject to comparisons with reference wetlands. Tidal elevation monitoring will be conducted to confirm that the predicted TIFs are achieved and habitat becomes established as designed (in specified locations and at target acreages). Tidal elevation can also be used to indicate tidal circulation and flushing in the form of tidal prism within the tidally influenced portion of the lagoon. Tidal elevations are anticipated to vary over time depending on inlet condition, as well as sedimentation within channels, and inlet maintenance is taken into account in the performance standards. Finally, tidal elevation ranges can be used to infer circulation and water residence time in the marsh, as a first order proxy for water quality. They can be used as input data to the existing numerical model (RMA) to quantify water residence times, as well as to calculate TIF for habitat analyses.

Other processes influencing water surface elevations within the lagoon will also be considered in the tidal data acquisition. For instance, storm flow events that raise water levels in the lagoon will be captured in the tidal data collection. Tide gauges serve as water level recorders and will provide storm event data combined with tides. The storm flow event data will be quantified and analyzed over time to better understand lagoon hydrodynamics and effects on geomorphology.

5.1 METHODS

5.1.1 Data Collection

Tidal elevations in each basin will be measured using pressure sensors to supplement the existing sondes deployed for water quality monitoring (see Chapter 8). Pressure sensors and data sondes are capable of recording water pressure, which can be converted to water surface elevation above the gauge, as discussed previously. Data collected from data loggers will be integrated with topographical data and added to the numerical model, as presented in Chapter 3, to calculate the TIF for the restored basins. Data will be downloaded every 90 days for analysis. Water surface elevation data are also calibrated with a topographic survey of the water surface near the gauge by the surveyor during the tide data collection period to reduce the possibility of error introduced during to conversion of pressure to elevation.

A network of tidal elevation measurements was made prior to construction and a slightly expanded and potentially modified network of measurements will also be made after construction. Pre-construction areas included the tidal inlet and west and central basins, while post-construction will include those same sites or slightly modified sites, with the addition of the east basin. Additional gauges may be added post-construction to each basin to increase coverage and data quality if determined appropriate. Monitoring during construction was conducted, as feasible, in the inlet channel and west and central basins around activities to record data at important events such as mandatory monthly lagoon draining during dredging.

5.1.1.1 Pre-Construction

Pressure sensors were installed by the design team at five locations within the lagoon to record existing water levels. Figure 5-1 shows the locations of the six tide gauges installed pre-construction in September 2016. Locations include the west and central basins, and the tidal entrance channel. The locations were identified as those that will not change substantially due to project implementation, in that they will remain open water prior to and after construction.

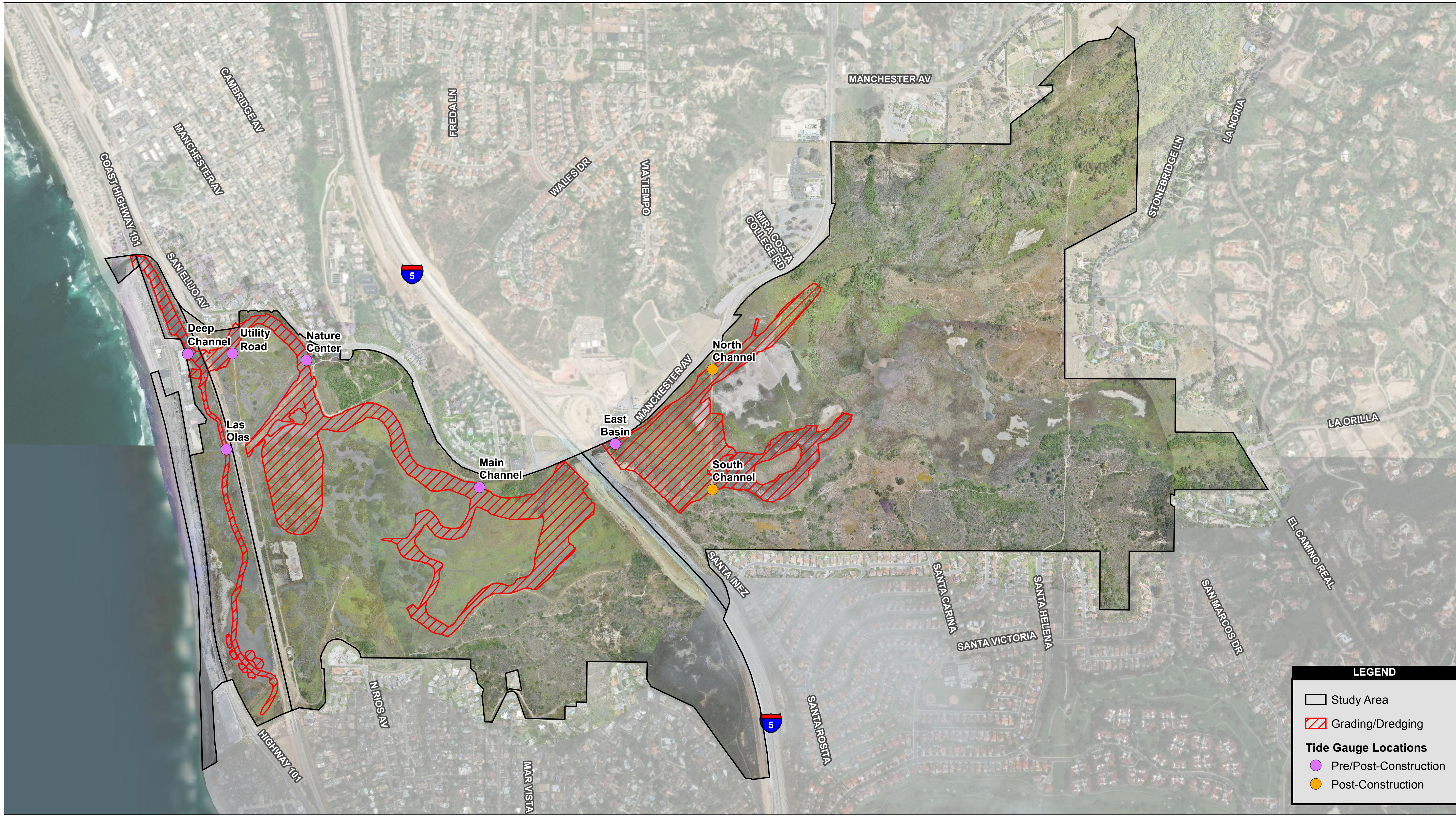
One sensor, labeled as Deep Channel, exists in the tidal entrance channel between Highway 101 and the railroad bridge. Deep Channel replaced the previous gauge at Highway 101, which no longer exists as it was either lost or stolen from under the bridge. The location proved problematic due to sedimentation and vandalism, and potential exposure to wave impact. It is not recommended as a permanent gauge location unless considered sacrificial. The Deep Channel gauge has proven reliable and secure compared to the one at Highway 101. Another sensor exists in the west basin near the Las Olas restaurant dirt parking lot.

Two more sensors are in the main channel of the central basin, with one at the north end of the utility road and the other near the proposed new reach of the main tidal channel in the northeast area of the basin. One additional gauge was installed near the San Elijo Lagoon Nature Center to provide for a more accessible and dependable location.

Also, one gauge was installed for a short period of time in the east basin just upstream of the I-5 bridge. That gauge was removed to prevent it from being damaged during construction. The network of data sondes for water quality monitoring, installed by Nature Collective, will be in place for additional data.

5.1.1.2 Post-Construction

The same network of gauges installed pre-construction will remain after construction for the monitoring period, but with additional sensors to record tides in newly restored areas. Additional gauges will be installed post-construction in new tidal areas (Figure 5-1). The east basin will be monitored by the existing sondes but also with two new pressure sensors in the new northern tidal channel just downstream of the former CDFW dike and toward the upstream end of the new channel.



MoffattNichol (2015-18); AECOM (2018), SanGIS (2018).

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Figure 5-1
Tide Gauge Locations

SELRP Wetland Habitat and Hydrology Monitoring Plan

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One additional flow velocity measuring gauge, referred to as an Acoustic Doppler Current Profiler, or ADCP, will be installed during construction and will continue to be used post-construction. The ADCP gauge will sit either in the tidal inlet channel or the main channel upstream near the Nature Center and provide flow velocity over time as well as water surface elevation. Those data will be useful in calculating the tidal prism as needed. The gauge will be located very close to the Deep Channel tide gauge or the Nature Center tide gauge.

5.1.2 Monitoring Frequency

Monitoring has been conducted pre-construction and during construction, and will continue post-construction for water surface elevations. Monitoring during construction has been judicious, with efforts designed to continue data collection to the extent possible while avoiding construction activities. Monitoring of the tidal inlet and west basin has been possible until construction activities encroached on those locations. However, the entirety of the central basin could not be monitored continually because construction equipment was working in the channels. Once construction moved away from areas where gauges were located monitoring tidal elevations resumed. Post-construction tidal monitoring will be maintained on a basis that is as close to continual as possible.

5.1.2.1 Pre-Construction

Pre-construction monitoring was conducted for 1 year prior to construction. Tidal elevation data were collected and downloaded roughly each quarter in 2017. More frequent data downloading occurred initially to verify that data were being recorded successfully and accurately, and to check on the condition of the gauge batteries and of marine growth on the gauges. The frequency of data download was set at a minimum of quarterly after confirming that the data acquisition was successful, the batteries were charged, and marine growth on the gauges was not excessive. More frequent data downloads occurred when opportunities to visit the site were presented.

One factor that affected the gauge readings was build-up of seaweed and kelp over the gauges. The gauges were anchored to the bed on fence posts, and seaweed/kelp was caught on the posts and accumulated over time. If the accumulation became a mound around the gauge, then the gauge readings could be affected. These factors have been accounted for, and in the future more frequent visits to the gauges that tend to accumulate seaweed/kelp (behind the Las Olas restaurant and at the utility road) will provide the opportunity to keep them relatively free of such problems.

5.1.2.2 Post-Construction

Post-construction, this same type of data collection and retrieval will continue, and gauge maintenance frequency post-construction will be the same as that which occurred pre-construction. At a minimum, data will be collected quarterly and potentially more often at certain locations if they experience seaweed/kelp accumulation for the first 10 years post-construction. Cleaning the gauges of marine growth will occur at least quarterly, and possibly more often during summer months when marine growth accelerates. This frequency of monitoring will continue until 10 years post-construction or until overall project performance standards have been met.

5.2 PERFORMANCE STANDARDS

Tidal elevation is an absolute monitoring variable and will not be subject to comparisons with reference wetlands. Tidal elevation is expected to change over time depending on the condition of the inlet, which is maintained annually, the tidal cycle in the ocean (neap or spring tides), and/or other regional conditions such as large storm events or El Niño events. These short-term cycles (less than a year) are not anticipated to result in substantial changes to habitat areas once the habitat is established. This is because the habitat becomes established in response to a range of TIF and is resilient to moderate ranges in TIF. This is an accurate statement if the ranges in TIF are not variable from year to year, and are not trending in one direction or another. Sea level rise will eventually throw off this "dynamic equilibrium" and cause habitat areas to begin transgressing toward higher elevations.

Performance standards therefore include the following metrics to address habitat areas, circulation, and water quality:

1. Habitat areas must fall within 10% of the designed habitat area targets in response to TIF; and
2. Predicted seawater residence time must remain on average shorter than 7 days in the central basin and 9 days in the east basin, as estimated using a numerical hydrodynamic model (such as RMA) to indicate first order water quality.

Tidal prism is not a performance standard because tidal elevation more directly addresses the important issues of habitat, circulation, and water quality. Tidal elevation ranges will yield the data needed to determine whether problems that may exist within channels and the tidal inlet would trigger maintenance. Maintenance is already expected and planned to be conducted annually into perpetuity. Tidal elevations targeted for the restored wetland, as compared to existing conditions, are shown below in Tables 5-1 and 5-2. These elevations represent cleared conditions of the tidal inlet, or immediately after restoration, and then immediately after annual maintenance dredging. Shoaled conditions will result in a compressed tidal range and slightly muted tidal elevations.

Table 5-1 Predicted Tidal Ranges for Cleared Conditions with Ocean Sea Level in 2017

Alternative	Tidal Range (ft)[1]					
	Open Ocean	Hwy 101 Bridge	West Basin (Las Olas)	Central Basin (PWA Dock)	I-5 Bridge	East Basin (CDFW Dike)
Existing	7.97	4.56	3.99	3.85	3.78	3.76
Proposed (1B)	7.97	6.58	5.44	5.42	5.42	5.42

ft = foot/feet; CDFW = California Department of Fish and Wildlife; Hwy = Highway;
PWA = Philip Williams & Associates

[1] Numbers represent the difference between high and low tide elevations (see Table 5-2).

Table 5-2 Predicted Spring High and Low Tidal Elevations for Cleared Conditions with Ocean Sea Level in 2017

Alternative	High and Low Tidal Elevations (ft NAVD88)											
	Open Ocean		Hwy 101 Bridge		West Basin (Las Olas)		Central Basin (PWA Dock)		I-5 Bridge		East Basin (CDFW Dike)	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Existing	6.50	-1.47	6.30	1.74	5.77	1.78	5.65	1.80	5.63	1.85	5.63	1.87
Proposed (1B)	6.50	-1.47	6.41	-0.17	6.00	0.56	6.00	0.58	6.00	0.58	6.00	0.58

ft NAVD88 = feet North American Vertical Datum of 1988; CDFW = California Department of Fish and Wildlife; Hwy = Highway; PWA = Philip Williams & Associates

Sand and cobble will deposit in the tidal inlet channel as delivered by the ocean. That material typically does not migrate upstream of the railroad bridge due to distance and the channel bend at the bridge that modifies flow. Also, even if some of the finer sand were to move farther upstream, there would not likely be a substantial shoal formation that would impede tidal exchange because the channel is being widened and deepened substantially by restoration. However, should shoaling be observed to occur in areas other than the inlet (i.e., upstream of the railroad bridge), the effects of such shoaling on tidal elevations will be present in the tide data and can be evaluated for potential secondary effects to habitat, circulation, and water quality. Nature Collective can analyze both TIF and residence time at that time with the new tide data and the model to determine if habitat areas and circulation/water quality will change in response.

The tide data recorded will be used to calculate both the TIF relationship with habitat areas, and the estimated tidal residence time. The design team will model the site after restoration to determine tidal residence times within each basin. If the residence time is estimated to be longer than 7 days in the central basin and 9 days in the east basin, then the water quality conditions will need to be more closely monitored within a particular area to determine potential degradation. Likewise, the TIF relationship with habitat will be analyzed by basin. If it seems to indicate a variation of that condition from pre-restoration design objectives, then that habitat will be monitored closely to determine if there are anomalies from the pre-construction design condition.

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6. HABITAT AREAS

Habitat areas are a project design absolute monitoring variable and will not be subject to comparisons with reference wetlands for purposes of determining success of the SELRP. Methodology to calculate habitat area reflects methods used at the reference wetlands, however, because it is relevant and provides consistency across projects. Performance standards for habitat areas include standards that habitat distribution falls within 10% of designed acreages by habitat, which are dependent upon various other metrics, including topography, bathymetry, and tidal elevation.

6.1 METHODS

6.1.1 <u>Data Collection</u>

Habitat will be classified based on the dominant and characteristic plant species, plant physiognomy, and soils in accordance with the *Draft Vegetation Communities of San Diego County* (Oberbauer et al. 2008), based on the *Preliminary Descriptions of the Terrestrial Natural Communities of California* (Holland 1986). Subtidal, intertidal mudflat, and intertidal salt marsh habitats will be categorized based on the criteria identified in the San Dieguito Wetlands Restoration Project:

- Areas will be assessed as subtidal habitat if they remain continuously submerged.
- Areas will be assessed as intertidal mudflat if they are intertidal, are located below an elevation of +3.2 feet NAVD88, and are sparsely vegetated (possess <5% cover of vegetation).
- Areas will be assessed as salt marsh if they are intertidal, are at or below an elevation of +5.5 feet NAVD88, and have a cover of native salt marsh vegetation of 30% or greater.
- Areas at appropriate elevations for specific habitat elevations that are not assessed as one of the delineated habitats will be assigned to a category characterizing it as not achieving performance standards.

Monitoring will be conducted using low-level multi-spectral aerial photography acquired by Unmanned Aerial Vehicle (UAV) during low tides and in the late summer (e.g., August through September). The aerial images will be ground-truthed to ensure accuracy of habitat delineation using the aerial photographs. Elevation contours at +3.2 and +5.5 feet NAVD88 will be determined using the methods described for topography in Section 3.1.1. Areas to be monitored for habitat acreage include both those directly impacted by dredging/grading as well as those predicted to convert over time, in addition to the rest of the lagoon. Areas predicted to convert from one habitat to another are based on the modeled TIFs post-construction. These areas will not be planted but are expected to gradually develop and ultimately support the appropriate species within a given elevation range; monitoring to track conversion will be conducted using the aerial images described above.

In addition, habitat monitoring will be conducted at the six mounds located at the southern portion of the west basin, as shown in Figure 1-2, where material taken from the channel was side-cast and contoured to create mounds of varying elevation. Monitoring will be conducted to confirm if vegetation establishes along these mounds.

6.1.2 Monitoring Frequency

Monitoring was conducted pre-construction and will continue post-construction for habitat areas within the lagoon; no monitoring was conducted during construction. Monitoring will be conducted annually in late summer to capture the maximum vegetative cover during the height of the growing season.

6.1.2.1 Pre-Construction

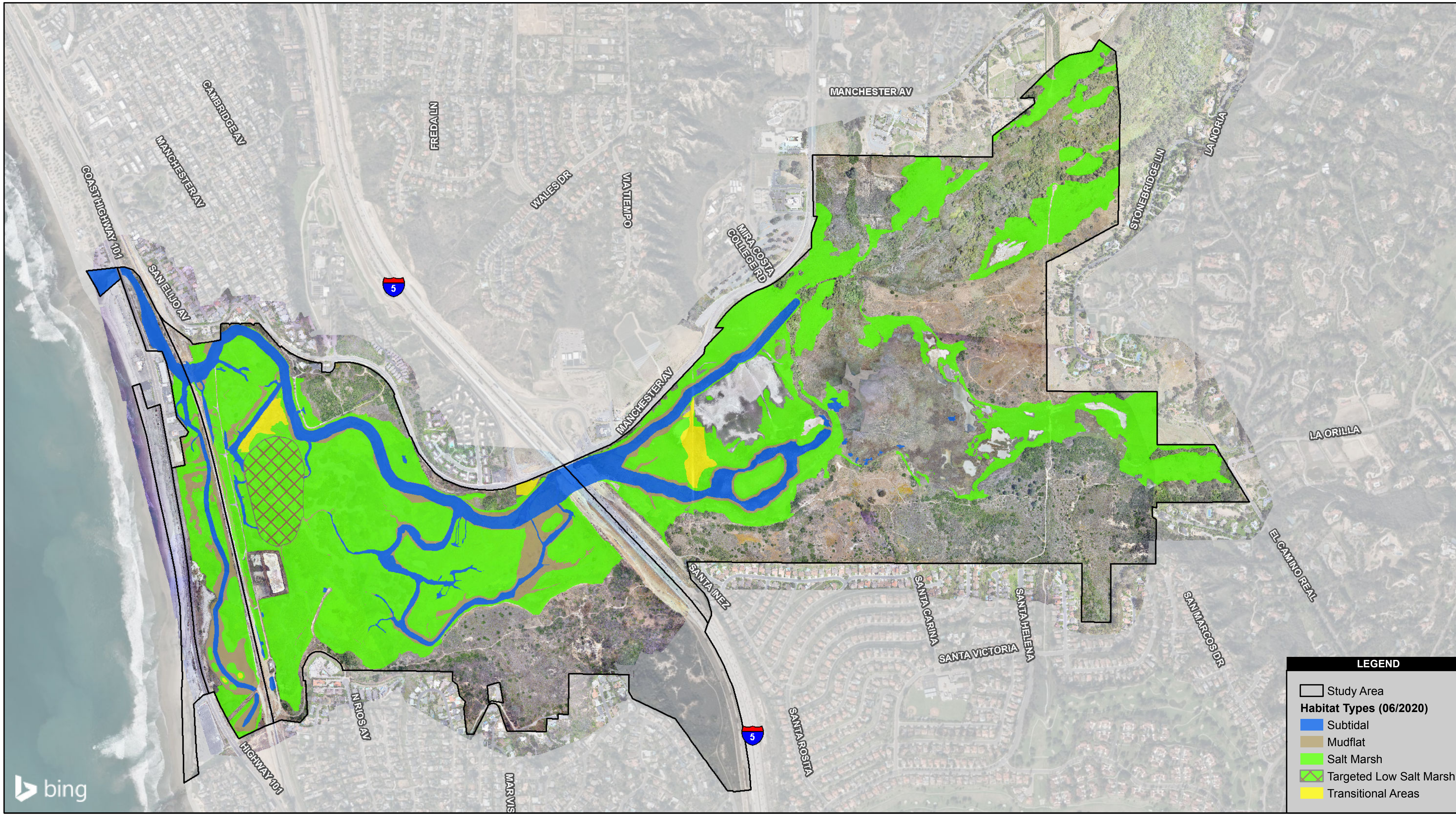
Vegetation mapping was completed throughout the project area by AECOM during the spring of 2010 and was updated in 2012 and 2015. Prior to the start of construction, in late summer of 2017, vegetation was monitored in the lagoon to refine monitoring methods.

