The Los Cerritos Wetlands Habitat Restoration Plan

Final Draft
March 2021

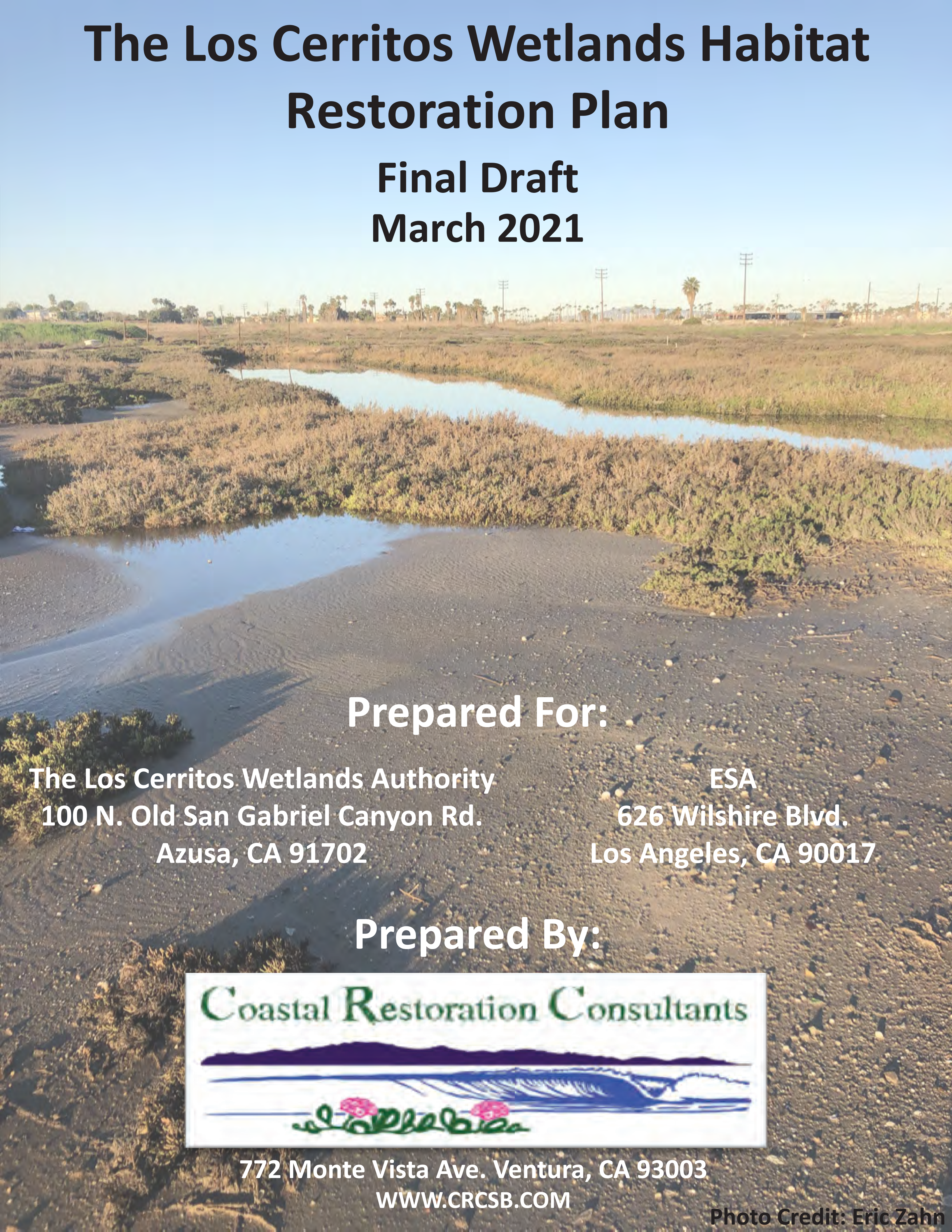

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Photo Credit: Eric Zahn

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0 EXECUTIVE SUMMARY

The Los Cerritos Wetlands (LCW) complex includes about 503 acres of publicly and privately owned open space in the cities of Long Beach and Seal Beach, California that were historically part of a much larger tidal estuarine system at the mouth of the San Gabriel River (SGR). In its current state, the LCW consists mostly of degraded tidal and non-tidal salt marsh habitats behind levees and weedy uplands where tidal marshes were filled over the last 100 plus years. This document lays out the approach and the rationale for restoring tidal wetlands and other habitats on 166 acres within the complex that are currently owned by the Los Cerritos Wetlands Authority (LCWA) and the remaining 337 acres under different ownerships.

The LCWA properties cover three distinct areas, the largest of which, known as the South LCWA Site, covers 100-acres. The LCWA views restoration in this area as a near-term priority so restoration designs for this area are developed in the most detail in this plan. The smallest of the LCWA areas already has a restoration plan being implemented and the third area is currently constrained by active oil leases and easements so further planning and implementation will occur later. Restoration planning is occurring on non-LCWA owned properties as well. Restoration designs for all these other areas are discussed in considerably less detail in this plan.

This restoration plan is based heavily on background information developed for the Los Cerritos Wetlands Final Conceptual Restoration Plan (CRP) and environmental impact analyses conducted for CEQA as part of the Los Cerritos Wetlands Restoration Plan Program Environmental Impact Report (PEIR). The CRP identified goals and objectives related to restoring resilient tidal wetlands on large parcels that support public access and scientific research. The CRP also identified a wide range of opportunities for restoration including enhancing existing wetlands, the availability of multiple sources of tidal waters, expanding existing populations of salt marsh dependent plants and wildlife, accommodating habitat transgression with sea-level rise (SLR), and connecting to existing trail systems. Important constraints related to contaminated soils, flood protection, existing infrastructure, water quality, and complex land ownership were identified in both documents as well.