6.1.2.2 Post-Construction

Post-construction monitoring of habitat areas will be conducted using the same methods as the pre-construction baseline surveys presented above. Post-construction monitoring will be conducted annually until 10 years post-construction or until performance standards have been met.

6.2 PERFORMANCE STANDARDS

The attainment of predicted habitats, including subtidal, intertidal mudflats, intertidal salt marsh, and transitional areas, is an absolute monitoring variable specific to two separate permit/approval requirements, is based on design target elevations, and will not be compared to reference wetlands. CCC Coastal Development Permit conditions stipulate that areas of different habitats not vary by more than 10% from the final approved habitat distribution. Target habitat acreages for CCC requirements are identified in Table 6-1 and shown in Figure 6-1. For restored areas, categorized acreages are derived from restoration acreages within the construction limits as indicated in Table 3-1 of the final restoration plan (AECOM 2017a). Areas anticipated to convert over time (e.g., west basin mounding) are derived from the difference between existing habitat distribution and that predicted post-restoration as identified in Table 6-1.



Source: SANDAG 2012; Moffatt & Nichol 2020; AECOM.

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Figure 6-1
Proposed Habitats

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Table 6-1 Target Habitat Distribution

Habitat Type	Target Acres
Subtidal	62
Intertidal Mudflat[1]	32-47
Intertidal Salt Marsh[1]	293-308
Transitional[2]	7
Total[3]	**409**

[1] Intertidal salt marsh and mudflat ranges are due to uncertainty of converted low marsh areas within the overdredge pit.
[2] Transitional habitat acreage has been updated to reflect refinements in geographic information system information.
[3] The total is based on the fixed area in which restoration is occurring.

Acreages will be summed by habitat category with the aid of geographic information system (GIS) software and compared to the planned acreages to determine whether they are within 10% of the planned areas. USFWS has also identified a habitat target acreage specific to low marsh, which supports the endangered light-footed Ridgway's rail within San Elijo Lagoon. This is considered a separate performance standard pertinent only to the USFWS requirements. The target acreage for low marsh is represented as a range due to the relative uncertainty associated with the ultimate elevations of the overdredge pit and the continued conversion of areas based on modeled inundation frequencies. Low marsh target acreage encompasses the lagoon as a whole since it is focused on species support, including planted areas, areas anticipated to convert over time, and existing low marsh, as identified in Table 6-2.

Table 6-2 Target Low Marsh Acreage

Habitat Type	Target Acres – Restored (Planted)	Target Acres – Converted (Unplanted)	Existing Pre-Construction Low Marsh[1]	Total Target Acres[2]
Low Marsh	19	12–27	27.0	57–73

[1] Based on 2015 information
[2] Biological Opinion total target acreage requirements of low marsh is a range of 57–73 acres.

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7. VEGETATION

Vegetation cover can reflect the health of habitat within a system and subsequent suitability for support of sensitive species. Vegetation monitoring contains three types of variables to satisfy the condition of the CCC Coastal Development Permit and the USFWS Biological Opinion. The three variables are proportion of total vegetative cover and open space and plant species diversity in each restored habitat type; California cordgrass (*Spartina foliosa*) canopy architecture; and exotic species cover within restored areas.

7.1 VEGETATIVE COVER

Vegetative cover is an absolute variable. Absolute monitoring requirements approved by USFWS in the SELRP Wetland Restoration Plan include comparison of cover to project design absolute performance standards (AECOM 2017a). Areas directly impacted by grading/dredging that are proposed to be vegetated areas will be planted. Mid and high marsh areas will be planted with appropriate species, then will rely on natural recruitment of native species, such as pickleweed (*Salicornia pacifica*), which currently exists throughout the lagoon adjacent to planted areas, to enhance diversity within those marsh habitat types. Standards have been established for planted areas based on the restoration plan that has been submitted and approved by wildlife agencies for other permit requirements.

Vegetation cover was monitored prior to construction (late summer 2017) to assess pre-project conditions of areas to be impacted by restoration activities, as shown in Figure 7-1. Post-construction monitoring to assess establishment of planned planted habitat types will occur in the same locations, as well as those areas anticipated to convert over time. Post-construction monitoring will focus on establishment of low, mid-high salt marsh, and transitional habitats following the 240-workday plant establishment period (PEP). Areas impacted by grading will be planted based on the SELRP Wetland Restoration Plan (AECOM 2017a).

7.1.1 Methods

7.1.1.1 Data Collection

Monitoring methods described herein will be conducted in both planted and unplanted areas. Planted areas within the limits of grading/dredging for the project (e.g., marsh and transitional habitat) will be monitored for success based on plant survival and, ultimately, canopy cover. Unplanted areas to be monitored include those anticipated to passively convert to vegetated habitat due to changes in hydrology and TIF within the lagoon. It is proposed that the success of unplanted areas be based on the percent cover of plant species appropriate to that elevational range. The SELRP Wetland Restoration Plan defines plant species associated with each habitat type (AECOM

2017a). For example, conversion of mid-marsh to low marsh would be confirmed by the presence of a high percentage of California cordgrass within the low marsh versus pickleweed, marsh jaumea (*Jaumea carnosa*), and saltwort (*Batis maritima*) (among others) found within the mid-marsh. To determine the vegetation composition of high-quality low marsh, areas of San Elijo Lagoon where light-footed Ridgway's rail have been present in the past were monitored using the California Native Plant Society (CNPS) point intercept method and 0.25-square-meter (m^2) quadrats. A relative analysis between California cordgrass and other native species indicates that, in existing low marsh, California cordgrass cover is approximately 70% while the other species comprise approximately 23% and open space between plants accounts for the remaining percentage to add up to 100%.

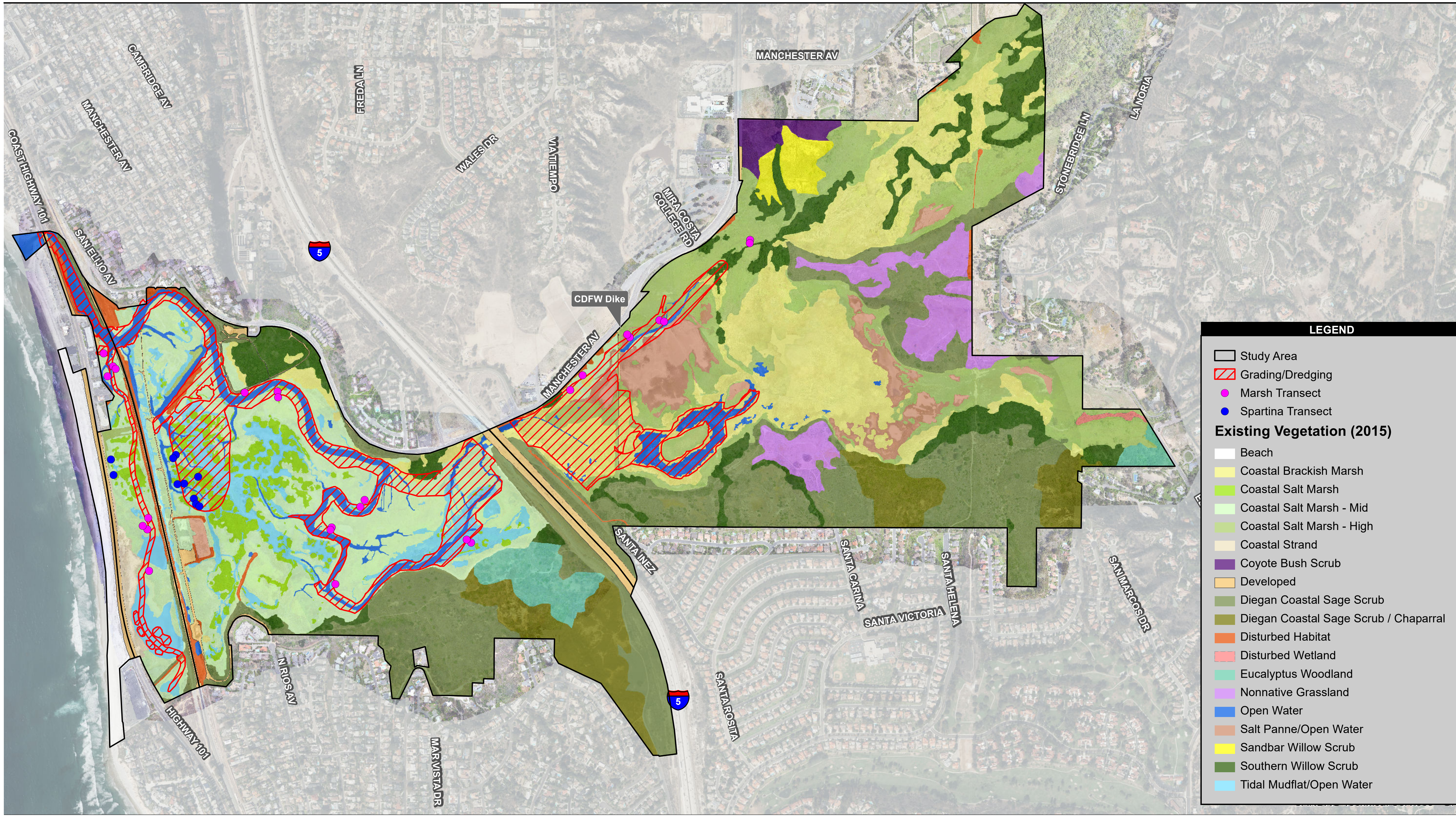
Quantitative Monitoring

Quantitative monitoring will be conducted post-construction and consists of multi-spectral aerial imagery (as described in Section 6.1.1), point-intercept transects, and diversity belt transects. Locations where post-restoration transects are planned are shown in Figure 7-2.

Point-Intercept and Diversity Belt Transects

Permanent point-intercept transects 30 meters (m) long will be placed at a density of approximately one per acre within the areas to be planted and areas expected to convert to salt marsh habitat post-construction, and will be used to determine native and nonnative cover during the monitoring program. Much of the area identified for planting will be linear because channel edges are linear in nature and therefore will be planted in narrow bands. Transects will not work in a perpendicular fashion along these narrow linear bands and must be placed nearly parallel or in line with the channel edges). Canopy cover of vascular plant species will be assessed along transects using the point-intercept method recommended by the CNPS, which involves dropping a vertical line at 0.5-m intervals along each transect. Each species intercepted by the vertical line is recorded. In addition to collecting point-intercept data, plant species not encountered along the transect will be recorded within a 2.5-m-wide diversity belt along each side of the transect to capture species diversity.

To calculate total cover (i.e., the proportion of area covered by the plant canopy relative to bare ground), the number of points that intercept live plant material will be summed and divided by the number of possible intercepts along the transect (i.e., 60; 2 points per meter for 30 m). It should be noted that multiple hits of plant material are possible at a single point due to overlap of two or more species of varying heights. Additionally, one end of each vegetation transect will be used as a permanent photo station to visually record the progress of the restoration over the maintenance and monitoring period. Data will be collected each year in summer to coincide with aerial imagery and to capture the height of the growing season.

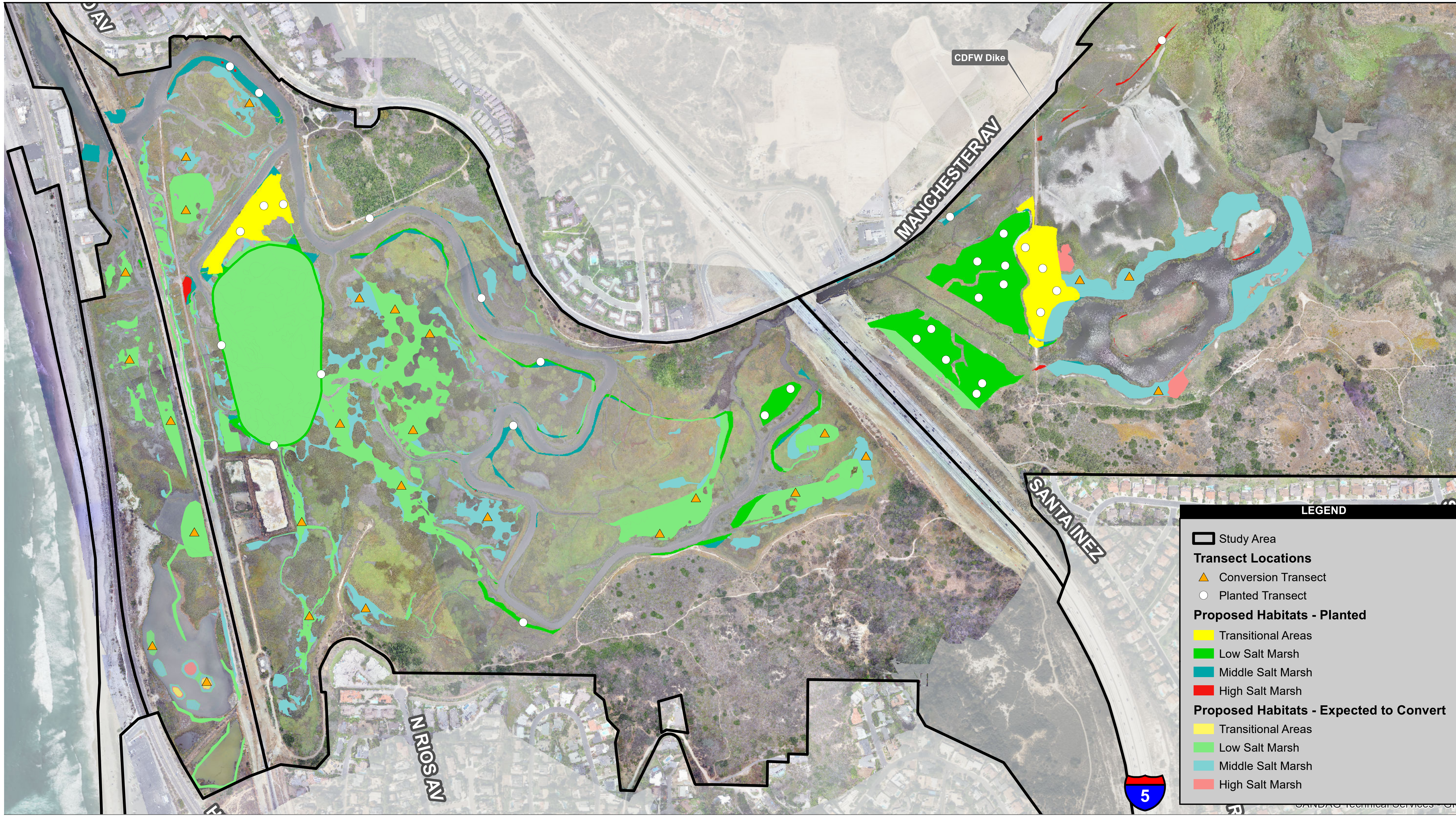


MoffattNichol (2015-18); AECOM (2018), SanGIS (2018).

1,100 550 0 1,100 Feet

Scale: 1:13,200; 1 inch = 1,100 feet

Figure 7-1
Pre-Construction
Vegetation Transects



Source: MoffattNichol (2015-18); AECOM (2018), SanGIS (2018).

600 300 0 600 Feet

Scale: 1:7,200; 1 inch = 600 feet

Figure 7-2
Post-Construction Vegetation Transects

Qualitative Monitoring

Qualitative monitoring will be conducted post-construction to inform maintenance activities that may be required to achieve quantitative goals. Qualitative monitoring will include an assessment of vertical of soil conditions, plant health and growth, visual estimate of plant survival, visual estimate of seed germination rates, presence of native and nonnative plant species, major disease or pest problems, and erosion problems. The Restoration Biologist will be responsible for a visual estimate of plant survival and condition during qualitative visits. Remedial recommendations will be provided as necessary based on the expert opinion of the Restoration Biologist. Recommendations may include supplemental planting and seeding.

During each qualitative site visit, the Restoration Biologist will conduct a site overview of the restoration site to evaluate the following:

- Overall site conditions
- Qualitative hydrological functions
- General condition of plants, including plant health/vigor and mortality
- Visual estimate of seed germination rates
- Visual estimate of native plant recruitment
- Potential issues, including hydrology, irrigation problems (too much or too little), invasive nonnative species of concern (e.g., pampas grass and ice plant), vandalism, and other problems that need to be addressed by the installation or maintenance contractor

It is unrealistic to conduct a formal plant count, but the Restoration Biologist will conduct a visual estimate of plant survival and condition during qualitative visits. During each late-summer site visit, the Restoration Biologist will assess the need for potential remedial planting during the winter. Remedial recommendations will be provided as necessary. Recommendations may include container planting and broadcast seeding, weeding, irrigation scheduling, trash removal, and pest control. In addition, the Restoration Biologist will identify the following:

- Scheduling upcoming maintenance based on the maintenance needs and priorities at the restoration site.
- Walking the restoration site to identify problems, including erosion, irrigation damage, occurrence of invasive nonnative species, and potential human impacts such as vandalism.
- Providing support to field maintenance crew in the identification of native and nonnative species.

- Determining an irrigation schedule (for a given period of time) based on seasonal and annual variation in rainfall, native plant water requirements, and site-specific conditions (e.g., soil condition and slope), if different from scheduled irrigation.

Photo-documentation

In addition to the photo stations associated with the permanent vegetation transects, 10 fixed photo stations were established at representative points within the lagoon. These photo stations have been used to document the construction process. During construction, one photo station in the east basin has been moved to a better vantage point and an additional photo station was added in the west basin (Figure 7-3). After construction, photos will be collected twice per year for the first 4 years of the 10-year monitoring program, concurrent with quantitative monitoring, and once per year for the remaining 6 years. Representative photos taken from these points will be included in annual reports to document progress of the restoration site. Photo stations will be marked using global positioning system (GPS) units and displayed on a map in the annual report.

7.1.1.2 Monitoring Frequency

Monitoring will be conducted pre-construction, during construction, and post-construction.

<u>Pre-construction</u>

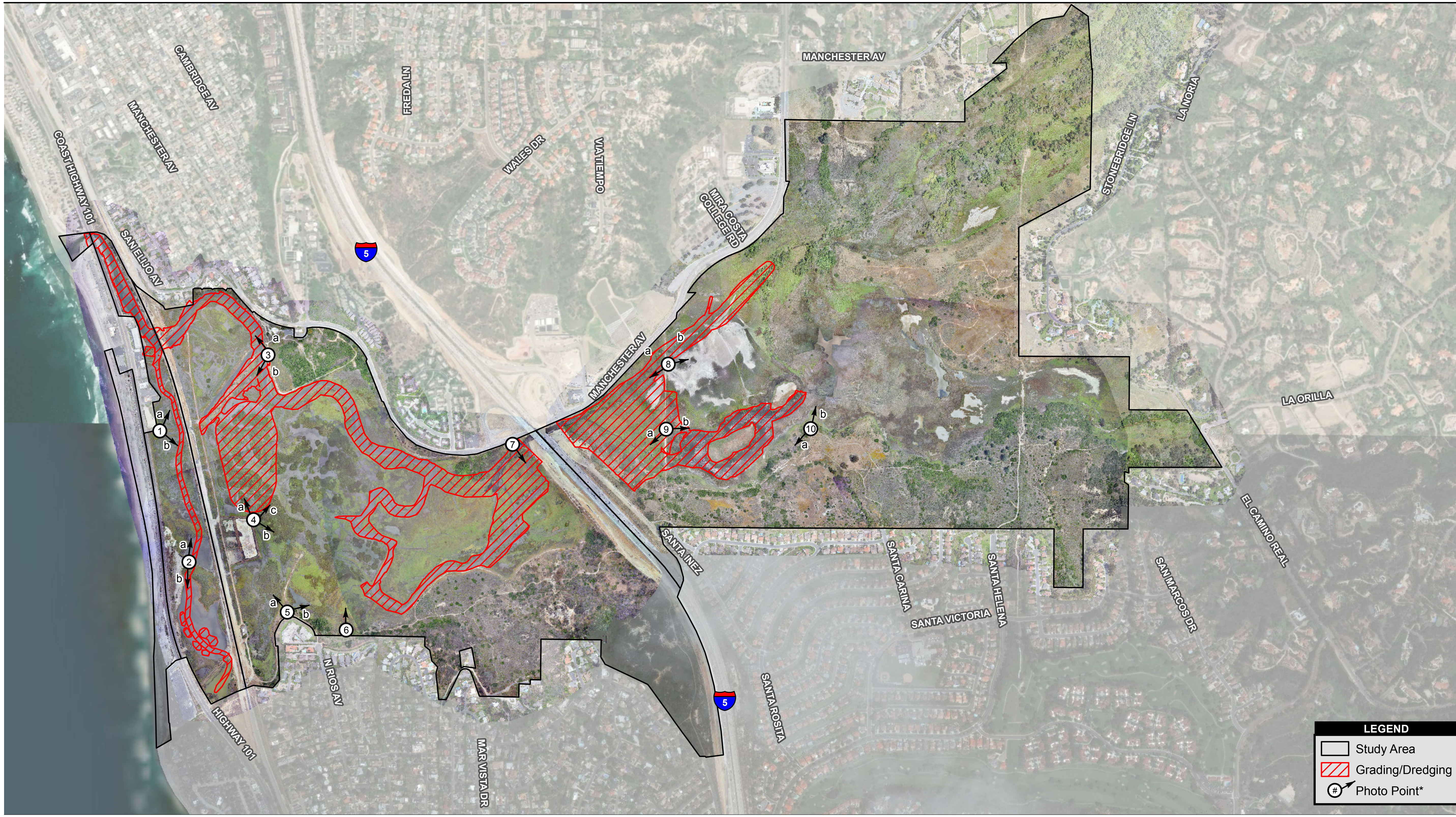
AECOM conducted quantitative monitoring within and outside of the planned limits of disturbance in late summer 2017.

<u>Construction</u>

As previously noted, impact monitoring has been conducted throughout construction. In addition, monitoring will occur during the 240-workday PEP. The 240-workday PEP is considered part of construction. Additional details regarding monitoring during the 240-workday PEP can be found in the SELRP Wetland Restoration Plan (AECOM 2017a).

<u>Post-construction</u>

The restoration of each basin will be monitored for successful reestablishment over the monitoring period. The Restoration Biologist will conduct qualitative monitoring of the restored areas quarterly during the first 2 years post-construction, semi-annually during Years 3 and 4, and annually Year 5 through Year 10. Quantitative monitoring will be conducted annually in the late summer to coincide with the multi-spectral aerial photography. The Restoration Biologist will continue monitoring at the same frequency until performance standards have been met.



MoffattNichol (2015-18); AECOM (2018), SanGIS (2018).

1,100 550 0 1,100 Feet

Scale: 1:13,200; 1 inch = 1,100 feet

* Photo point locations will be used pre- and post-construction.
Arrows depict direction of photo.

Figure 7-3
Photo Point Locations

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7.1.2 Performance Standards

Performance standards for vegetation cover address the post-construction 240-workday PEP during which the contractor is responsible for maintaining plants as well as the performance standards necessary to meet longer-term habitat goals.

Plant Establishment Period Monitoring

After planting/installation work is completed within each basin and/or planting area, a 240-workday PEP will begin. During the 240-workday PEP, the restoration contractor will provide regular maintenance of the restoration site. At the end of the 240-workday PEP, 100% survival of planted species will be achieved with the exception of transplanted cordgrass. The survival of transplanted cordgrass cannot be determined until approximately 1 year after installation as this species frequently dies back above ground but rhizomes continue to grow below ground. Based on experience with other restoration projects, typical survival of transplanted cordgrass is approximately 35% to 40%. Should that range be attained at San Elijo Lagoon, further transplantation may not be required. Should survival drop substantially below that range (i.e., below 40% survival), the Restoration Biologist may determine that additional transplantation is required.

Nursery-grown container stock (container plants) will achieve 100% survival at the end of the 240-workday PEP or be replaced prior to acceptance by the Caltrans Resident Engineer. Additional details regarding monitoring during the 240-workday PEP can be found in the SELRP Wetland Restoration Plan (AECOM 2017a).

Absolute Performance Standards

Absolute performance standards are provided to verify that the restoration program achieves desirable native salt marsh habitat characteristics within 5 to 10 years. Performance standards are based on the composition of native salt marsh habitat and reasonable expectations regarding the condition of created/restored habitats after 10 years. Interim yearly performance standards are also provided as milestones to help determine if the restoration is on an adequate trajectory and to aid in adaptive management decisions, including the need for planting and/or seeding or other remedial measures (Chapter 16). The interim yearly performance standards are absolute (Table 7-1) and require the separation of low marsh from the other marsh types (mid and high marsh). Final standards will be considered met when the Year 10 cover standards have been met.

Table 7-1 10-Year Absolute Performance Standards

Milestone	Planted Low Marsh Native Cover (absolute)	Planted Mid and High Marsh Native Cover (absolute)	Unplanted Marsh Native Cover (absolute)[1]	Planted Transitional Habitat Native Cover (absolute)	Species Diversity	Nonnative Cover (absolute)	Container Plant Survival
240-Workday Plant Establishment Period	N/A	N/A	N/A	N/A	N/A	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	100%
Year 1	5%	10%	N/A	10%	80% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 2	10%	20%	N/A	20%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 3	20%	30%	N/A	35%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 4	35%	45%	N/A	50%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 5	45%	55%	30%	70%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)

Milestone	Planted Low Marsh Native Cover (absolute)	Planted Mid and High Marsh Native Cover (absolute)	Unplanted Marsh Native Cover (absolute)[1]	Planted Transitional Habitat Native Cover (absolute)	Species Diversity	Nonnative Cover (absolute)	Container Plant Survival
Year 6	50%	60%	30%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 7	55%	65%	35%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 8	60%	70%	40%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 9	65%	75%	40%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 10	70%	80%	45%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)

Cal-IPC = California Invasive Plant Council; N/A = not applicable
[1] Performance standards for low marsh and mid to high marsh will be separated by planned acreage for respective habitat types.

7.2 CALIFORNIA CORDGRASS (*SPARTINA FOLIOSA*) CANOPY ARCHITECTURE

California cordgrass canopy architecture is a relative monitoring variable and will be compared to reference wetlands for purposes of determining success of the SELRP.

7.2.1 Methods

To comply with CCC Coastal Development Permit conditions, areas of low salt marsh dominated by California cordgrass that are within the area to be impacted during restoration activities will be monitored pre-construction and post-construction. Such areas will include the overdredge pit, low marsh created in the central and east basins, and areas where channel widening and deepening will result in cordgrass growth after restoration is complete. Monitoring will be conducted using the methodology described in *Handbook for Restoring Tidal Wetlands* (Zedler 2001).

7.2.1.1 Data Collection

Transects will be established in the areas of cordgrass-dominated low marsh that will be impacted during construction (Figure 7-2). Each transect will be 20 m long, extending parallel to the water and through several stands of cordgrass, where applicable. As cordgrass has been colonizing former mudflat habitat at San Elijo Lagoon, extending transects parallel to the water may not be feasible. The end points of each transect will be recorded by GPS so that transects can be reestablished following restoration activities, e.g., grading and replanting. The number and height of cordgrass stems will be assessed in 0.1-m^2 (circular) quadrats placed over the cordgrass every 2 m along each transect. Maximum height (excluding flowering culms) of stems present in the quadrat will be recorded. The mean proportion of stems >3 feet in height will be determined for each cordgrass stand.

7.2.1.2 Monitoring Frequency

Pre-construction monitoring was conducted in 2017. Post-construction monitoring will be conducted annually until overall project performance standards have been met. Monitoring will be conducted in late August to coincide with the end of the growing season for Southern California salt marshes and the attainment of maximum annual cordgrass height.. A number of factors can contribute to cordgrass density and height, including freshwater input, disease, insect infestation, and competition with other low marsh species, such as marsh jaumea. In addition, cordgrass populations occasionally die, in response to environmental variables or from unknown biological mechanisms. For example, California cordgrass populations in San Diego Bay died back substantially in 2016, presumably due to high tides exceeding predicted levels by as much as 1 foot during the El Niño event. Prior to 2016, cordgrass populations declined dramatically in portions of San Diego Bay for unknown reasons and, as of 2017, had not regained their previous density or height. Furthermore, as one of the main goals of the SELRP is to remove eutrophic sediment to improve water quality, such removal may affect the growth of cordgrass in these artificially enriched soils.

7.2.2 Performance Standards

California cordgrass is a relative standard, which will be used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The restored wetland areas shall have a California cordgrass canopy architecture similar to reference wetlands. The relative performance standard will be considered met if the 4-year running average of the mean proportion of stems >3 feet is not significantly worse than the mean value at the lowest performing reference wetland.

7.3 EXOTICS

Exotic plant cover is an absolute monitoring variable and will not be subject to comparisons with reference wetlands for purposes of determining success of the SELRP.

7.3.1 Methods

7.3.1.1 Data collection

While it is not anticipated that exotic plant species will colonize the low and mid intertidal salt marsh areas to be restored by the SELRP, it is likely that such species could invade high salt marsh and transition areas. Surveys of vegetative cover in restored areas described in Section 7.1, including 2.5-m-wide diversity belt along each side of the transects for species composition, will inform the monitoring program on the presence of exotic species.

7.3.1.2 Monitoring Frequency

Exotic cover will be monitored during surveys of total vegetative cover. Monitoring in restored areas will occur quarterly during the first 2 years post-construction, semi-annually during Years 3 and 4, and during Year 5. Monitoring will continue annually until 10 years post-construction or until performance standards for vegetation cover have been met.

7.3.2 Performance Standards

Conditions included in the CCC Coastal Development Permit and the USFWS Biological Opinion state that important functions of the restored wetland shall not be impaired by exotic species, including 0% coverage by California Invasive Plant Council "Invasive Plant Inventory" species of "high" or "moderate" threat and no more than 5% coverage by other exotic/weed species. Should such species exceed the thresholds, they will be removed.

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8. WATER QUALITY

The SELRP is being implemented to improve water quality for the benefit of the plants and animals of the lagoon. Thus, water quality monitoring is a crucial component of the monitoring program. Water quality is a relative monitoring variable and will be compared to reference wetlands for purposes of determining success of the SELRP. Because of its documented importance to wetland health, the concentration of dissolved oxygen will be used to evaluate water quality within the restored wetland. Additional water quality data will be collected within the lagoon to enable effective adaptive management post-construction if the SELRP fails to meet the relative performance standard. If relative performance standards are not met, additional water quality data (turbidity, chlorophyll, pH, temperature, and depth) will be used to identify the location and probable cause of water quality issues. These additional spatially distributed time series data will provide a mechanism for identifying probable causes of failure to meet the performance metric. Other metrics will also affect water quality (e.g., sediment quality) or be affected by water quality (e.g., fish and benthic invertebrates), and are discussed separately in their respective sections.

8.1 METHODS

8.1.1 Data Collection

Nature Collective conducts water quality monitoring throughout the year to comply with permit requirements for the inlet maintenance, as well as to ensure that water quality parameters critical to wildlife are being maintained. Nature Collective has surveyed dissolved oxygen, salinity, and temperature at San Elijo Lagoon sites that are spread from the inlet at the Pacific Ocean to a point east of the freshwater dike in the east basin since 1991.

Reference wetlands employed for relative variable monitoring for the San Dieguito Lagoon Wetlands Restoration Project have one station for collecting water quality data generally located near their inlet, as shown in Appendix A. To calculate the relative performance metric for the SELRP, one continuous-monitoring data sonde will be deployed following the same method. The data sonde will be placed near the inlet at a comparable distance with reference wetland stations at approximately 4,700 feet from the inlet (Success Criteria Continuous Station, Nature Center; Figure 8-1). Dissolved oxygen, water depth, conductivity, temperature, pH, turbidity, and chlorophyll will be recorded every 15 minutes by the data sonde. Continuous monitoring provides a valuable tool to examine sustained oxygen levels on a daily or hourly basis, and can capture events such as first-flush storm peaks. In addition to the data sonde used for calculating the relative standard, Nature Collective will continue to conduct its historical monitoring using weekly sampling stations established in 1991 (Adaptive Management Weekly Stations; Figure 8-1) and add three additional data sondes to capture the spatial and temporal variability of water quality for informing adaptive management strategies (Adaptive Management Continuous Stations; Figure

8-1). These additional sondes and weekly water quality data will not be used for evaluation of the performance standard; they are for informing adaptive management strategies and long-term monitoring at these stations will continue at the discretion of Nature Collective.

An adaptive management data sonde will be placed in the west basin, the tidal basin between U.S. Highway 101, and the railroad double track (West Basin Station; Figure 8-1). Another adaptive management data sonde will be placed in the back of the central basin, the tidal basin between the railroad double track, and the I-5 freeway (Rios Station). The third adaptive management data sonde will be placed in the east basin, the tidal basin east of I-5 (Manchester Station). Prior to the restoration, W6, shown in Figure 8-1, was the hydrologically equivalent location in the watershed to the Manchester adaptive management station. W6 was the historical connection point between Escondido Creek and San Elijo Lagoon. Post-construction, the Manchester sonde will be placed in the post-restoration main channel, which is a constructed feature of the project and did not exist for historical water quality observations. The historical W6 sonde pre-construction data are baseline data comparable to measurements taken at the Manchester sonde post-construction.

Weekly sampling will be performed at seven locations in San Elijo Lagoon, and at one site located at the inlet from the Pacific Ocean (i.e., eight total; Adaptive Management Weekly Stations; Figure 8-1). Monitoring of these manual stations will include weekly measurements recorded at dawn for dissolved oxygen, temperature, and conductivity at the surface (~20 centimeter [cm] depth), channel edge bottom (~50–100 cm depth) and in the center of the channel bottom (~100–300 cm depth). The data from the weekly stations and the additional data beyond dissolved oxygen collected by the data sondes are an invaluable data asset for informing adaptive management if the SELRP fails to meet the relative performance standard.

To protect against data loss from sensor failure, live data stream capabilities will be added to each sonde as opposed to the double data sondes approach used by the San Dieguito Wetlands Restoration Project. Real-time data streams will eliminate field-based data downloads and allow for alerts regarding sensor failure to be provided in real time. This will allow for quick and efficient sensor replacement as opposed to traditional methods that do not allow for detection of sensor failures until data are downloaded. In addition, the data sondes' internal clocks will be synced so that sondes record synchronously every 15 minutes to allow for true snapshots of the water quality across the lagoon.

8.1.2 Monitoring Frequency

Monitoring will be conducted post-construction for water quality. No monitoring will be conducted during construction. Post-construction monitoring will begin in the first year following completion of all phases of the SELRP and will continue annually until 10 years post-construction or until overall project performance standards have been met. The data sonde that replicates the data collection at the reference wetlands will be used to calculate performance standards.

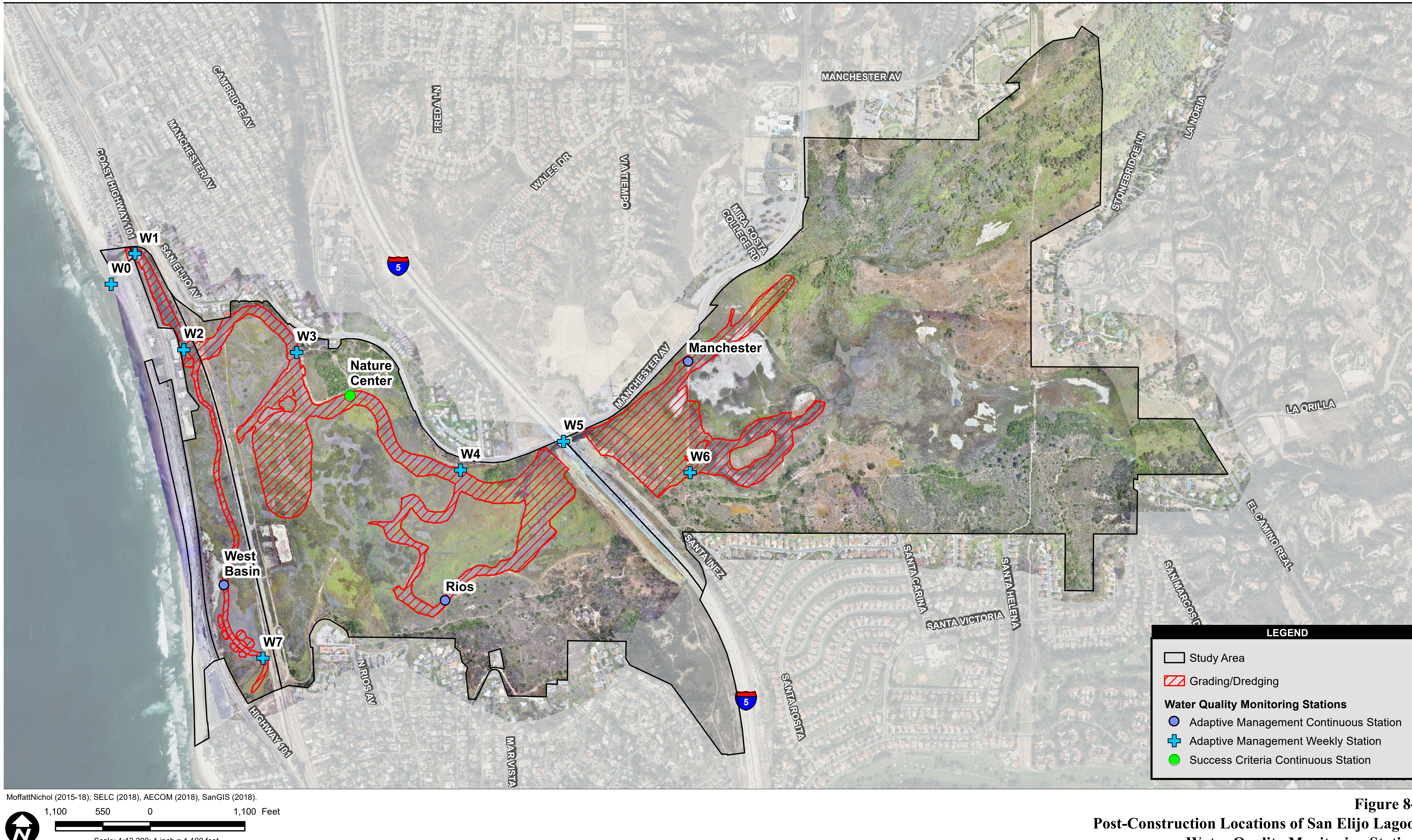

Figure 8-1
Post-Construction Locations of San Elijo Lagoon Water Quality Monitoring Stations

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8.2 PERFORMANCE STANDARDS

Water quality is a relative standard, which will be used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. A dissolved oxygen concentration below 3 parts per million (ppm) is considered hypoxic, and sustained concentrations below this value may be detrimental to estuarine biota (Ecological Society of America 2012). One approach to assessing dissolved oxygen is to assess the length of time continuously spent below this concentration. The water quality standard is evaluated by comparing the mean length in hours of continuous hypoxia between the restored San Elijo Lagoon and the reference wetlands. If the mean number of consecutive hours with dissolved oxygen <3 ppm is significantly higher in San Elijo Lagoon than in the reference wetland with the highest value, then San Elijo Lagoon fails to meet the standard.

The final relative performance standard will be considered met if the 4-year running average of the mean number of consecutive hours with dissolved oxygen <3 ppm is not significantly worse than the mean value at the lowest performing reference wetland.

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9. BENTHIC INVERTEBRATES

Benthic invertebrates are a relative monitoring variable and will be compared to reference wetlands for purposes of determining success of the SELRP. Methodology for measuring benthic invertebrate abundance/density, frequency of monitoring, and performance standards are described in the following sections.

9.1 METHODS

9.1.1 Data Collection

The benthic invertebrate sampling methods proposed for both pre-construction and post-construction monitoring are modeled after those conducted as part of the San Dieguito Wetlands Restoration Project (Page et al. 2018a). This will allow comparison with sampling at Mugu Lagoon, Carpinteria Salt Marsh, and Tijuana Estuary. These methods are summarized below:

- **Epifauna.** Epifauna, such as the California horn snail (*Cerithidea californica*) will be sampled by counting individuals in 0.25-m x 0.25-m quadrats. Pre-construction data will be collected at 12 sampling stations located in tidally influenced areas throughout the lagoon with six stations in main channels and six stations in tidal creeks (Figure 9-1). Only tidally influenced locations were chosen in order to facilitate data comparisons with reference wetlands; therefore, no sampling stations are located in the east basin for pre-construction surveys. Six additional locations (three main channel and three tidal creek) will be added to the east basin for the post-construction monitoring program once newly proposed tidally influenced areas develop (Figure 9-1).