This restoration plan was developed within a planning framework that considers multiple factors. First, the historical ecology of the site was considered. Historical maps show the entire LCW complex was a tidal wetland in the late 1800’s. The nearly 2,400-acre estuary was severely altered by filling, channelization of waterways, and diking starting in the early 20th century. This suggests that tidal salt marsh and related habitats are generally the most appropriate targets for restoration at the site.

Second, natural ecosystem process in need of restoration were identified. These processes are mostly related to hydrology, landforms, soils, vegetation communities, and food webs.

This analysis revealed that the primary needs for the site are reintroduction of tides, removal of fill from former wetlands, and reintroduction of native species.

Third, the regional and local biological and socioeconomic needs were analyzed. Biological needs include re-establishing historic habitat and species diversity including rare species, building resilience of habitats to SLR, and restoring habitat connectivity and more natural dynamics. Socioeconomic needs include supporting local fisheries, providing sites for mitigation, and providing space for recreation, education, and a true “sense of place” for visitors. Given the relatively large size of the LCW complex, many of these needs can be met in different areas and over different time frames.

Fourth, this plan reviews different strategies for helping to assure restored habitats are resilient to SLR. A range of strategies were considered, including incorporation of broad transition zones to facilitate up-slope migration of habitats, beneficial sedimentation to slowly raise the marsh surface over time, and a novel approach that involves tiered wetland terraces that “type convert” to different habitats as sea level rises. All of these approaches were found to be appropriate for this project.

Finally, field studies informed an understanding of current biotic and abiotic conditions at the site related to vegetation and wildlife, soils, hydrology, regulatory jurisdictions, current land use, and cultural resources. These analyses revealed extensive areas of functioning salt marsh that could be enhanced instead of graded, appropriate sources of tides to support restoration of high-functioning habitats, areas with sensitive species to avoid disturbing, and the need to preserve certain infrastructure. There remain important data gaps in some of these areas, especially related to soils and cultural resources.

All of this guidance along with the best available science and principles of Restoration Ecology were used to develop a basis of design that will guide restoration designs so that many of the ecological functions and values that have been lost at the site since human alterations began in the 20th century, can be restored. Given the unique opportunities and constraints of this site, it is not feasible to try to restore the site to precisely what it may have looked like at some point in history (*e.g*., before European colonization). Rather, the restoration design was optimized to balance accomplishment of a range of sometimes-competing goals and objectives.

In this plan, the basis of design is used to develop the Refined Restoration Plan for the South LCWA site (Figure 0-1). The key action is restoration of tides to areas with limited or no tidal flushing now. This is accomplished by considerable grading, including a new tidal channel connecting to the Haynes Cooling Channel once it is decommissioned from once-through cooling, and removal of fill from historic tidal wetlands. Much of the existing wetland habitat on the site is preserved and enhanced. Flood protection for infrastructure and neighbors is included where needed. Considerable high marsh and transition zone habitats are included as are adjacent uplands. Non-wetland special status plant species are largely protected.

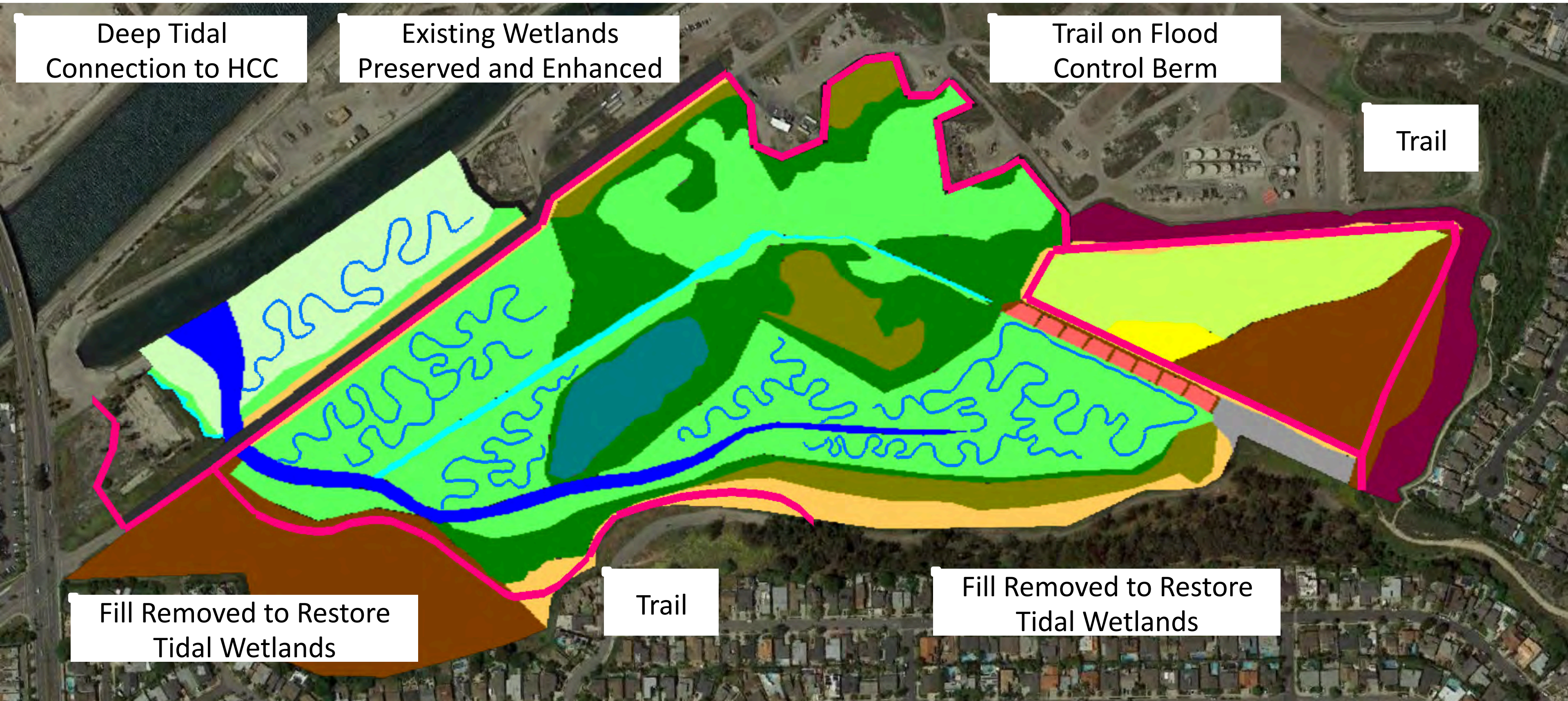
Public access is focused around the perimeter of the property with connections to existing nearby trails and roads.