  Each of the 18 sampling stations will be composed of five substations where epifauna will be assessed post-construction. Data collection at each of the substations (18 sampling stations x 5 substations = 90 substations) will consist of counting individual epifauna present within three pairs of 0.25-m x 0.25-m quadrats, which will be spaced uniformly and confined to mudflat habitat. Upper, middle, and lower tidal elevations of the mudflat habitat will each have a set of quadrats.

- **Infauna.** Infaunal sampling, as with epifauna sampling, will be confined to the tidally influenced areas throughout the restored lagoon as it is sampled in conjunction with the epifaunal assessment. Three sets of uniformly spaced cores (10-cm- and 3.5-cm-diameter core) will be collected at each substation located at the 18 sampling stations described above for epifauna. Infaunal core samples will be taken at the upper, middle, and lower tidal elevations of the channels.

Deep burrowing infauna (clams and ghost shrimp) will be sampled using a 10-cm-diameter core expressed into the sediment to a depth of 50 cm. The 10-cm-diameter cores will be sieved through a 3-millimeter (mm) screen in the field. Infauna collected using the 10-cm-diameter cores will be identified, counted, and released.

Smaller invertebrates (mostly annelids) will be sampled using a 3.5-cm-diameter core expressed into the sediment to a depth of 6 cm. The 3.5-cm-diameter cores will be preserved in the field in 10% buffered formalin and processed in the laboratory by sieving the core through a 0.5-mm mesh screen. The organisms retained by the 0.5-mm mesh will be preserved in alcohol and identified to as low a taxonomic level as possible. Sorted specimens will be archived for more detailed identification based on availability of resources and changes in project goals.

- **Metrics**. Density will be standardized to number per 100 square centimeters for each quadrat/core and then averaged across quadrats/cores at a given sampling station. Species richness will be standardized to number of unique species per sampling location (i.e., quadrat and core combined). In addition, unique benthic species captured during fish seining and enclosure trapping described in Section 11.1.1 (Data Collection) are also included in the species richness metric, but they are not included in the density metric.

9.1.2 Monitoring Frequency

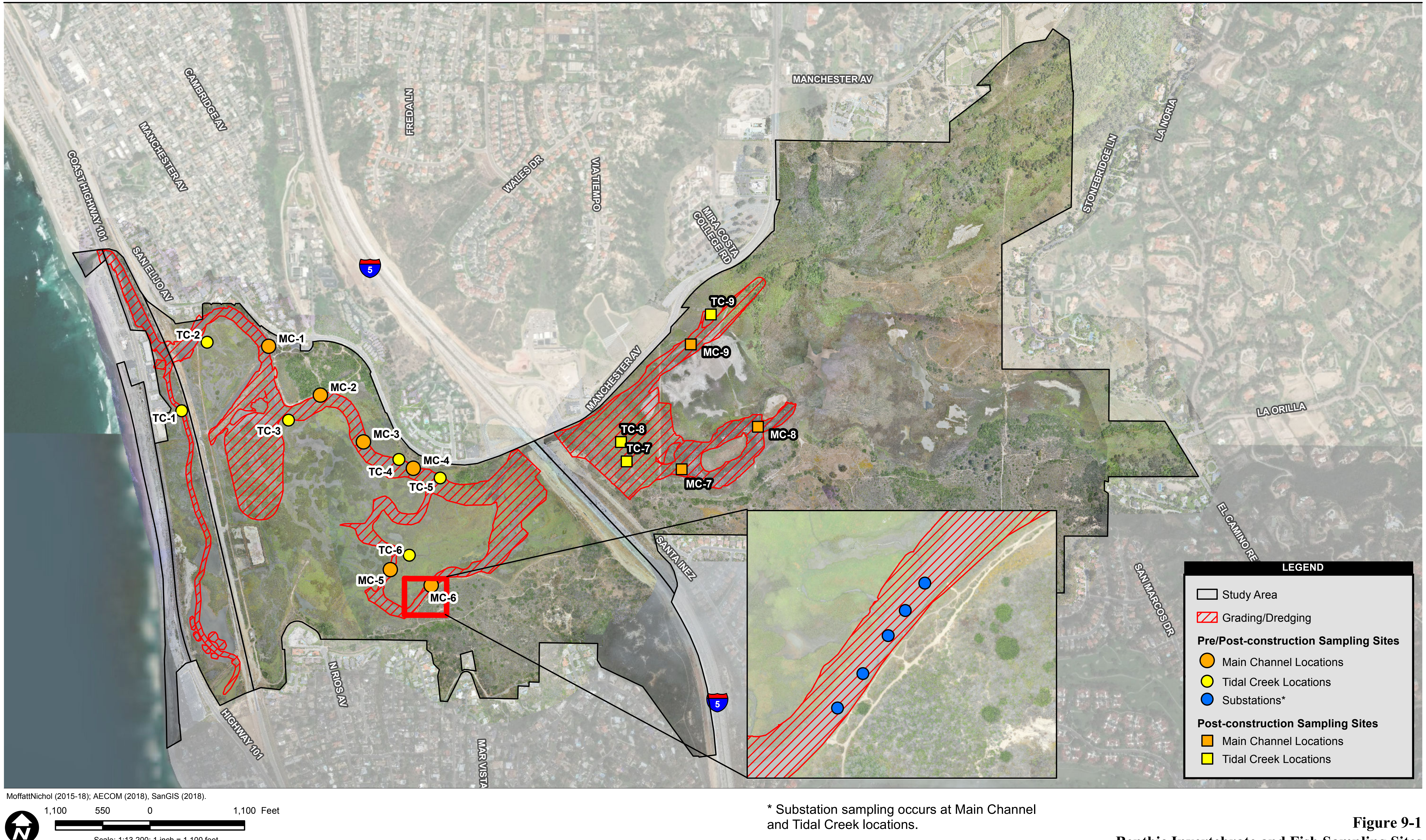
Benthic invertebrate monitoring was conducted pre-construction and will continue post-construction. Invertebrate measurements will be taken during the summer months (August through September) following the protocol of the San Dieguito Wetlands Restoration Project (Page et al. 2018a).

9.1.2.1 Pre-Construction

Pre-construction monitoring was completed in late October through early November 2017. Pre-construction monitoring data will serve as the baseline data used for comparison with post-construction data.

9.1.2.2 Post-Construction

Benthic communities are expected to take several years to establish following restoration. Therefore, benthic sampling will be conducted at Year 0, 1 and Year 3 after completion of restoration and then will be conducted annually beginning in Year 5. Year 0, Year 1, and Year 3 sampling is intended to provide data points to see where benthic recovery is starting from. Should these data points indicate benthic communities are recovering quicker than expected, annual monitoring may commence before Year 5. Once annual monitoring commences, it will continue until overall project performance standards have been met.



* Substation sampling occurs at Main Channel and Tidal Creek locations.

Figure 9-1
Benthic Invertebrate and Fish Sampling Sites

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9.2 PERFORMANCE STANDARDS

Benthic invertebrate community composition is a relative standard, which will be used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The relative performance standard will be considered met if the 4-year running average of the benthic invertebrate densities and number of species at San Elijo Lagoon are not significantly worse than the mean value at the lowest performing reference wetland.

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10. SEDIMENTS

Sediment quality can affect lagoon health, particularly in historically eutrophic systems such as San Elijo Lagoon. The SELRP seeks to address sediment quality issues within historic wastewater discharge areas by removing high-nutrient sediments that lead to eutrophication, water quality impairments, and degradation of benthic invertebrate communities. Similar to water quality, however, improvements to the system are inherently limited to areas authorized for sediment removal, and areas of legacy high-nutrient sediments will remain in place. Soil and sediment quality within the lagoon will be monitored in conjunction with water quality and benthic invertebrate monitoring, with sediment nutrient levels informing potential adaptive management strategies if performance standards for water quality and/or benthic invertebrate populations are not met. This metric will be informative only and no specific performance standard will be associated with sediments. If benthic invertebrate populations fail performance standards, remnant legacy sediment nutrients may be a causative factor. Accordingly, sediment nutrients Total Nitrogen (TN) and Total Organic Carbon (TOC), and sediment grain size, will be monitored within the project footprint in conjunction with benthic invertebrate monitoring.

10.1 METHODS

10.1.1 Data Collection

Sediment samples will be collected from the upper, middle, and lower tidal elevations at the same sampling stations where invertebrate communities will be assessed, which includes 12 sites pre-construction and 18 sites post-construction (see description of sampling points in Chapter 9 and Figure 9-1). A sample from each tidal elevation will be composited into a single sample for each sampling station for laboratory analysis of TN, TOC, and grain size, resulting in 18 composite samples per monitoring event. Soil collections consist of taking 300–500 grams (wet weight) of sediment for each of the 18 composite samples. To ensure that the sediment is being collected at the same depth as the samples used to assess invertebrate communities, the same diameter / length core and core collection methods will be used for collecting sediment samples as well as invertebrate samples (Chapter 9). However, anywhere from six to eight total cores will have to be collected (depending on the consistency of the sediment) in order to obtain the weight necessary to execute all the different parameters of soil analyses being requested. After collection, samples will be placed in sealed plastic bags and homogenized by massaging the bag thoroughly to ensure the breaking up of large chunks. After soil is fully collected and homogenized, it will be sent to University of California, Davis (or another laboratory) for analysis.

10.1.2 Monitoring Frequency

Sediment monitoring was conducted pre-construction and will be conducted in conjunction with benthic invertebrate monitoring post-construction once per year.

10.1.2.1 Pre-Construction

Pre-construction monitoring was completed in December 2017. Pre-construction monitoring data will serve as the baseline data used for comparison with post-construction data.

10.1.2.2 Post-Construction

Post-construction sampling for sediment quality will begin after restoration activities are complete and continue until water quality and benthic invertebrate performance standards have been met.

10.2 PERFORMANCE STANDARDS

Sediment quality will be collected for information only and will not have a specific performance standard associated with it, as described above. In the event benthic invertebrate populations or water quality performance standards are not met, reference monitoring for sediment quality will be used to help identify whether there is continued presence of historic high-nutrient sediments and/or whether they continue to affect metrics with performance standards. Monitoring for grain size is supplemental to nutrients and may be referenced for adaptive management actions if nutrient levels appear improved, but benthic invertebrate populations are not establishing as anticipated.

11. FISH

Fish are a relative monitoring variable and will be compared to reference wetlands for purposes of determining success of the SELRP.

11.1 METHODS

11.1.1 Data Collection

Fish data will be collected using two methods: seining and enclosure traps. Methodology is based off the sampling protocol provided in Appendices 2 and 3 of the San Dieguito Wetlands Restoration Project (Page et al. 2018a). Fish habitat created by implementation of the SELRP will include primarily shallow subtidal channels. Intertidal channels are expected to develop and can be added to the post-construction monitoring program upon their development; however, for the purposes of this monitoring program, fish monitoring in basins will be confined to shallow (-1.5 to -3.6 ft NAVD88) subtidal habitats (Table 3-1).

Fish sampling stations will be in the same locations where invertebrate and sediment sampling will be conducted. Pre-construction data will be collected at 12 sampling stations located throughout the lagoon with six stations in the main channel and six stations in tidal creek habitat (Figure 9-1). Stations are located at least 100 m apart to account for patchy fish distribution. As with invertebrates, only tidally influenced locations were chosen in order to facilitate data comparisons with reference wetlands; therefore, no sampling stations are located in the east basin for pre-construction surveys. Six additional locations (three main channel and three tidal creek) will be added to the east basin for the post-construction monitoring program once newly proposed tidally influenced areas develop (Figure 9-1), for a total of 18 sites post-construction.

11.1.1.1 Seining

Seining at each fish sampling station will be conducted by blocking each end of an approximately 7-m-long channel/creek segment using blocking nets. Blocking nets will consist of bagless seines approximately 15.2 m x 1.8 m with 3.2-mm mesh. Small seines (approximately 7.6 m x 1.8 m with 3.2-mm mesh) will be used to sample the 7-m-long area blocked by the blocking nets. The small seine will be hauled across the blocked area (perpendicular to the long axis of the channel) to collect the fish trapped by the blocking nets. Five replicate hauls will be made at each station (18 stations total) and each station will be visited on 3 distinct days. Samples will be processed in the field to the extent possible. Fish will be processed in the following manner: the first 10 fish of each fish species will be measured (total length) to the nearest millimeter and the remaining individuals will only be counted. Fish will be returned to the water immediately after processing, when possible. Fish abundance will be expressed in terms of density (number per square meter) for each seining event and then averaged across the 3 days of seining at a given sampling station. Species will be standardized to number of unique species per replicate (3 days of seining at given location equals one replicate). Macroinvertebrates collected during seine hauls will be identified to major taxonomic categories and released.

11.1.1.2 Enclosures

Enclosures will be employed to sample demersal, burrowing fish. Following the sampling protocol of the San Dieguito Wetlands Restoration Project (Page et al. 2018a), an enclosure trap (Figure 11-1) will be used to sample primarily gobies (family *Gobiidae*), which are small, burrowing fishes that are often poorly sampled by other methods. The enclosure trap is composed of a polypropylene sheet fixed as a 1-m-tall cylinder with a 0.4-m^2 sampling area. The trap is thrown away from the sampler in an attempt to minimize the startling of fish nearby. A BINCKE net is then swept inside the trap and fish are identified by species, counted, measured for length, and released. This is repeated until no fish are caught a total of three times.

Post-construction enclosure trapping will be conducted at five substations (similar to invertebrate methods) located at each of the 18 sampling stations (Figure 9-1). Thus, a total of 90 enclosure samples will be collected during each monitoring effort. Density will be expressed in terms of density (number per square meter) for each enclosure and then averaged across enclosures at a given sampling station. Species richness of demersal, burrowing fish will be standardized to number of unique species per sampling station.

Figure 11-1 Enclosure Trap

11.1.2 Monitoring Frequency

Monitoring of fish was conducted pre-construction and will also be conducted post-construction. No monitoring will be conducted during construction. Fish sampling will be collected in late summer and early fall, following the protocol of the San Dieguito Wetlands Restoration Project (Page et al. 2018a), to avoid nesting activities of the federally endangered light-footed Ridgway's rail. This will allow comparison with sampling at reference wetlands.

11.1.2.1 Pre-construction

Pre-construction monitoring was completed in late October through early November 2017. Pre-construction monitoring data will serve as the baseline data used for comparison with post-construction data.

11.1.2.2 Post-construction

Post-construction monitoring will begin in the first year following completion of all phases of the SELRP and then annually until overall project performance standards have been met.

11.2 PERFORMANCE STANDARDS

Fish community composition is a relative standard, which will be used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The relative performance standard will be considered met if the 4-year running average of fish densities and number of species at San Elijo Lagoon are not significantly worse than the mean value at the lowest performing reference wetland.

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12. BIRDS

Avian monitoring focuses on bird species that use wetland and open water habitat at the lagoon because the SELRP will primarily affect these species. The avian community at the lagoon was already thriving prior to the SELRP and it is not an objective of the SELRP to increase populations of bird species. As discussed in Section 2.2.2, avian surveys have been designed mainly to ensure numbers of key species do not decline from pre-restoration levels. This is more appropriately assessed using pre-construction absolute performance standards rather than relative performance standards. Surveys are specifically proposed for federal and/or state listed species because of their sensitivity status and the goal of the SELRP to maintain habitat for these species. Other avian species using wetland habitats will also be monitored as their presence is another indicator of lagoon health. Surveys will be conducted to assess the following bird species and species groups:

- Breeding marsh birds, including light-footed Ridgway's rail
- Waterbirds, including western snowy plover and California least tern
- Belding's savannah sparrow

Surveys that target all bird species will not be conducted at San Elijo Lagoon because more specialized methods are needed to effectively monitor the sensitive species listed above. The surveys listed above provide adequate coverage of the bird species with the greatest potential to be affected by the SELRP. Avian monitoring will assess populations of seabirds, waterbirds, wading birds, and waterfowl that, according to Page et al. (2018a; Appendix 6, Table 1), comprise 82.4% of 108 bird species detected in Southern California coastal wetlands. Raptors and other land birds are unlikely to be negatively affected by the SELRP because upland habitats will not be substantially impacted. Furthermore, these species groups comprise a small fraction of total bird abundance (density per hectare) in Southern California wetlands (e.g., Page et al. 2018b; Figure 3.3.1).

The suitability of one avian survey methodology over another can vary due to differences in the habitat of the survey area and the biology of the birds, as described by Page et al. (2018a; Appendix 6). Each survey effort listed above utilizes an approach specifically suited to assess abundance of the targeted species or species group, as described in greater detail under each survey subsection below.

The proposed avian surveys will cover federal and/or state listed species with the potential to be impacted by the SELRP. Least Bell's vireo and southwestern willow flycatcher surveys were conducted in 2016; however, surveys will not be continued moving forward due to the absence of detections during the 2016 surveys. Least Bell's vireo and southwestern willow flycatcher are not considered focal species for the SELRP because they occur in riparian habitat that is generally outside the impact area of the SELRP. No surveys will be conducted for coastal California gnatcatcher because it is an upland species and impacts of the SELRP are not expected to benefit or adversely impact this species.

The avian surveys described herein will be conducted before, during, and after construction of the SELRP and their methodologies will be identical for pre-construction, construction, and post-construction monitoring. This will ensure data collection is standardized, which will allow for unbiased comparisons of avian results between years. A summary of surveys to be conducted during monitoring is provided in Table 12-1.

12.1 BREEDING MARSH BIRD SURVEYS INCLUDING LIGHT-FOOTED RIDGWAY'S RAIL

As discussed in Section 2.2.2, monitoring breeding marsh birds is a pre-restoration absolute monitoring variable and will not be compared to reference wetlands for purposes of determining success of the SELRP. Additionally, the specialized surveys required to adequately estimate abundance of secretive marsh bird species are not being conducted at reference wetlands, thereby making comparison impossible. Standardized monitoring protocol (Conway 2011) recommends focused monitoring for the following secretive marsh bird species: light-footed Ridgway's rail (federally and state endangered), Virginia rail (*Rallus limicola*), least bittern (*Ixobrychus exilis*) (CDFW Species of Special Concern), American bittern (*Botaurus lentiginosus*), common gallinule (*Gallinula galeata*), and pied-billed grebe (*Podilymbus podiceps*).

Each of the six species noted above will be monitored through pre- and post-construction surveys. The species of primary interest is the light-footed Ridgway's rail, a federally and state listed endangered marsh bird species known to be present at the lagoon since the 1980s (Zembal et al. 2014). This species' sensitivity status and range, restricted to coastal salt marshes in Southern California where vegetation is dominated by California cordgrass and pickleweed (*Salicornia* sp.), make it an important species to monitor at the lagoon. The remaining five species will be monitored because of their utility as "indicator species" for assessing wetland ecosystem quality (Conway 2011).

The primary objectives of breeding marsh bird surveys are as follows:

- Compare presence and distribution of breeding marsh birds between pre-construction and construction/post-construction conditions;
- Compare density and abundance of breeding marsh birds between pre-construction and construction/post-construction conditions; and
- Estimate the construction/post-construction population trend for breeding marsh birds in the SELRP area.