The basis of design was also used to develop a conceptual design for the Central LCWA site that includes a tidal connection to the SGR via one or more culverts, as opposed to a breach in the levee (Figure 0-2). This approach allows a sufficient tide range to support high functioning salt marsh while limiting flood heights, which results in much smaller levees around the perimeter of the site and oil wells. This conceptual design will need to be refined by engineering a culvert connection to the San Gabriel River that provides a balance between maximizing tidal range and minimizing flooding elevation.

The PEIR evaluated the potential environmental impacts of a range of restoration alternatives. This restoration plan shares the goals and general approach of the program described in the PEIR, but it differs in certain details and design features. In some cases, the PEIR made assumptions that resulted in extensive impacts in order to provide flexibility for future project designs. The restoration designs in this plan are intended to be less impactful than designs analyzed in the PEIR.

Looking forward, the next stages of the planning process will need to refine designs proposed in this plan and fill in crucial data gaps. This next round of planning will happen first for the South LCWA site. This restoration plan identifies general implementation strategies and next steps that should inform the direction of that planning effort.

Finally, an important theme that is apparent throughout this plan is that tradeoffs must be made on a wide range of issues in the development of restoration designs. For instance, low-lying uplands and broad gently sloping transition zones are probably good for SLR resilience. However, the footprint of such features directly affects the area of tidal marsh habitats that can be restored in the near-term. Smaller marsh areas will not provide the same level of functioning in the near-term as larger systems. Therefore, a tradeoff between function over time must be made. Similarly, it is apparent that even the existing weedy uplands at the site are providing ecosystem functions currently. By converting these areas to wetlands, most of the existing functions are lost. Again, these tradeoffs must be carefully considered in the design process. At its root, the process of designing ecological restoration projects is about making informed decisions of how to balance the myriad tradeoffs to optimize the accomplishment of the project’s goals and objectives. This restoration plan presents the decision-making framework for planning restoration throughout the LCWA complex and refined restoration designs for LCWA-owned properties based on the framework.



Legend

- Sub-tidal
- Tidal Channel
- Cordgrass Marsh
- Mid Marsh
- High Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- C. lewisii Preservation
- C. lewisii Mitigation
- Upland on Fill
- Bioswale/Riparian
- Experimental Plot

Refined Restoration Plan for the LCWA South Site

Los Cerritos Wetlands Habitat Restoration Plan

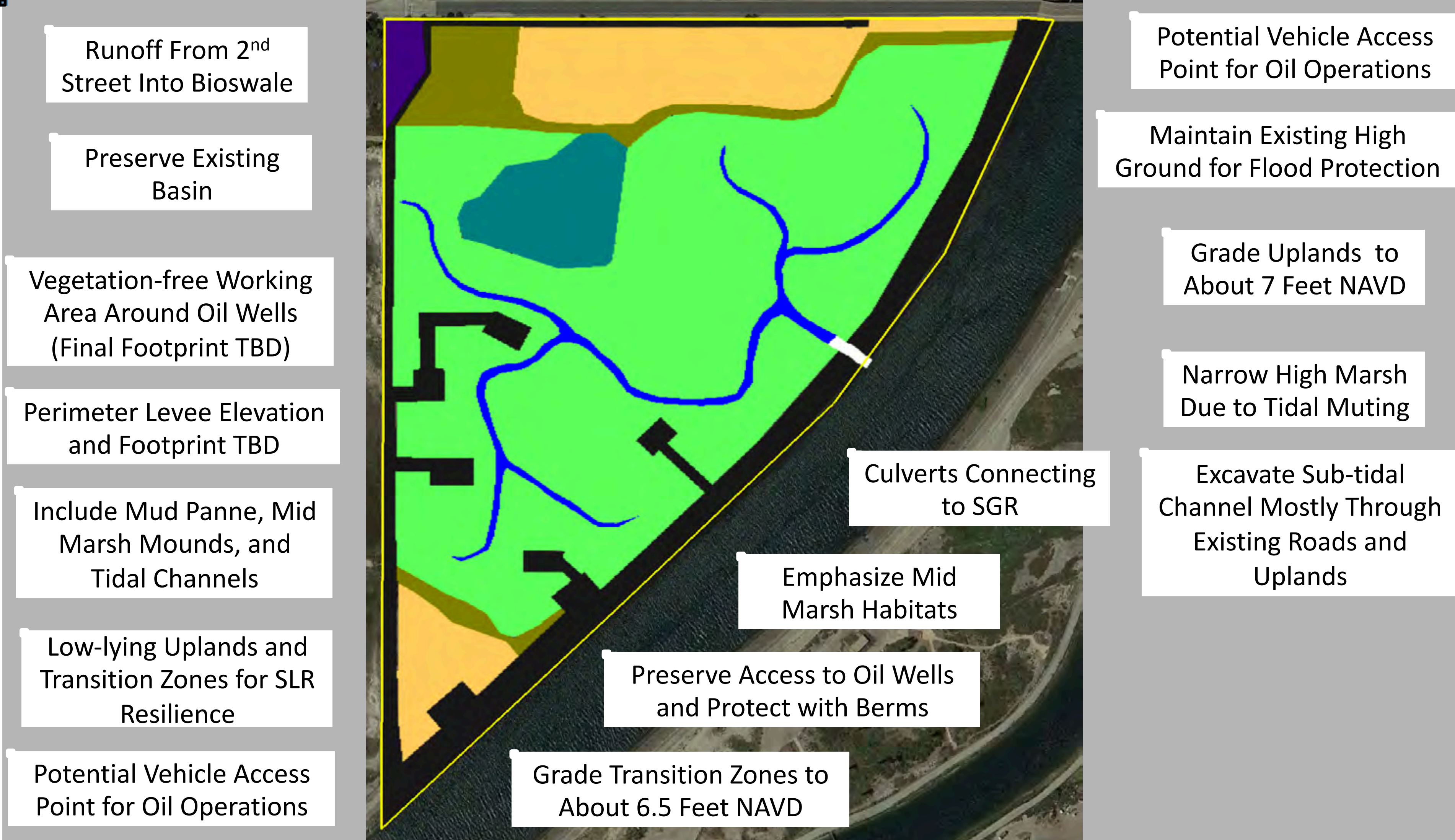
Figure 0-1

750 feet

N

Photo Source: Google Earth May 2019

Coastal Restoration Consultants



Legend

- Sub-tidal
- Mid Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- Bioswale/Riparian
- Project Boundary

Culvert Alternative – LCWA Central Site

Los Cerritos Wetlands Habitat Restoration Plan

750 feet

N

Figure 0-2

Coastal Restoration Consultants

Photo Source: Google Earth May 2019

1 INTRODUCTION

The Los Cerritos Wetlands (LCW) complex includes multiple parcels of publicly and privately owned open space in the cities of Long Beach and Seal Beach, California (Figure 1-1) that were historically part of a large tidal estuarine system at the mouth of the San Gabriel River (SGR). In its current state, the LCW consist mostly of degraded tidal and non-tidal salt marsh habitats behind levees and weedy uplands where tidal marshes were filled over the last 100 plus years. The general lack of development and close proximity to tidal waters makes the area a high-priority for restoring tidal wetlands. The relative scarcity of publicly accessible open space in the area makes improving public access an important part of the restoration effort as well. The LCW is divided into four Areas (South, Central, Isthmus, and North), each of which includes multiple landowners (Figure 1-2).