Table 12-1 Summary of Avian Surveys for Each Calendar Year of Monitoring

Survey Type	January	February	March	April	May	June	July	August	September	October	November	December
Breeding Marsh Birds with Focus on Light-footed Ridgway's Rail			March 15 through June 15 (6 surveys)									
Western Snowy Plover; California Least Tern; and Waterbird	2 surveys per month March through September (breeding season); 1 survey per month October through February (non-breeding season)											
Belding's Savannah Sparrow			March through May (4 surveys)									

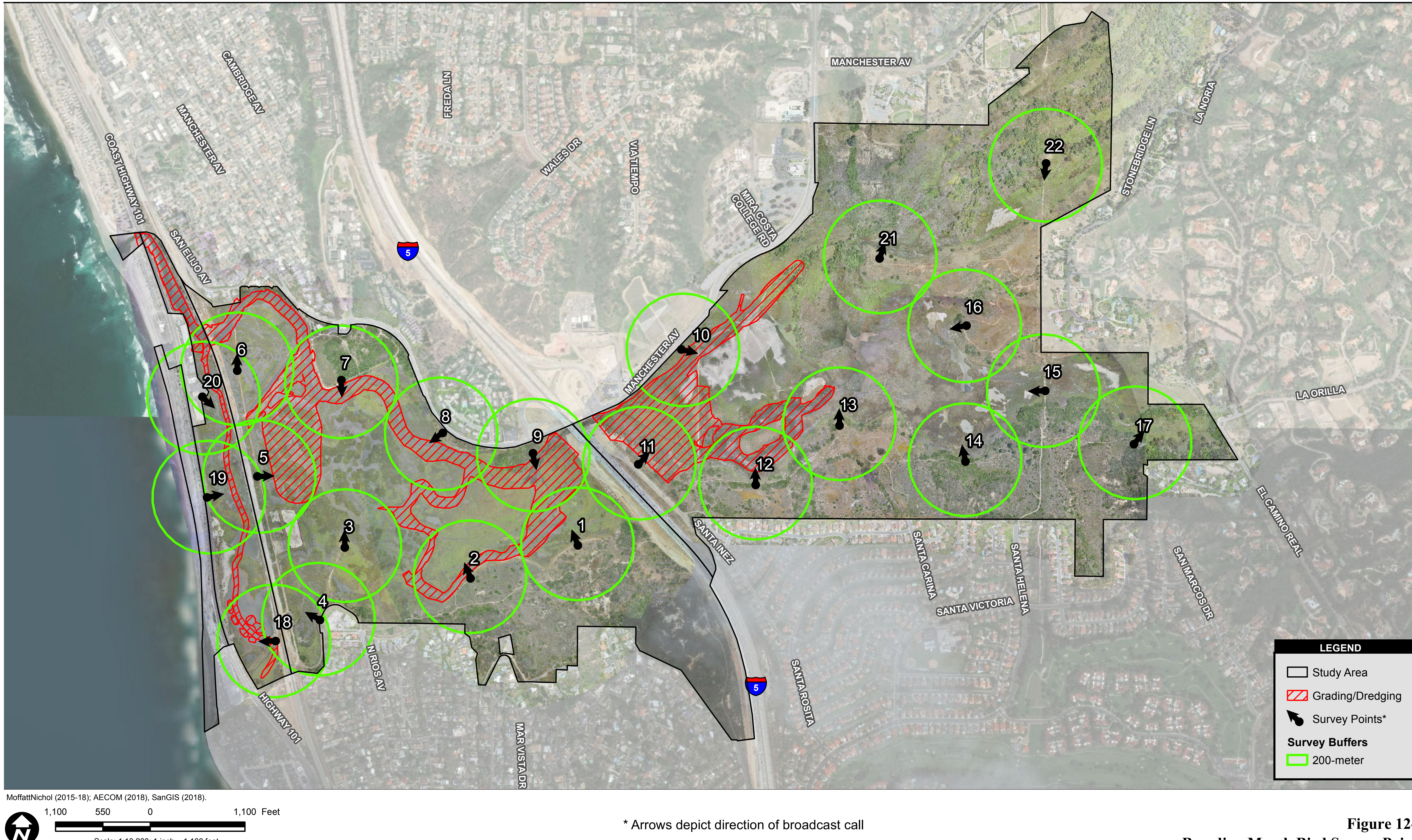
12.1.1 Methods

The methods for breeding marsh bird surveys are primarily based on three sources: Standardized North American Marsh Bird Monitoring Protocol (Conway 2011), Survey Frequency and Timing Affect Occupancy and Abundance Estimates for Salt Marsh Birds (Wiest and Shriver 2015), and an unpublished protocol (Konecny et al. 2009). The secretive nature and preference for dense emergent vegetation of the marsh bird species evaluated by these surveys make them difficult to detect during surveys. Page et al. (2018a; Appendix 6) recommend line or strip transects to survey for marsh birds during the breeding season, noting that territorial birds are vocal and easier to detect during the breeding season. However, Zembal and Massey (1987) found that light-footed Ridgway’s rails exhibited variation in calling frequency, even within the breeding season. The standardized monitoring protocol recommended by Conway (2011) was chosen over other avian survey methods mainly because the approach increases the probability of detection through the use of recorded audio playback of vocalizations, and because it evaluates detection probabilities to better estimate abundance by applying a double-observer approach, as described in greater detail below.

12.1.1.1 Data Collection

Surveys will be conducted by experienced marsh bird ornithologists with required permits from USFWS and CDFW. Six surveys will be conducted between March 15 and June 15 with at least one survey within each of the following survey windows: March 15–March 31; April 1–April 14; April 15–April 30; May 1–May 14; May 15–May 31; and June 1–June 15. This time period coincides with the approximate peak of the marsh bird breeding season and the seasonal peak in vocalization for most marsh birds. It is noted that the majority of light-footed Ridgway’s rail “kekking” calls have been documented March through June in Southern California (Zembal and Massey 1987).

Surveys will be conducted at dawn and dusk. Dawn surveys will be conducted at or during a period that begins 30 minutes before sunrise and will proceed for no more than 3 hours after sunrise. Dusk surveys will be conducted during a period that begins no more than 2 hours before sunset and ends by 30 minutes after sunset. Surveys will only be conducted during temperatures greater than 50 degrees Fahrenheit. Surveys will not be conducted when wind speed is greater than 12 miles per hour or during sustained rain or heavy fog. Surveys will be conducted at 22 survey points to provide coverage of existing marsh habitat and areas that are predicted to be marsh habitat after construction (Figure 12-1). Survey points are located throughout the lagoon in a variety of habitat types that potentially support breeding marsh birds, with specific interest in light-footed Ridgway’s rail habitat. Survey points are spaced at least 400 m apart to avoid the risk of double counting birds located closer to adjacent points during the call broadcast. Points separated by either the railway or I-5 may be slightly closer than 400 m because these features (railway, I-5) provide a natural sound barrier between points, therefore reducing the possibility of double counting.



* Arrows depict direction of broadcast call

Figure 12-1
Breeding Marsh Bird Survey Points

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Each pre- and post-construction survey will follow a similar survey route to the extent feasible so the methods are similar between surveys (i.e., same timing and same points, and follow the same survey routes). Consistency in the chronological order of survey points will help reduce the sampling variation created by changes in vocalization probability of marsh birds as the survey progresses.

The following information will be recorded at each survey point for each survey:

- Survey point number
- Observer's name
- Survey period start and end times
- Weather (temperature, average wind speed, precipitation) at the start and end of each survey period. Temperature and wind data will be obtained using a handheld weather meter (e.g., Kestrel 3000)
- The background noise category at each point on a scale from 0 to 4 (or 9):
    - 1 = faint background noise during at least half of the survey,
    - 2 = moderate background noise (probably cannot hear some birds beyond 100 m during >30 seconds of the survey),
    - 3 = loud background noise (probably cannot hear some birds beyond 50 m during >30 seconds of the survey),
    - 4 = intense background noise (probably cannot hear some birds beyond 25 m during >30 seconds of the survey), or
    - 9 = not recorded.

Survey methodology for the breeding marsh bird surveys will consist of a passive component and broadcast component at each survey point. The six focal survey species noted above (light-footed Ridgway's rail, Virginia rail, least bittern, American bittern, common gallinule, and pied-billed grebe) are considered secretive species. These species require the use of broadcast calls to elicit vocalizations in order to detect them. For these "broadcast" species, a portable audio player with speakers will be used to broadcast calls at a volume of 80 to 90 decibels at 1 m in front of the speakers.

Upon arriving at a survey point, ornithologists will stand quietly for 5 minutes (i.e., passive component) and record bird observations both aurally and visually. After 5 minutes, ornithologists will play approximately 30 seconds of calls for each "broadcast" species followed by 30 seconds of silence. Because there are six species that require the use of broadcast calls to elicit vocalizations, the survey time at each survey point will be approximately 11 minutes (5 minutes initially plus 1 minute for each species [i.e., 6 species equals 6 minutes]). Ornithologists will stand 2 m to one side of the speaker while listening for vocal responses. Ornithologists will point the speaker toward the center of the marsh and will not rotate the speaker during the call-broadcast survey. The speakers will be pointed in the same direction for replicate surveys within and among years. At points where the direction to point the speakers is not obvious (i.e., on a road or in a canal bisecting two marshes), ornithologists will record the direction of the speakers at each point on a map and on datasheets and will refer to this information on replicate surveys.

Marsh birds visually and aurally detected during the survey period will be recorded. Monitoring data collected for each marsh bird detected will include the following:

- Time of observation (1-minute increments)
- Detection type (visual, aural)
- Type of call if detection aural
- Species (American Ornithologists' Union [AOU] four-letter code, including an unknown category)
- Number of individuals, sex, age class, if possible
- Distance of observation from observer (a range finder will be used to help determine the distance)
- Locations of light-footed Ridgway's rail noted on a map

Data will be recorded on field data sheets and later transcribed into a database (e.g., Excel, Access) for analysis. As time permits (i.e., when focal species are not calling), other avian species detected incidentally during breeding marsh bird surveys will be recorded. Avian species will also be recorded incidentally while ornithologists travel between points.

While conducting surveys, the number of focal species counted is assumed a subset of actual species abundance because some individuals may not be detected by ornithologists. Thus, detection probabilities and abundance need to be estimated. There is no way to know what detection probabilities will be in the future as detection can be affected by aspects controllable (e.g., training of field crews) as well as aspects not controllable (e.g., weather); thus, detection needs to be estimated during each survey period. Multiple visits are needed to estimate detection probability. The six repeat surveys will allow detection probabilities to also be estimated.

An independent double-observer survey approach will be used for surveys, meaning two ornithologists will be present for each survey (Nichols et al. 2000) and the two ornithologists will each record data independently of the other ornithologist. The double-observer approach will allow for estimation of detection probabilities between observers and will improve overall detection probabilities to yield more precise estimates of abundance than if a single observer were used. At the end of each survey at a specific point count station, observers will compare data to determine which individual birds were detected by both observers or only detected by one observer.

Descriptive statistics will be used to summarize data across periods—pre-construction, construction, and post-construction—and among years (when possible). The data for each species will be reviewed to determine the most appropriate statistical analysis for the data set, but it is anticipated that light-footed Ridgway's rail abundance will be estimated using a Huggins (1991) closed mark recapture model. With the closed mark recapture model, data used for analysis will be the observations at the first time period of each individual's detection (i.e., the specific minute in the survey during which an individual was first detected). Detection probabilities will be estimated from these data to derive abundance.

Marsh birds other than the light-footed Ridgway's rail are not expected to be detected frequently enough to allow for modeling of detection probabilities and true densities or abundance. For these species, unadjusted estimates based on the number of birds detected will be compared among periods. Analyses may involve the use of a generalized linear model with independent variables, such as temperature, precipitation, vegetation, water conditions, and/or location. Following each year of data collection, data will be analyzed to assess precision of abundance estimates and to revisit the survey methodology and effort if needed.

Data Metrics

Because two independent observers simultaneously surveyed each point on each day, an encounter history will be constructed for each detected light-footed Ridgway's rail. Encounter histories will be denoted by 1s (i.e., detected) and 0s (i.e., not detected in the data set). For example, if only the first observer detected an individual rail, the encounter history will be denoted as 1, 0, or 10. If only the second observer detected an individual, then the encounter history will be 01; if both observers detected an individual, the encounter history will be 11. Only observations recorded during the 11-minute survey period will be used for analysis in order to standardize the data. Observations detected beyond 200 m will not be included in the analysis to minimize the potential for double counting individuals between survey points. Thus, raw counts of birds will be greater than those included in the independent double-observer statistical analyses.

The probability of detecting individual light-footed Ridgway's rail (p) and a corrected estimate of abundance (N) at the survey points will be derived using a Huggins model (Huggins 1989, 1991) as implemented in Program MARK (White and Burnham 1999). Models will be constructed for detection probability such that detection will be constant across observers and surveys; detection will vary by observer only; detection will vary by survey only; and detection will vary by observer and survey, additively and interactively. Due to variability between surveys, abundance or N will be estimated separately for each of the six surveys. Akaike's Information Criterion will be used with a small sample size correction (AICc) for model selection (Burnham and Anderson 2002). AICc is a measure of the relative support of a statistical model (the lower the AICc value, the better the fit or model) given the data.

For the purposes of this analysis, abundance will reflect number of individual light-footed Ridgway's rail present. Separate estimates will not be completed for pairs of light-footed Ridgway's rail versus single observations of light-footed Ridgway's rail. Abundance will be estimated for the area that was surveyed within the 200-m radius of survey points. Following each year of data collection, data will be analyzed to assess precision of abundance estimates and to revisit the survey methodology and effort if needed.

12.1.1.2 Monitoring Frequency

Monitoring will be conducted pre-construction, during construction, and post-construction for marsh birds. As previously noted, six surveys will be conducted between March 15 and June 15 with at least one survey within each of the following survey windows: March 15–March 31; April 1–April 14; April 15–April 30; May 1–May 14; May 15–May 31; and June 1–June 15.

Pre-Construction

Pre-construction monitoring was completed in 2016 and 2017. Pre-construction monitoring data will serve as the baseline data used for comparison with post-construction data.

Construction

Marsh bird monitoring described herein will also be implemented annually throughout the course of construction to monitor marsh bird responses, in particular light-footed Ridgway's rail, during construction as numbers or distribution could change dramatically during this time period. Data collected during this time will provide valuable information related to performance standards and post-construction monitoring results.

Post-Construction

Post-construction monitoring will begin in the first year following completion of all phases of the SELRP and will continue annually until the performance standards have been met.

12.1.2 Performance Standards

Success for breeding marsh birds will be measured by comparing project-specific pre-construction (defined as those data collected in 2016 and 2017) and construction/post-construction data metrics using the "floating alpha" method described in Sections 2.1.2 and 2.2.2.2. Specifically, based upon recommendations from USFWS, interim standards will be considered met if the construction/post-construction monitoring 4-year running average of density and number of individuals is 75% or greater than that of pre-construction survey data (2016, 2017) by Year 7 post-construction. Upon recommendations from USFWS, final standards will be considered met if the construction/post-construction monitoring 4-year running average of density and number of individuals is 95% or greater than that of pre-construction survey data (2016, 2017) by Year 10 post-construction. Running averages will be used to account for annual population variability. In addition, as described in Section 2.3, this standard will not be considered met until performance standards are met for 3 consecutive years.

12.2 WATERBIRD SURVEYS, INCLUDING WESTERN SNOWY PLOVER AND CALIFORNIA LEAST TERN

Monitoring waterbird species (e.g., seabirds, waterfowl, shorebirds, wading birds) that use the SELRP study area is a pre-restoration absolute monitoring variable and will not be compared to reference wetlands for purposes of determining success of the SELRP. These avian surveys will also focus on western snowy plovers and California least terns. The specialized surveys designed to adequately estimate abundance of these species at San Elijo Lagoon are not being conducted at reference wetlands, thereby making comparison impossible. The western snowy plover is a federally threatened species and a CDFW species of special concern. Western snowy plovers are regularly detected foraging within mudflats present in the SELRP area (eBird 2015). The California least tern is a federally and state listed endangered species and is present in the SELRP area in low numbers (eBird 2015). In addition, a wide variety of waterbirds (e.g., seabirds, waterfowl, shorebirds, wading birds) use habitat in San Elijo Lagoon.

The primary objectives of western snowy plover, California least tern, and waterbird surveys are as follows:

- Compare presence and distribution of western snowy plover, California least tern, and waterbird species between pre-construction and construction/post-construction conditions; and
- Compare abundance of western snowy plover, California least tern, and waterbird species between pre-construction and construction/post-construction conditions.

12.2.1 Methods

Waterbird surveys will be conducted using a census approach to determine the numbers of seabirds, waterfowl, shorebirds, and wading birds present in the lagoon at the time of each survey. Censusing is used extensively for counting shorebirds and waterfowl in tidal wetlands because these species are generally easily detected on mudflats and open water (Wetlands International 2010). As noted by Page et al. (2018a; Appendix 6), area effects can confound comparisons of species richness and density estimates obtained using census methods. However, the potential for area effects will be minimized in waterbird surveys at San Elijo Lagoon by dividing the lagoon into three smaller subsections (i.e., east, central, and west basins), which will be censused independently. In addition, because pre- and post-construction data will be collected using the same methods at the same locations, area effects are not expected to confound comparisons.

12.2.1.1 Data Collection

Ornithologists will survey each basin within San Elijo Lagoon where suitable foraging and roosting habitat is present for western snowy plover, California least tern, and other waterbird species. Surveys will be conducted two times per month, at least 10 days apart, during the breeding season (March through September) and once per month during the non-breeding season (October through February).[2] Surveys will generally be conducted during low to mid-tides when foraging habitat, such as wet sandy beaches and mudflats, will be most exposed. Surveys will be conducted at this frequency to capture fluctuations of spring and fall migrants, wintering populations, and potential breeders or over-summering individuals. When necessary, surveys will be conducted in the morning or evening to avoid peak midday temperatures, ensuring heat shimmers radiating from the earth do not distort viewing.

Two ornithologists will conduct the surveys together to allow one individual to focus on western snowy plover and California least tern, and one individual to focus on the other waterbirds that use San Elijo Lagoon. The basins will be divided into specific search areas as necessary to facilitate obtaining accurate counts in a given area (i.e., a census of each basin). Ornithologists will tally individual western snowy plovers, California least tern, and other waterbird species. The two-observer approach will also help ornithologists track individuals during surveys.

Together, ornithologists will conduct surveys by walking along established/existing trails (when possible) and stopping at locations that provide good viewsheds of visible exposed mudflats, and other foraging/roosting habitats. The ornithologists will scan suitable habitats and flocks of birds with the use of a spotting scope and binoculars.

[2] Surveys in 2016 were conducted twice per month for a calendar year. A review of the 2016 data indicated that one survey per month provided adequate data during the non-breeding season.

If a western snowy plover or California least tern is banded, attempts will be made to obtain the band combination. If breeding behavior is observed, the ornithologists will spend extra time monitoring these activities and follow up on subsequent surveys to determine if the pair is nesting, or if there was an attempt to nest in the area. It is important to note that the survey methods are designed to document western snowy plover and California least tern abundance and distribution rather than nesting activity. The *Western Snowy Plover and California Least Tern Nest Monitoring and Management Plan for the San Elijo Lagoon Restoration Project* (AECOM 2017b) describes actions to be taken to monitor and manage the nest area being designed as part of the SELRP.

Data collected during surveys will include the following:

- Ornithologist's name, date, location (e.g., east basin, coastal area), time, temperature, average wind speed, wind direction, cloud cover, precipitation, and visibility (time and weather data to be taken at the start and end of survey)
- Time of observation
- Age, sex, (when possible), number of individuals
- Habitat (e.g., beach, mudflat, salt panne, dike)
- Activity (e.g., nesting, foraging, roosting, loafing)
- Flyover (i.e., Yes or No)
- Detection type (i.e., visual or auditory)
- Other avian species incidentally detected during surveys to also be recorded

12.2.1.2 Data Metrics

The data will be used to provide a general estimate of abundance (i.e., observations per survey) during the migratory, breeding, and overwintering seasons. The survey methodology is designed so that a census of each basin within the SELRP area is conducted during each survey. Individual estimates of abundance will be provided for western snowy plover and California least tern. Abundance estimates for other waterbird species recorded will be calculated for groups of species (i.e., seabirds, shorebirds, waterfowl, and wading birds) rather than for each species observed. Groups will be determined pending the results of surveys.

12.2.1.3 Monitoring Frequency

Monitoring will be conducted pre-construction, during construction, and post-construction for avian species, including western snowy plovers, California least terns, and other waterbirds. As previously noted, surveys will be conducted two times per month, at least 10 days apart during the breeding season (March through September) and once per month during the non-breeding season (October through February).

Pre-Construction

Pre-construction monitoring was completed in 2016 and 2017. Pre-construction monitoring data will serve as the baseline data used for comparison with post-construction data.

Construction

Monitoring of avian species, including western snowy plovers, California least terns, and other waterbird species, will also be implemented annually to monitor avian responses throughout the course of construction as distribution and/or numbers could change dramatically during this time period. Data collected during this time will provide valuable information as it relates to performance standards and post-construction monitoring results.

Post-Construction

Post-construction monitoring will begin in the first year following completion of all phases of the SELRP and will continue annually until the performance standards have been met.

12.2.2 Performance Standards

Success for avian species, including western snowy plovers, California least terns, and other waterbird species will be measured by comparing pre-construction data (defined as those data collected in 2016 and 2017) and construction/post-construction data metrics using the "floating alpha" method described in Sections 2.1.2 and 2.2.2.2. Specifically, based upon recommendations from USFWS, interim standards will be considered met if the construction/post-construction monitoring 4-year running average number of individuals observed per survey is 75% or greater than that of pre-construction survey data (2016, 2017) by Year 7 post-construction. Upon recommendations from USFWS, final standards will be considered met if the construction/post-construction monitoring average number of individuals per survey is 95% or greater than that of pre-construction survey data (2016, 2017) by Year 10 post-construction. Running averages will be used to account for annual population variability. In addition, as described in Section 2.3, this standard will not be considered met until performance standards are met for 3 consecutive years.

In addition, documentation of western snowy plover or California least tern nesting in the west, central, or east basins would be considered a success since nesting by these species has been absent or sporadic in the lagoon. In 2015, one successful nesting event was observed on Cardiff Beach; however, the beach area nesting conditions are not expected to change as a result of restoration efforts. The *Western Snowy Plover and California Least Tern Nest Monitoring and Management*

Plan for the San Elijo Lagoon Restoration Project (AECOM 2017b) describes actions to be taken to monitor and manage the nest area being designed as part of the SELRP.

12.3 BELDING'S SAVANNAH SPARROW SURVEYS

Belding's savannah sparrow is a pre-restoration absolute monitoring variable and will not be compared to reference wetlands for purposes of determining success of the SELRP. Additionally, the specialized surveys required to adequately estimate abundance of Belding's savannah sparrow are not being conducted at reference wetlands, thereby making comparison impossible. Belding's savannah sparrow, a California endangered species, occurs in the salt marsh habitat present in the SELRP area. This species is endemic to the coastal salt marshes of Southern California and northern Baja California (AOU 1983). The primary objectives of the Belding's savannah sparrow surveys are as follows:

- Compare presence and distribution of Belding's savannah sparrow between pre-construction and construction/post-construction conditions; and
- Compare density of Belding's savannah sparrow between pre-construction and construction/post-construction conditions.

12.3.1 <u>Methods</u>

Belding's savannah sparrows inhabit emergent wetland vegetation, which cannot be traversed and is often difficult to detect birds in when they are present. Spot-mapping can be used to estimate the abundance of Belding's savannah sparrows, but this approach is focused on identifying the size of the population (Zembal et al. 2015). This approach was not chosen for the SELRP since the monitoring objective is to determine if the density changes through time rather than population size. Page et al. (2018a; Appendix 6) noted that point counts could be used to sample Belding's savannah sparrows in coastal marsh habitat, but that line transects may provide better density estimates. The line transects approach was selected over other methods in part for this reason, and also because the approach has been used to assess Belding's savannah sparrow density during the breeding season in other Southern California wetlands (e.g., Rosencranz et al. 2018). It is also notable that linear paths were already present to function as survey transects without disturbing habitat (e.g., existing dike system and other pathways throughout the lagoon). Additionally, suitable habitat is often present in discrete linear areas, such as those along channels or roadway edges, making linear methods more appropriate.

12.3.1.1 Data Collection

Belding's savannah sparrow surveys will be conducted four times between March and May (i.e., breeding season).[3] Line transect surveys will be conducted in coastal salt marsh habitat to record birds detected while walking a fixed route. Line transect surveys involve recording birds on either side of the line and estimating the perpendicular distance to each bird detected. A total of 19 transects, each 100 m in length, will be sampled (Figure 12-2). Transects were placed throughout the lagoon to provide coverage of existing Belding's savannah sparrow habitat and areas that are predicted to be Belding's savannah sparrow habitat after construction.

Ornithologists will conduct surveys between sunrise and 11:30 a.m., when Belding's savannah sparrows are actively singing and most detectable. Using binoculars and spotting scopes, ornithologists will passively survey birds and listen for singing birds. No method of attraction such as playback recordings or "pishing" will be used. Information recorded during the line-transect sampling will include the following:

- Ornithologist's name
- Transect start time
- Number of birds seen
- Horizontal distance (perpendicular) to the survey line
- Behavior during observation
- Transect end time

Other avian species detected incidentally during Belding's savannah sparrow surveys will also be recorded.

12.3.1.2 Data Metrics

Data will be analyzed using a distance sampling approach (Buckland et al. 2001) to account for differences in detectability and estimation of distance from an observer to estimate density (per hectare) of Belding's savannah sparrow pairs. For the purposes of distance sampling analyses, transects were considered two-sided (birds may be located on either side of the transect) or one-sided (when a natural or human-made barrier was prohibitive of bird location on one side of the transect). For one-sided transects, the transect length was halved to account for the difference in estimation (i.e., 50%).

[3] Six surveys were conducted in 2016. An analysis of the 2016 data indicated that a reduction from six to four surveys would still provide adequate data for analysis.

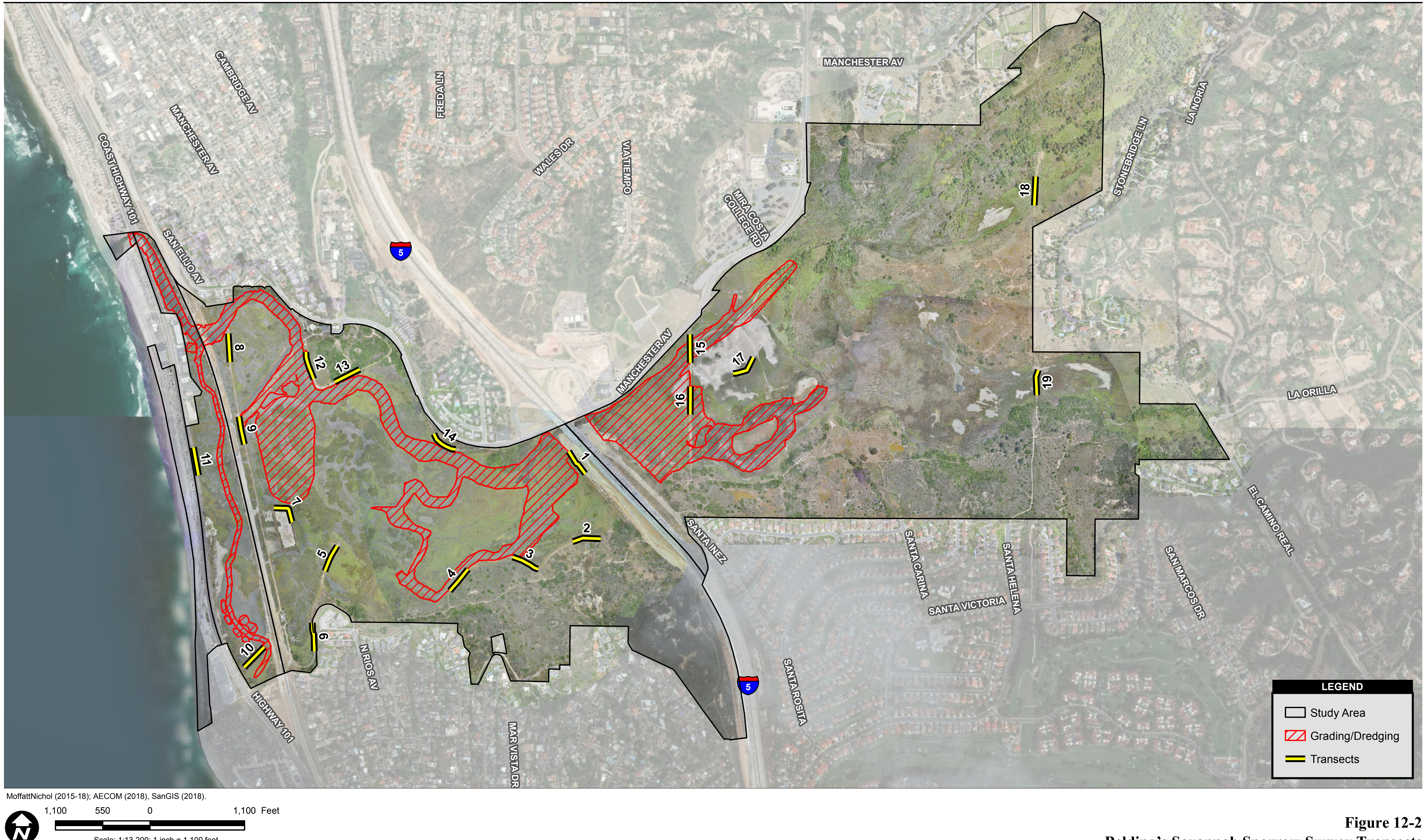

Figure 12-2
Belding's Savannah Sparrow Survey Transects

Path: L:\DCS\Projects_6058\60582908_SELRP_ConPh2\900-CAD-GIS\920 GIS\map_docs\mxd\Report\HMMP\Belding's Savannah Sparrow Survey Transects.mxd, 8/18/2020, paul.moreno

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12.3.1.3 Monitoring Frequency

Belding's savannah sparrow monitoring will be conducted pre-construction, during construction, and post-construction. As previously noted, surveys will be conducted four times between March and May (i.e., breeding season).

Pre-Construction

Pre-construction monitoring was completed in 2016 and 2017. Pre-construction monitoring data will serve as the baseline data used for comparison with post-construction data.

Construction

Belding's savannah sparrow monitoring will also be implemented annually throughout the course of construction to monitor responses during construction as distribution and/or numbers could change dramatically during this time period. Data collected during this time will provide valuable information as related to performance standards and post-construction monitoring results.

Post-Construction

Post-construction monitoring will begin in the first year following completion of all phases of the SELRP and will continue annually until the performance standards have been met.

12.3.2 Performance Standards

Success for Belding's savannah sparrow will be measured by comparing pre-construction (defined as those data collected in 2016 and 2017) and construction/post-construction data metrics using the "floating alpha" method described in Sections 2.1.2 and 2.2.2.2. Specifically, based upon recommendations from USFWS, interim standards will be considered met if the construction/post-construction monitoring 4-year running average of density is 75% or greater than that of pre-construction survey data (2016, 2017) by Year 7 post-construction. Upon recommendations from USFWS, final standards will be considered met if the construction/post-construction monitoring average density is 95% or greater than that of pre-construction survey data (2016, 2017) by Year 10 post-construction. Running averages will be used to account for annual population variability. In addition, as described in Section 2.3, this standard will not be considered met until performance standards are met for 3 consecutive years.

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13. WETLAND FUNCTION

Wetland function is an absolute monitoring variable and will not be subject to comparisons with reference wetlands for purposes of determining success of the SELRP. Wetland function of the lagoon before and after restoration will be measured or assessed using CRAM. CRAM monitoring is a requirement of the RWQCB CWA Section 401 Certification, and the Corps CWA Section 404(b)(1) Permit and is not an approval condition of the CCC Coastal Development Permit.

The overall goal of CRAM is to "provide rapid, scientifically defensible, standardized, cost-effective assessments of the status and trends in the condition of wetlands and related policies, programs, and projects throughout California" (CWMW 2013a). CRAM is a rapid assessment method that requires collecting Level 2 data (coarse data) for monitoring wetland function and conditions. It is expected to become the chosen functional assessment method for future permitted projects throughout California, and is currently included in the Corps mitigation ratio checklist.

One of the benefits of CRAM is that it does not require an intensive watershed-level assessment to calibrate variable scores. Instead, CRAM has been calibrated throughout California and in various wetland types. CRAM is an ambient monitoring and assessment tool that can be performed on different scales, ranging from an individual wetland to across a watershed or a larger region. CRAM is designed to collect a coarse assessment of a site's ambient conditions, but can be used to measure progress toward meeting performance standards established for wetland function/condition, and can be repeated over the long term if necessary or desired. Level 3 (fine scale) data are not necessary to complete a CRAM assessment, but are useful when determining many of the CRAM attribute scores and interpreting the final CRAM scores. For this project, CRAM is being used to assess the condition of San Elijo Lagoon before restoration activities begin and then, over time, post-restoration to assess the recovery of the lagoon compared to performance standards.

13.1 METHODS

CRAM assessments will be performed following the latest guidelines, currently version 6.1 (CWMW 2013a) and the field book of the appropriate wetland module (CWMW 2013b, 2013c). There are generally five steps to performing CRAM, which are described herein:

1. Assemble background information about the management of the wetland.
2. Classify the wetland using the CRAM manual.
3. Verify the appropriate season and other timing aspects of the field assessment.

4. Estimate the boundary of the assessment area (AA).
5. Conduct assessments of stressors and on-site conditions of the AA and complete CRAM assessment scores.

13.1.1 Data Collection

13.1.1.1 Assemble Background Information

Nature Collective completed a CRAM assessment of San Elijo Lagoon in 2010 using CRAM version 5.0.2 (Collins et al. 2008), the most current version at the time. This assessment was reviewed and information on the current and future management of the lagoon was gathered from Nature Collective.

13.1.1.2 Classify the Wetland

Following the wetland type/subtype flowchart depicted in the CRAM manual (CWMW 2013a) and based on the results from the 2010 Nature Collective CRAM assessment, perennial estuarine and depression wetlands are known to occur on-site.

- **Estuarine** wetlands consist of aquatic (i.e., subtidal) and semi-aquatic (i.e., intertidal) environments that are strongly influenced by mixtures of ocean water and upland runoff due to tidal processes operating through an ocean inlet. Estuaries are mostly enclosed by land. Their inlets may be natural or unnatural. The estuarine wetland AAs are in the west, central, and east basins.
- **Depressional** wetlands occur in topographic lows (i.e., closed-elevation contours) that allow the accumulation of surface water and, in some cases, groundwater. These systems can be natural or artificial in origin, and can occur on the landscape as isolated basins with distinct boundaries, as a complex of shallows and seasonally wet depressions created by the slight topographic relief with indistinct boundaries, or as a large complex of interconnected basins. The east basin has depressional wetlands.

13.1.1.3 Verify Appropriate Season and Timing for Assessments

The appropriate timing for CRAM assessments falls within the growing season for the characteristic plant community of the wetland type to be assessed (CWMW 2013a). For perennial estuarine wetlands, this is middle summer (late July/early August). While depressional wetlands could be assessed earlier, in late June or early July, they will be conducted at the same time as the estuarine for efficiency. Late July or early August is not outside the growing season for depressional wetlands.

13.1.1.4 Estimate the Boundary of the AA

The CRAM assessment completed by Nature Collective in 2010 used 25 AAs distributed across the lagoon (Figure 13-1) to determine the condition of the lagoon. For documenting baseline/pre-restoration function and conditions, the 25 AAs developed and assessed in 2010 will be used (Figure 13-1) for pre-construction and post-construction CRAM assessments. The boundaries of the AAs will be verified in the field and adjustments will be made based on the latest CRAM guidance (CWMW 2013a, 2013b, 2013c) if necessary.

For estuarine wetlands, the boundary of the AA will be verified during low tide. The AA should not extend above the backshore, as indicated by wrack lines, transitions from intertidal to upland vegetation, etc., and should not extend more than 10 m across a non-vegetated tidal flat that adjoins the foreshore. The AA should not extend across a tidal channel wider than 30 m or that cannot be safely crossed at low tide. The boundary of the AA can extend along the midline of such channels but not across them. The AA can incorporate smaller channels that can be safely crossed on the ground. The AA will, therefore, include the intertidal marsh plain and associated features, such as pannes and natural levees, plus the tidal channels that can be crossed, plus the exposed banks and beds of channels that border the AA. The recommended size and shape for estuarine wetlands is a 1-hectare circle, but the shape can be non-circular, if necessary, to fit the wetland with a minimum size of 0.1 hectare (CWMW 2013b).

For depressional wetlands, the AA boundaries should extend from the backshore, as indicated by high-water marks or a transition from wetland to upland plants; to the foreshore, the boundary between the vegetated wetland and adjoining semi-aquatic, non-wetland area, or a fully aquatic area such as open water. If open water is present, the AA should be extended 10 m beyond the foreshore into open water. The backshore (landward boundary) of the AA should include adjacent riparian vegetation directly overhanging the wetland, including the footprint of individual trees or plants overhanging the wetland. If riparian vegetation does not overhang the wetland, an area 2 m wide extending landward from the backshore as part of the AA should be included. The recommended AA size for depressional wetlands is 1 hectare, and no larger than 2 hectares (CWMW 2013c).

13.1.1.5 Assessments and Scoring

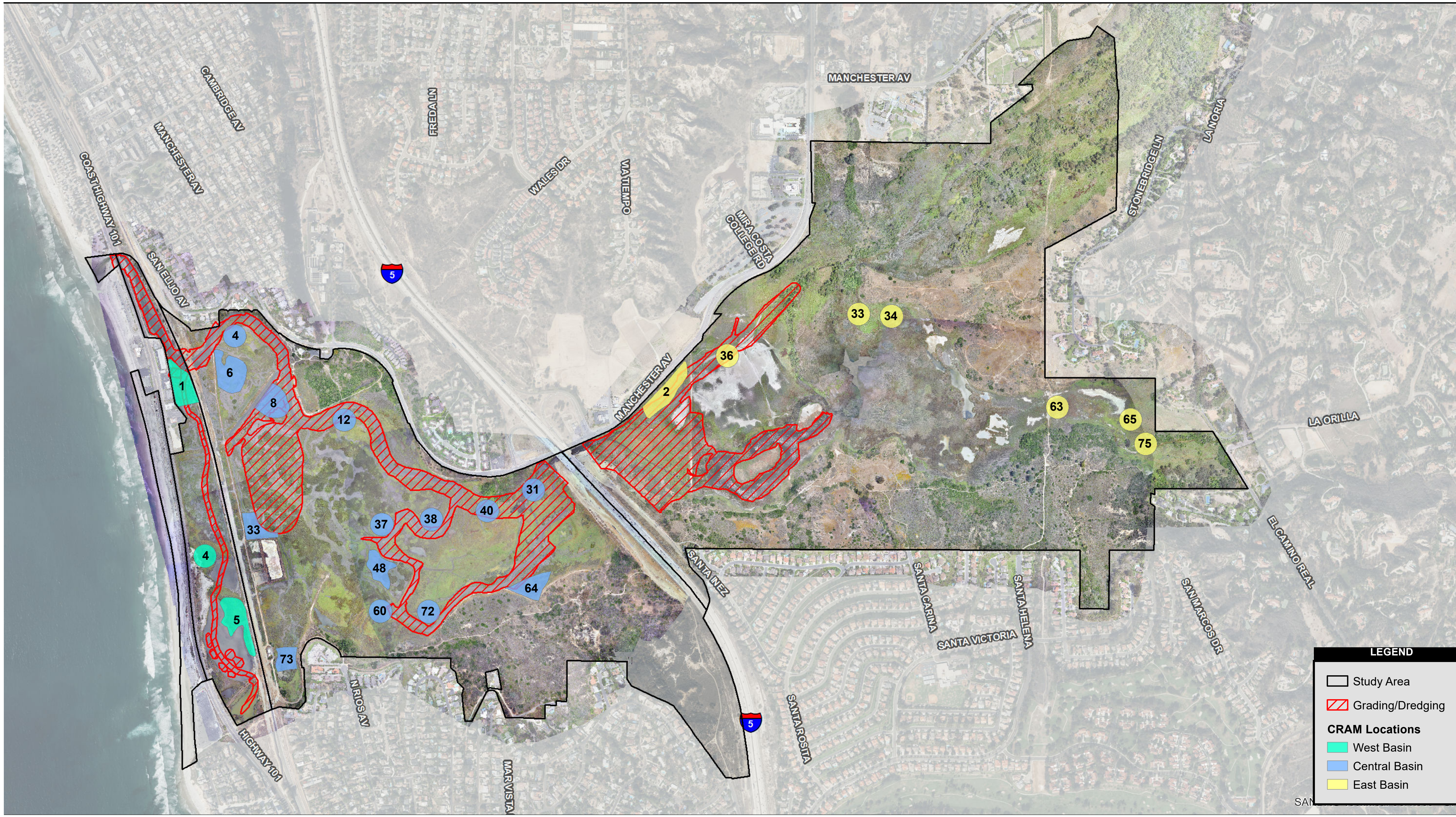
Once the AA boundaries are verified, the field assessment and scoring occur. The overall CRAM score for each AA is composed of four main attribute scores (buffer and landscape context, hydrology, physical structure, and biotic structure; see Table 13-1), which are based on the metric and submetric scores (a measurable component of an attribute). The anticipated relationships between the CRAM attributes and metrics, and various ecological services expected from conceptual models of wetland form and function, are presented in Table 13-2. CRAM practitioners assign a letter rating (A–D) for each metric/submetric based on a defined set of condition brackets ranging from an "A" as the theoretical best case achievable for the wetland class across California, to a "D," the worst case achievable. Each metric/submetric condition level (A–D) has a fixed numerical value (A=12, B=9, C=6, D=3), which, when combined with other metrics, results in a score for each attribute. That number is then converted to a percentage of the maximum score achievable for each attribute, and represents the final attribute score, ranging from 25% to 100%. The final overall AA CRAM score is the average of the four final attribute scores and ranges from 25% to 100%. Once the CRAM assessments have been completed in the field and verified in the office, individual AA scores will be averaged to provide a lagoon overall CRAM score.