Restoration efforts at the LCW started with the formation of the Los Cerritos Wetlands Authority (LCWA) in 2006. The LCWA has acquired about 166 acres within the complex (Figure 1-2) with the goal of restoring wetlands, improving public access, and supporting education and outreach. The LCWA first acquired 66 acres straddling the SGR in 2006. An additional 100 acres, the South LCWA Site, was acquired in 2010. The first major step in the restoration planning effort for these areas was the development of the Los Cerritos Wetlands Final Conceptual Restoration Plan (CRP) (Moffatt & Nichol 2015), which developed and analyzed a range of restoration and public access alternatives for the entire LCW complex (*i.e.*, not just properties owned by the LCWA). In 2017, the LCWA began the next phase of restoration planning, which involved the preparation of the Los Cerritos Wetlands Restoration Plan Program Environmental Impact Report (PEIR) and this habitat restoration plan. The PEIR included restoration and public access designs developed primarily to support environmental review required by the California Environmental Quality Act (CEQA) and technical studies related to hydrodynamic modeling, sediment dynamics, and design of flood protection structures. The primary goal of this plan is to refine the designs presented in the PEIR.

This restoration plan builds on work presented in the CRP and the additional analyses conducted for the PEIR. The primary purpose of this restoration plan is to present the basis of design, and the background information that was used to develop it, for restoration throughout the LCW complex. Chapters 2 through 5 of this plan include important background information from the CRP. These include the project's Goals and Objectives (Chapter 2) and Opportunities and Constraints (Chapter 3), which were developed with extensive input from stakeholders, a Technical Advisory Committee (TAC), and the public. Goals and Objectives remain unchanged from the CRP while the Opportunities and Constraints have been slightly updated. Chapter 4 presents the Planning Framework that was used to develop alternatives in the CRP. The Planning Framework is largely unchanged save for the expansion of the historical ecology analysis. Chapter 5 presents the alternative designs for habitats and public access from the CRP and PEIR. All of this background information, and more recent studies conducted as part of the PEIR were used to develop a Basis of Design (Chapter 6) for restoration throughout the LCW complex. The Basis of Design defines the target habitats and then lays out the important ecosystem processes that need to be restored in order to establish self-sustaining habitats throughout the site. Chapter 7 includes an analysis of how current conditions at the site were taken into consideration in choosing which types of restoration actions are most appropriate for the South LCWA Site. Chapter 8 presents the Refined Restoration Plan for the South LCWA Site and semi-quantitative analyses including projections of how restored habitats might be expected to change with SLR of up to 4.4 feet. In this current stage of planning, engineering drawings were not developed, so any of the analyses that would rely on such drawings (e.g., hydrodynamic modeling, grading volume estimates, cost estimates, etc.) will need to be conducted in the next round of planning. During that phase, the Refined Restoration Plan for the South LCWA Site will be revised as needed. Chapters 9 and 10 look forward in the restoration process towards Implementation and Next Steps, including identification of important data gaps that will need to be addressed to inform both design revisions and the environmental review process.