Table 13-1 CRAM Attributes and Metrics

<table>
<tr><th colspan="2">Attributes</th><th>Metrics and Submetrics</th></tr>
<tr><td colspan="2" rowspan="5">Buffer and Landscape Context</td><td>Aquatic Area Abundance</td></tr>
<tr><td>Buffer:</td></tr>
<tr><td>– Percent of Assessment Area with Buffer</td></tr>
<tr><td>– Average Buffer Width</td></tr>
<tr><td>– Buffer Condition</td></tr>
<tr><td colspan="2" rowspan="3">Hydrology</td><td>Water Source</td></tr>
<tr><td>Hydroperiod</td></tr>
<tr><td>Hydrologic Connectivity</td></tr>
<tr><td rowspan="8">Structure</td><td rowspan="2">Physical</td><td>Structural Patch Richness</td></tr>
<tr><td>Topographic Complexity</td></tr>
<tr><td rowspan="6">Biotic</td><td>Plant Community Composition:</td></tr>
<tr><td>– Number of Plant Layers</td></tr>
<tr><td>– Number of Co-dominant Species</td></tr>
<tr><td>– Percent Invasion</td></tr>
<tr><td>Horizontal Interspersion and Zonation</td></tr>
<tr><td>Vertical Biotic Structure</td></tr>
</table>

13.1.2 <u>Monitoring Frequency</u>

CRAM monitoring will be conducted pre- and post-construction. No monitoring will be conducted during construction.



MoffattNichol (2015-18); AECOM (2018), SanGIS (2018).

1,100 550 0 1,100 Feet

Scale: 1:13,200; 1 inch = 1,100 feet

Figure 13-1
CRAM Locations

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Table 13-2 Expected Relationship among CRAM Attributes, Metrics, and Key Services

Attributes		Buffer and Landscape Context	Hydrology			Physical Structure		Biotic Structure				
Metrics or Submetrics		Buffer and Landscape Connectivity Metrics	Water Source	Hydroperiod	Hydrologic Connectivity	Structural Patch Richness	Topographic Complexity	Number of Plant Layers	Number of Codominant Species	Percent Invasion	Horizontal Interspersion	Vertical Biotic Structure
KEY SERVICES	Short- or long-term surface water storage	√		√	√	√	√				√	√
	Subsurface water storage		√	√	√		√					
	Moderation of groundwater flow or discharge	√	√									
	Dissipation of energy					√	√	√			√	√
	Cycling of nutrients	√		√	√	√	√	√	√	√		√
	Removal of elements and compounds	√		√	√		√	√			√	
	Retention of particulates			√	√	√	√	√	√		√	
	Export of organic carbon			√	√			√		√	√	√
	Maintenance of plant and animal communities	√		√	√	√	√	√	√	√	√	√

13.1.2.1 Pre-Construction

AECOM CRAM-certified practitioners conducted the pre-construction CRAM assessment in 2016. The aforementioned 25 AAs used for the Nature Collective 2010 CRAM assessment served as the starting point for the 2016 baseline condition assessment (three of the AAs were adjusted to better align with the post-restoration landscape). This allowed for a comparison of the two pre-restoration condition assessments to aid in understanding how the lagoon changed over 6 years as well as to help forecast what can be expected after restoration. The results can be found in the *San Elijo Lagoon Restoration Project Pre-Restoration California Rapid Assessment Method Analysis* (AECOM 2016).

13.1.2.2 Post-Construction

After restoration activities are completed (construction on all phases complete and a successful 120-day PEP), post-restoration CRAM will be performed during Year 1, Year 3, and Year 5 and then every other year until performance standards are met, during the monitoring period. The AAs established in 2016 for baseline condition before restoration activities began will be used to assess wetland post-restoration function and condition. While not expected, if there has been an increase in variability created from restoration activities, additional AAs will be added to meet the sample size requirements of CRAM.

13.1.3 Performance Standards

The individual AA CRAM scores and averaged lagoon CRAM score will be used to compare post-restoration conditions to pre-restoration condition and function of the lagoon. This average score will serve as the reference for determining the success of the restoration activities. Table 13-3 contains the CRAM performance standards.

Table 13-3 CRAM Performance Standards

CRAM Score	Expected Results	Performance Standard	Year
Buffer and Landscape Context Attribute	Not expected to change, mostly outside the scope of the SELRP	Post-Restoration ≥ Baseline CRAM Attribute Score	Year 5
Hydrology Attribute	Expected to increase slightly due to dredging and topography changes to increase tidal flow and flushing	Post-Restoration ≥ Baseline CRAM Attribute Score	Year 5
Physical Structure Attribute	Expected to recover to equal or exceed Baseline condition	Post-Restoration ≥ Baseline CRAM Attribute Score	Year 5
Biotic Structure Attribute	Expected to recover to equal or exceed Baseline condition	Post-Restoration ≥ Baseline CRAM Attribute Score	Year 5
Overall CRAM	Expected to recover to equal or exceed Baseline condition	Post-Restoration ≥ Baseline CRAM Overall Score	Year 5

14. EELGRASS

Eelgrass is an absolute monitoring variable and will not be subject to comparisons with reference wetlands for purposes of determining success of the SELRP. Eelgrass monitoring is a requirement of the Corps CWA Section 404 Permit and is not an approval condition of the CCC Coastal Development Permit.

14.1 METHODS

14.1.1 Data Collection

Spatial extent data will be collected using a 3-D sidescan sonar (or similar system), which provides an acoustic backscatter image of the seafloor within the project area. Interpretation of the backscatter data allows for an assessment of the distribution of eelgrass. Sidescan backscatter data will be acquired at a frequency of 468 kilohertz scanning out 31 m on both the starboard and port channels for a 62-m-wide swath. The 3-D sidescan system integrates motion sensors to control for heave pitch and roll, a sound velocity sensor for speed of sound correction, and a dual antenna RTK GPS and electronic compass to control for vessel position and yaw. This rigid integration of the transducers within the positioning sensors increases precision and accuracy over conventional towfish sidescan sonar equipment.

The survey will be conducted by running parallel transects spaced to allow for overlap between adjoining sidescan swaths. Survey swaths will be navigated until the entirety of the survey area is captured for the survey. Data will be collected in latitude and longitude using the North American Datum of 1983 (NAD 83), converted to the Universal Transverse Mercator system in meters, and plotted on a geo-rectified aerial image of the project site. Following completion of the survey, sidescan sonar traces will be joined together and geographically registered. Following the sidescan survey, the sonar data will be ground-truthed using ultra-low altitude aerial photographic flights by a UAV within the extreme shallows during low tide. If the water depth is too deep or water clarity is not sufficient, ground-truthing may require snorkeling, the use of a Remotely Operated Vehicle, or underwater cameras to verify the sidescan survey. Orthomosaic processing will be used to develop a rectified aerial photograph of the surveyed site with a horizontal spatial registration error of less than 1 m. Snorkeling will also be conducted along each main channel in the lagoon on incoming tides to verify results from the remote sensing estimates. The metrics for eelgrass are as follows:

- **Spatial Distribution**

  The spatial distribution of eelgrass habitat will be delineated by a contiguous boundary around areas of vegetated eelgrass cover extending outward a distance of 5 m. The resultant spatial distribution boundary of the eelgrass habitat will then be clipped to remove areas determined unsuited to supporting eelgrass based on depth, substrate, or existing structures.

- **Areal Extent**

  The eelgrass habitat areal extent will include vegetated cover and extent of unvegetated habitat that defines a coalesced bed with gaps of less than 1 m across being considered part of the defined bed.

- **Percent Vegetated Cover**

  Eelgrass vegetated cover exists when one or more leaf shoots (turions) per square meter are present. The percent bottom cover within eelgrass habitat is determined by totaling the area of vegetated eelgrass cover and dividing this by the total eelgrass habitat area.

- **Turion (Shoot) Density**

  Turion density is the mean number of eelgrass leaf shoots per square meter within mapped eelgrass vegetated cover. Turion density will be reported as a mean ± the standard deviation of replicate measurements. The number of replicate measurements (n) will be reported along with the mean and deviation. Turion densities are determined only within vegetated areas of eelgrass habitat; therefore, it is not possible to measure a turion density equal to zero.

The mapping method applied during this investigation provides for a substantial degree of accuracy and repeatability over time.

14.1.2 <u>Monitoring Frequency</u>

Eelgrass monitoring will be conducted pre- and post-construction.

14.1.2.1 Pre-Construction

Merkel & Associates, Inc. conducted the pre-construction eelgrass survey on October 9 and 17, 2017. Pre-construction monitoring data will serve as the baseline data used for comparison with post-construction data.

14.1.2.2 Post-Construction

Per the National Oceanic and Atmospheric Administration Fisheries' California Eelgrass Mitigation Policy for localized temporary impacts, up to three surveys will be conducted post-restoration; one survey will be conducted within 30 days post-restoration, one survey after 1 year, and the last after Year 2 post-restoration. Surveys will be conducted during the growing season, between March and October.

14.1.2.3 Performance Standards

Eelgrass is an absolute standard in which pre-restoration conditions will be compared to post-restoration conditions. If, after the post-restoration surveys are completed, eelgrass has reestablished and no permanent losses are documented, the project will have met performance standards.

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15. *CAULERPA*

Caulerpa is an absolute monitoring variable and will not be subject to comparisons with reference wetlands for purposes of determining success of the SELRP. *Caulerpa* monitoring is a requirement of the Corps CWA Section 404 Permit and the USFWS Biological Opinion conditions. It is not an approval condition of the CCC Coastal Development Permit.

15.1 METHODS

15.1.1 Data Collection

Surveys will be conducted per the *Caulerpa* Control Protocol (Version 4.0, adopted February 25, 2008). The project area will be surveyed using one of several methods, including a 3-D sidescan sonar (or similar system), a UAV, snorkeling, and a deployed underwater video camera. The survey area will include the subtidal marine waters within the lagoon system and the method would be dependent on the site conditions.

15.1.2 Monitoring Frequency

15.1.2.1 Pre-Construction

Pre-construction monitoring was performed on October 9 and 17, 2017.

15.1.2.2 Post-Construction

Post-restoration monitoring for *Caulerpa* will include one survey conducted within 30 days post-restoration.

15.2 PERFORMANCE STANDARDS

Performance standards for *Caulerpa* are to confirm that *Caulerpa* is not present within the project site, and there would be no risk for introduction to other sites by project implementation.

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16. ADAPTIVE MANAGEMENT

For the SELRP, the adaptive management process described in this section is being implemented to direct achievement of restoration success of San Elijo Lagoon. Long-term maintenance of the lagoon after performance standards are met may expand on the strategies identified below, and will be discussed separately in the LTMP.

16.1 ADAPTIVE MANAGEMENT APPROACH

Adaptive management as applied to ecological restoration is a systematic decision-making process in which the results of restoration activities are consistently monitored and evaluated to identify whether the restoration program is reaching its desired results. After implementation of initial restoration or maintenance measures, the project enters an iterative phase with a focus on monitoring and assessment. Monitoring determines whether adjustments to maintenance and/or management measures are warranted. If it is found that the desired results are not being achieved or on a trajectory to be achieved, adaptive management can provide guidance to determine remedial actions to assist in achieving restoration success. For salt marsh restoration, an adaptive management framework can include triggers and targets for specific structural and functional components (e.g., vegetation and hydrology), a schedule for management and remedial activities, interim criteria (in some instances), and a monitoring plan to assess the progress of the project. Adaptive management is focused on achieving and/or maintaining system function and is not intended to provide a list of activities that are general maintenance such as removal of trash and prevention of inappropriate access.

Adaptive management is by nature an evolving strategy. An underlying assumption of adaptive management is that ecosystems are complex and inherently variable, making it difficult to precisely forecast the outcome of management action (Buchsbaum and Wigand 2012). Additionally, salt marsh system functions and services are inherently interrelated and some variables or metrics cannot be evaluated without also evaluating other associated metrics (e.g., fish populations may rely on water quality or sediment quality) or regional information.

Information does not always exist beforehand to be used to outline the best way to adjust the system and improve the function of the wetland. Zedler (2016) emphasizes the need to consider experimentation in the adaptive management process in order to iteratively identify remedial actions when results do not perform to the level desired. Therefore, the actions identified in this chapter are potential examples of remedial actions that could be implemented, but these may be replaced or augmented as new strategies are developed or identified in the future, or through coordination with permitting and resource agencies if specific concerns arise.

16.2 ADAPTIVE MANAGEMENT PROCESS

Data and assessments have been collected for 13 broad-level variables in San Elijo Lagoon as part of the monitoring program. The intent of the monitoring program is to demonstrate that implementation of the restoration project improves functions and services of the lagoon by meeting identified performance standards. Through collection and evaluation of data as either absolute or relative metrics, as discussed in specific chapters above, the success of the lagoon restoration process can be evaluated. Different variables may have different timelines for initial assessment of performance standards. For example, habitat is expected to reach performance standards first, while other variables are tied to the post-restoration improvement of habitat functions that may require time to establish to the point where they meet performance standards, (e.g., avian or benthic communities may require a number of years to grow into a stable community). Similarly, some variables may have interim performance standards that can help determine whether a specific function is on a trajectory to meet final performance standards, while other variables may not have such interim standards.

The process for adaptive management for each of the metrics being monitored in San Elijo Lagoon will be ongoing with timelines and actions depending on the individual variable, as described in the previous chapters. The monitoring protocol for each metric has been established to identify specific concerns associated with each variable early enough in the post-restoration phase to enable remedial measures to be taken if necessary and as feasible to achieve project success.

Nature Collective will evaluate and determine if the performance standards have been met and will document monitoring results within the annual report prepared at the end of each year. If performance standards have not been met for variables and monitoring trends indicate the specific function is not heading toward achieving success, adaptive management strategies will be identified and implemented. If necessary, Nature Collective will review the data with the relevant permitting and resource agencies, or with local experts, in an effort to devise a mutually agreed upon course of action to bring the particular variable into conformance with performance standards.

The monitoring program is described in the chapters above and briefly summarized in Table 2-1. Table 16-1 expands on that table to identify specific potential adaptive management strategies that may be implemented as remedial actions if specific performance standards are not being met, or monitoring results indicate that functions are not improving as anticipated post-restoration. Most metrics will be quantitatively assessed annually, and qualitatively assessed more frequently. Nature Collective staff and Project Restoration Biologists will be frequently on-site and monitoring the lagoon during various ongoing efforts, and will integrate qualitative assessments into their regular activities. Table 16-1 identifies the timeline for initial assessment to determine whether adaptive management measures are necessary to support and/or facilitate project success.

Table 16-1 Adaptive Management Actions

Chapter	Variable	Variable Type[1]	Performance Standard and/or Triggers	Timing to Trigger Adaptive Management[2]	Potential Adaptive Management Actions
3	Topography	Project Design Absolute	Within 10% (+/-) of habitat areas indicated in the final restoration plan by Year 5 post-construction.	• Year 1 post-construction • Major flood flow events may trigger post-storm inspection	• Focused grading and/or dredging within the restoration footprint may be conducted to correct elevations. • If flood flow events result in enough sedimentation to lead to habitat conversion, focused grading and/or dredging may be conducted to correct elevations.
4	Bathymetry	Project Design Absolute	Channels need to be sufficiently deep to provide approximately 2 feet of depth at low tide, and channel cross-sections need to be large enough to reduce friction and allow for tidal flow to be conveyed. Within 10% (+/-) of subtidal and area indicated in the final restoration plan by Year 5 post-construction.	• Year 1 post-construction • Years 5 and 10 post-construction • Major flood flow events may trigger post-storm inspection	• Focused grading and/or dredging within channels may be conducted to correct elevations. • If monitoring indicates shoaling of channels affects tidal process, focused grading and/or dredging may be conducted to correct problems.
5	Tidal Elevation	Project Design Absolute	Tidal elevations must remain within the range of existing tides as recorded prior to construction to be deemed successful at preserving tidal conditions for habitat, circulation, and water quality. Tidal elevations at locations upstream of existing tidal influence should be similar to those downstream in existing tidally influenced areas. Habitat areas must fall within 10% of the designed habitat area targets in response to TIF. Predicted seawater residence time must remain on average shorter than 7 days in the central basin and 9 days in the east basin, as estimated using a numerical hydrodynamic model (such as RMA) to indicate first order water quality.	• Annually	• It is anticipated that sand from the nearshore will continue to build up in the lagoon inlet, requiring periodic removal. Removal of soil depositions as needed. • Should shoaling be observed to occur in areas other than the inlet (i.e., upstream of the railroad bridge), the effects of such shoaling on tidal elevations will be present in the tide data and can be evaluated for potential secondary effects to habitat, circulation, and water quality. Nature Collective can analyze both TIF and residence time at that time with the new tide data and the model to determine if habitat areas and circulation/water quality will change in response. If necessary, remedial actions can be implemented if the post-construction habitat distribution varies by more than 10% of design or residence times are estimated to extend beyond 7 days.
6	Habitat Areas	Project Design Absolute	Within 10% (+/-) of areas indicated in the final restoration plan by Year 5 post-construction.	• Annually	• Could involve recontouring the channel or spot excavation or dredging to obtain the desired depth to promote the habitat that is not performing to its goal for growth. For vegetated areas, remedial earthwork will be followed by planting. • There may be some opportunities for planting if sensitive habitat/species are not present in areas identified for conversion and activities can occur without causing impacts to the area.
7.1	Vegetative Cover	Project Design Absolute	Meet the 5- and 10-year absolute performance standards defined in the final restoration plan as detailed in Table 7-1 in Chapter 7 of this Plan.	• Annually	• Supplemental planting of salt marsh and upland transitional plant species. • Consider and discuss opportunities for focused micro-grading, soil treatment, etc. to address issues that result in plants not establishing as expected.
7.2	*Spartina* Canopy Architecture	Relative	Not significantly worse than the mean value at the lowest performing reference wetland within 5 years of monitoring following construction.	• Annually	• Regrading discrete areas within the existing project limits, if necessary. • Supplemental California cordgrass installation.
7.3	Exotics	Project Design Absolute	No more than 0% coverage by California Invasive Plant Council "Invasive Plant Inventory" species of "high" or "moderate" threat and no more than 5% coverage by other exotic/weed species during any year.	• Following monitoring events	• Removal of weeds that exceed thresholds.
8	Water Quality	Relative	DO not significantly worse than the mean value at the lowest performing reference wetland within 5 years of monitoring following construction.	• Annually	• Review bathymetry, tidal elevation, and sediment quality data. • Additional inlet opening and focused channel dredging within restoration footprint if necessary. • If the SELRP fails to meet the relative performance standard, additional water quality data will be used to identify the locations and probable causes of failure. These additional data are continuous sonde data of turbidity, chlorophyll, pH, temperature, conductivity, depth, and DO at four spatially distributed sites that cover the hydrological extent of the wetland. The second additional dataset is the weekly manual water quality measurements of DO, temperature, and conductivity mentioned above. These additional measurements will help to pinpoint the probable cause and location of possible water quality issues (see Figure 8-1 for adaptive management sampling locations). • If supplemental information being collected to inform adaptive management (i.e., continuous and weekly stations described above) is not adequate, adaptive management strategies may also include the following: o A surface logger at an existing station to capture stratification information;

Table 16-1 Adaptive Management Actions

Chapter	Variable	Variable Type[1]	Performance Standard and/or Triggers	Timing to Trigger Adaptive Management[2]	Potential Adaptive Management Actions
					○ Augment or replace manual sampling at weekly stations with the deployment of miniDOT® loggers to capture oxygen and temperature dynamics over an extended period of time at a higher temporal resolution; and/or ○ Annual inspection and maintenance, if necessary, at the bridge crossing underneath Interstate 5, which could be completed concurrently with inlet maintenance. Sediment nutrient monitoring will be expanded into areas that were not within the project footprint, i.e., areas of known high nutrient levels that were not dredged due to USFWS constraints and/or the overdredge pit. Data from stations located outside of the project footprint or within the overdredge pit will be compared to stations within the footprint to determine if those outside the footprint are contributing to continued water quality degradation and depauperate benthic communities. Should such data suggest that undisturbed areas outside of the project footprint continue to affect water quality, no remedial actions may be feasible as part of this project. If data suggest that the overdredge pit could be contributing to water quality issues, additional measures such as supplemental capping may be appropriate within the pit boundary.
9	Benthic Invertebrates	Relative	Not significantly worse than the mean value at the lowest performing reference wetland within 10 years of monitoring following construction.	• Year 1, Year 3, and annually from Year 5 through Year 10 post-construction	• Review water and sediment quality data. • See potential action for water quality and sediment.
10	Sediments	Not Applicable	No specific performance standard associated with this variable. Collected to inform water quality and benthic invertebrate standards.	• Year 1, Year 3, and annually from Year 5 through Year 10 post-construction	• Additional dredging in remaining high-nutrient areas within restoration area. • Consider sampling in coordination with County of San Diego/City of Encinitas MS4 estuarine monitoring to compare San Elijo Lagoon with statewide and regional databases.
11	Fish	Relative	Not significantly worse than the mean value at the lowest performing reference wetland within 5 years of monitoring following construction.	• Annually	• Review water and sediment quality data. • See potential action for water quality and sediment.
12.1	Breeding Marsh Birds with Focus on Light-Footed Ridgway's Rail	Pre-Restoration Absolute	Within 95% or greater of pre-construction survey data (2016, 2017).	• Annually	• Review habitat and vegetation cover data; see remedial action for those metrics. • Review other physical and biological variables that may be impacting species populations. • Participate in captive release program as occurred in the past.
12.2	Western Snowy Plover, California Least Tern, and Waterbird Species	Pre-Restoration Absolute	Within 95% or greater of pre-construction survey data (2016, 2017).	• Year 1, Year 3, and annually from Year 5 through Year 10 post-construction	• Review habitat and vegetation cover data; see remedial action for those metrics. • Review other physical and biological variables that may be impacting species populations.
12.3	Belding's Savannah Sparrow	Pre-Restoration Absolute	Within 95% or greater of pre-construction survey data (2016, 2017).	• Year 1, Year 3, and annually from Year 5 through Year 10 post-construction	• Review habitat and vegetation cover data; see remedial action for those metrics. • Review other physical and biological variables that may be impacting species populations.
13	Wetland Function (CRAM)	Pre-Restoration Absolute	Post-Restoration greater than or equal to Baseline CRAM Attribute Score.	• Following each CRAM assessment of the lagoon	• See remedial actions for other variables.
14	Eelgrass	Pre-Restoration Absolute	No permanent losses of eelgrass.	• After the second year post-restoration	• Discuss potential eelgrass transplant options with the appropriate agencies. • Eelgrass planting in channels as appropriate.
15	*Caulerpa*	Pre-Restoration Absolute	*Caulerpa* absent from project site.	• Following surveys	• If *Caulerpa* is found, eradication shall take place.

CRAM = California Rapid Assessment Method; DO = dissolved oxygen; MS4 = Municipal Separate Storm Sewer System; SELRP = San Elijo Lagoon Restoration Project; TIF = tidal inundation frequency; USFWS = U.S. Fish and Wildlife Service

[1] See Section 2.1 for a definition of relative variables related to the San Dieguito Wetlands Restoration Project and Section 2.2 for a definition of the various absolute variables at San Elijo Lagoon.

[2] Timing to trigger adaptive management represents the first trigger point in the monitoring schedule to consider potential adaptive management actions. The post-construction monitoring schedule is detailed for each variable in its respective chapter.

Adaptive management strategies are also intended to evolve over time. Potential adaptive management strategies are described in the two right columns in Table 16-1. These strategies have been identified to provide an understanding of the activities that can be undertaken to remedy the deficit in the conformance of the variable to the performance standard and to set a path for increasing the function of the wetland ecosystem.

For a number of the variables that are being monitored, specific action can be taken to directly address activities that can increase the function of the wetland for the variable being analyzed. However, for a number of the variables, while performance standards have been created, the steps to be taken to change the situation and increase the function of that variable have not been identified. For those variables, Nature Collective staff will evaluate the data and, through experimental questioning and familiarity with the functions of the lagoon, make recommendations for improvements, and will coordinate with relevant permitting and resource agencies to implement identified adaptive management strategies. Should such data suggest that areas outside of the restoration project footprint continue to affect lagoon functions (e.g., water quality), a new, expanded lagoon restoration effort may be identified as the sole solution. It should be noted that such a plan would not be considered as part of this adaptive management program, since it would constitute a new project rather than remedial dredging, which would entail repeated dredging within the existing footprint. The SELRP was designed to take into account existing sensitive resources within the lagoon, including existing habitat that supports endangered species (e.g., light-footed Ridgway's rail), and certain limitations to functional improvements are inherent in the project due to those tradeoffs. A new lagoon restoration plan would continue to be limited by such resources and would be subject to environmental analyses and permitting requirements similar to the SELRP, making it unlikely that an expanded restoration footprint would be feasible.

Sea level rise is a long-term consideration that could substantially affect the ability of the lagoon to maintain functions and services over time. While the primary effects of sea level rise will be addressed in the LTMP, should sea level rise begin to affect the ability of the lagoon to meet identified performance standards for restoration success, as outlined in this Plan, adaptive management actions will be implemented as part of this monitoring phase. Such actions may include raising the elevation of the marsh plain through addition of sediment in selected areas within the restoration area to allow the marsh to persist as sea level rises.

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17. REFERENCES

AECOM. 2016. *San Elijo Lagoon Restoration Project Pre-Restoration California Rapid Assessment Method Analysis*. Prepared for the San Elijo Lagoon Conservancy. February 2016.

-------. 2017a. *San Elijo Lagoon Restoration Project Wetland Restoration Plan.* Prepared for the San Elijo Lagoon Conservancy. December.

-------. 2017b. *Western Snowy Plover and California Least Tern Nest Monitoring and Management Plan for the San Elijo Lagoon Restoration Project*. Prepared for U.S. Fish and Wildlife Service.

American Ornithologists' Union (AOU). 1983. *Checklist of North American Birds*, 6th ed. American Ornithologists' Union, Washington, D.C.

Buchsbaum, R. N., and C. Wigand. 2012. "Adaptive Management and Monitoring as Fundamental Tools to Effective Salt Marsh Restoration." Chapter 14 in *Tidal Marsh Restoration: A Synthesis of Science and Management*, edited by Charles T. Roman and David M. Burdick. Springer, New York, NY, pp. 213–231.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. *Introduction to Distance Sampling – Estimating Abundance of Biological Populations*. Oxford University Press, Oxford.

Burnham, K. P., and D. R. Anderson. 2002. *Model Selection and Multimodel Inference – A Practical Information-Theoretic Approach*. Second edition. Springer, New York.

California Wetlands Monitoring Workgroup (CWMW). 2013a. *California Rapid Assessment Method (CRAM) for Wetlands, User's Manual*, Version 6.1, p. 67.

-------. 2013b. *California Rapid Assessment Method (CRAM) for Wetlands, Perennial Estuarine Wetlands Field Book*, Version 6.1, p. 38.

-------. 2013c. *California Rapid Assessment Method (CRAM) for Wetlands, Depressional Wetlands Field Book*, Version 6.1, p. 43.

Collins, J. N., E. D. Stein, M. Sutula, R. Clark, A. E. Fetscher, L. Grenier, C. Grosso, and A. Wiskind. 2008. *California Rapid Assessment Method (CRAM) for Wetlands*, Version 5.0.2. 157 pp.

Conway, C. J. 2011. Standardized North American Marsh Bird Monitoring Protocol. *Waterbirds* 34(3): 319–346.

eBird. 2015. Online at http://ebird.org/content/ebird/.

Ecological Society of America. 2012. Online at https://www.esa.org/esa/wp-content/uploads/2012/12/hypoxia.pdf. Accessed December 19, 2018.

Gibson, D. 2011. Executive Director & Principal Scientist. San Elijo Lagoon Conservancy. Personal communication with Moffatt & Nichol. October.

Hjulstrom, F. 1935. "Studies of the Morphological Activity of Rivers as Illustrated by the River Fyris," *Bulletin,* Geological Institute of Upsala, Vol. XXV, Upsala, Sweden, 1935.

Holland, R. 1986. *Preliminary Descriptions of the Terrestrial Natural Communities of California*. Nongame Heritage Program. State of California Department of Fish and Game.

Huggins, R. M. 1989. On the Statistical Analysis of Capture-Recapture Experiments. *Biometrika* 76:133–140.

-------. 1991. Some Practical Aspects of a Conditional Likelihood Approach to Capture Experiments. *Biometrics* 47.

Konecny, J., R. Zembal, and S. Hoffman. 2009. Survey Guidelines to Determine Presence/Absence of the Light-footed Clapper Rail in Southern California; Recommendations of the Clapper Rail Study Team. Unpublished Protocol.

Merkel & Associates, Inc. (Merkel & Associates). 2018. *San Elijo Lagoon Restoration Project Marine Ecosystem Monitoring, Adaptive Management, and Mitigation Plan*. January 2019. Prepared for the San Elijo Lagoon Conservancy.

Moffatt & Nichol (M&N). 2012. *San Elijo Lagoon Restoration Project Water Quality Study. Final Report*. June 2012. Prepared for the San Elijo Lagoon Conservancy.

-------. 2014. *San Elijo Lagoon Restoration Project Hydrology/Hydraulic Study*. Prepared for the San Elijo Lagoon Conservancy.

Nichols, J. D., J. E. Hines, J. R. Sauer, F. W. Fallon, J. E. Fallon, and P. J. Heglund. 2000. A Double-Observer Approach for Estimating Detection Probability and Abundance from Point Counts. *Auk* 117:393–408.

Oberbauer, Thomas, Meghan Kelly, and Jeremy Buegge. March 2008. *Draft Vegetation Communities of San Diego County*. Based on "Preliminary Descriptions of the Terrestrial Natural Communities of California," Robert F. Holland, Ph.D., October 1986.

Page, M., S. Schroeter, D. Reed, and M. Steele. 2018a. Monitoring Plan for the SONGS' Wetland Mitigation Project. Online at http://marinemitigation.msi.ucsb.edu/documents/wetland/ucsb_mm_reports/wetland_mitigation_monitoring_plan_august2018.pdf. Accessed December 19, 2018.

Page, M., S. Schroeter, and D. Reed. 2018b. *Annual Report of the Status of Condition A: Wetland Mitigation. San Onofre Nuclear Generating Station (SONGS) Mitigation Program*. Online at http://marinemitigation.msi.ucsb.edu/documents/wetland/annual_monitoring_reports/2017_annualreport-SONGS_wetland_mitigation.pdf. Accessed May 15, 2019.

Raimondi, P. 2019. A summary of the Coastal Commission approach of assessing permit compliance of relative standards for the SONGS mitigation program. Memorandum provided on August 12, 2019.

Rosencranz J. A., K. M. Thorne, K. J. Buffington, J. Y. Takekawa, R. F. Hechinger, T. E. Stewart, R. F. Ambrose, G. M. MacDonald, M. A. Holmgren, J. A. Crooks, R. T. Patton, and K. D. Lafferty. 2018. Sea-Level Rise, Habitat Loss, and Potential Extirpation of a Salt Marsh Specialist Bird in Urbanized Landscapes. *Ecol Evol.* 8:8115–8125. Online at https://doi. org/10.1002/ece3.4196.

Wetlands International. 2010. Guidance on Waterbird Monitoring Methodology: Field Protocol for Waterbird Counting. Online at https://europe.wetlands.org/wp-content/uploads/sites/3/2016/08/Protocol_for_waterbird_counting_En_.pdf. Accessed May 17, 2019.

White, G. C., and K. P. Burnham. 1999. Program MARK: Survival Estimation from Populations of Marked Animals. *Bird Study* 46:120–139.

Wiest, A. W., and W. G. Shriver. 2015. Survey Frequency and Timing Affect Occupancy and Abundance Estimates for Salt Marsh Birds. *The Journal of Wildlife Management* 80(1): 48–56.

Zedler, J. 2001. *Handbook for Restoring Tidal Wetlands*. CRC Marine Science (Book 21). CRC Press.

-------. 2016. Adaptive Approaches to Wetland Restoration in Southern California. Maven Conferences and Seminars, Science Features. Online at https://mavensnotebook.com/2016/03/24/adaptive-approaches-to-wetland-restoration-in-southern-california/. Accessed February 6, 2018.

Zembal, R., S. M. Hoffman, and J. Konecny. 2014. *Status and Distribution of the Light-footed (Ridgway's) Clapper Rail in California*. 2014 Season. State of California, Natural Resources Agency, Department of Fish and Wildlife, Wildlife Branch.

Zembal, R., S. M. Hoffman, and R. Patton. 2015. A survey of the Belding's Savannah Sparrow (*Passerculus sandwichensis beldingi*) in California, 2015. Sacramento, CA: California Department of Fish and Wildlife, Habitat Conservation Planning Branch, Species Conservation and Recovery Program Report 2015-02.

Zembal, R., and B. W. Massey. 1987. Seasonality of Vocalizations by Light-footed Clapper Rails. *Journal of Field Ornithology* 58:41– 48.

Appendix A

Water Quality Data Sonde Locations of Reference Wetlands

Source: ESRI, SDL Restoration Project 2019.

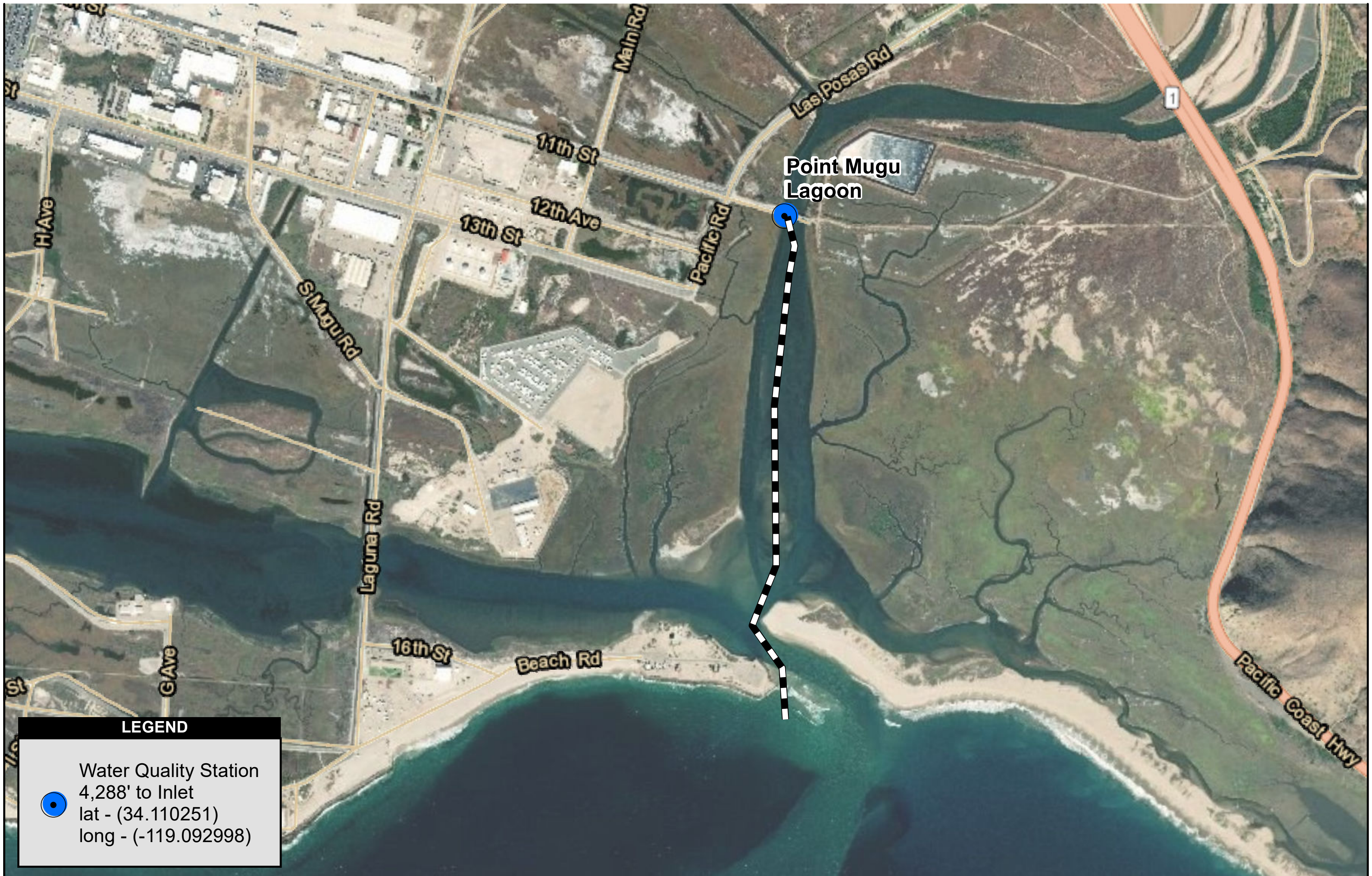
1,250 625 0 1,250 Feet

Scale: 1:15,000; 1 inch = 1,250 feet

Figure 1
Water Quality Station
Tijuana Estuary

Path: P:_6058\60582908_SELRP_ConPh2\900-CAD-GIS\920 GIS\map_docs\mxd\Water_Quality_Stations\Location of Water Quality Station at Tijuana Estuary.mxd, 10/15/2019, paul.moreno

SELRP & San Dieguito Lagoon Restoration Project Water Quality Monitoring Stations



Source: ESRI, SDL Restoration Project 2019.

1,250 625 0 1,250 Feet

Scale: 1:15,000; 1 inch = 1,250 feet

Figure 2
Water Quality Station
Point Mugu Lagoon

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SELRP & San Dieguito Lagoon Restoration Project Water Quality Monitoring Stations

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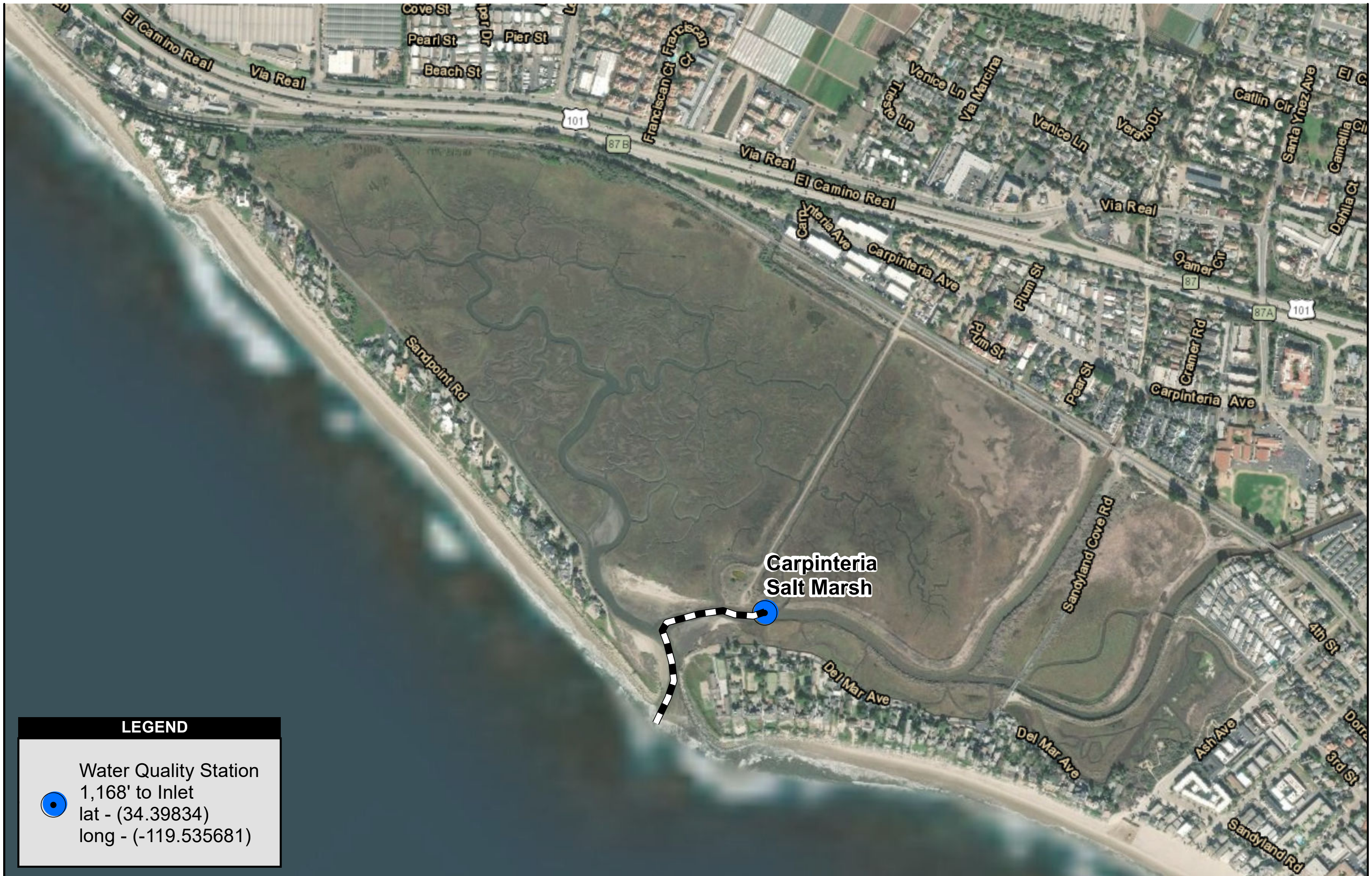

Source: ESRI, SDL Restoration Project 2019.

850 425 0 850 Feet

Scale: 1:10,200; 1 inch = 850 feet

Figure 3
Water Quality Station
Carpinteria Salt Marsh