Potential restoration in the LCW beyond the South LCWA Site (Figure 1-2) are discussed in this plan in less detail (Table 1-1) because either there are other ongoing planning efforts or restoration is considered to be a long-term goal. The design presented in this plan for the Central LCWA Site is highly conceptual, with the design of many features (e.g., flood control structures) being dependent on future environmental review and permitting. Planning for the Central LCWA Site is expected to follow further design refinements and environmental review of the South LCWA Site. There is potential for tidal restoration in the Isthmus Area, but given its smaller area and considerable constraints, planning for this area has been progressing on a parallel track (*see* Tidal Influence 2017). In the North area, a project-level EIR was prepared for the City of Long Beach in 2018 to evaluate the environmental effects associated with the Los Cerritos Wetlands Oil Consolidation and Restoration Project (State Clearinghouse No. 2016041083). The project would create a wetlands mitigation bank and consolidate oil infrastructure.

Table 1-1. Summary of how this plan discusses restoration on all LCW properties (Figure 1-2). The Refined Restoration Plan for the South LCWA Site is developed in the most detail.

Area	Sub-Area	Anticipated Phase	Treatment in This Restoration Plan
South	South LCWA Site	Near-Mid	Refined Restoration Plan in Section 8-1
South	State Lands Parcel	Near-Mid	Reference to PEIR Chapter 2
South	Hellman Retained Site	Long	Reference to PEIR Chapter 2
South	Orange County Site	Near	Reference to PEIR Chapter 2
South	OC Retarding Basin	Mid	Reference to PEIR Chapter 2

	Site		
Central	Central LCWA Site	Near-Long	Refined Culvert Alternative in Section 8-2
Central	Bryant Central Site	Near-Long	Refined Culvert Alternative in Section 8-2
Central	Long Beach Property Site	Long	Reference to PEIR Chapter 2 and other planning efforts
Isthmus	Zedler Marsh Site	Near	Not included – site is currently being enhanced
Isthmus	Isthmus LCWA Site	Long	Reference to PEIR Chapter 2
Isthmus	Isthmus Bryant Site	Near	Reference to other planning efforts in Section 8-3
Isthmus	Callaway Marsh Site	Mid	Reference to other planning efforts in Section 8-3
North	Southern Synergy Oil Field Site	Long	Reference to other planning efforts in Section 8-4
North	Northern Synergy Oil Field Site	Near	Reference to other planning efforts in Section 8-4
North	Alamitos Bay Partners Site	Long	Reference to PEIR Chapter 2 and other planning efforts

1.1 The Need for Restoration

The LCW includes about 503 acres of mostly undeveloped land that was once part of a 2,400-acre tidal wetland complex called New River Slough on the earliest maps (Figure 1-3). Beginning in the late 1800's, the wetlands began being degraded by filling for farming, ranching, and development. Oil was discovered in the area in 1921 and wetland areas were de-watered and filled to facilitate oil extraction. Extensive areas were dredged to build Los Alamitos Harbor and the Marine Stadium in the early 1920's as well. Today, there is only one remnant of the original tidal wetlands remaining at Steam Shovel Slough (Figure 1-2). Fragmented and degraded wetlands have re-established in basins fed by rainwater and runoff and in areas with tenuous tidal connections. These wetlands and adjacent uplands have long been recognized as having high potential for tidal wetland restoration.

The primary actions needed to restore tidal wetlands at LCW are re-establishing good tidal connections to areas behind levees and removing fill from historic wetlands. Accomplishing these major actions is complicated by, among other things, the need to provide flood protection for neighboring properties, ongoing oil extraction in some areas, and extensive areas of contaminated soils due to historic oil operations. Working within these constraints, this plan presents an approach to restoration that includes providing functional lift for existing wetlands, converting uplands to intertidal wetlands, and restoring weedy uplands to native-dominated upland habitats, all while improving public access to the site.

Development of this restoration plan and the basis of design were based on principles of Restoration Ecology, past studies on current site conditions and hydrologic modeling, and stakeholder input. The Refined Restoration Plan for the South LCWA Site and the conceptual design for the Central LCWA Site include major design elements, locations of different habitats, general grading footprints, a potential approach to phasing, and a general approach to public access improvements. These designs are meant to guide subsequent phases of planning, which will refine the design based on new data and analyses.

1.2 The LCW Restoration Plan Program Environmental Impact Report

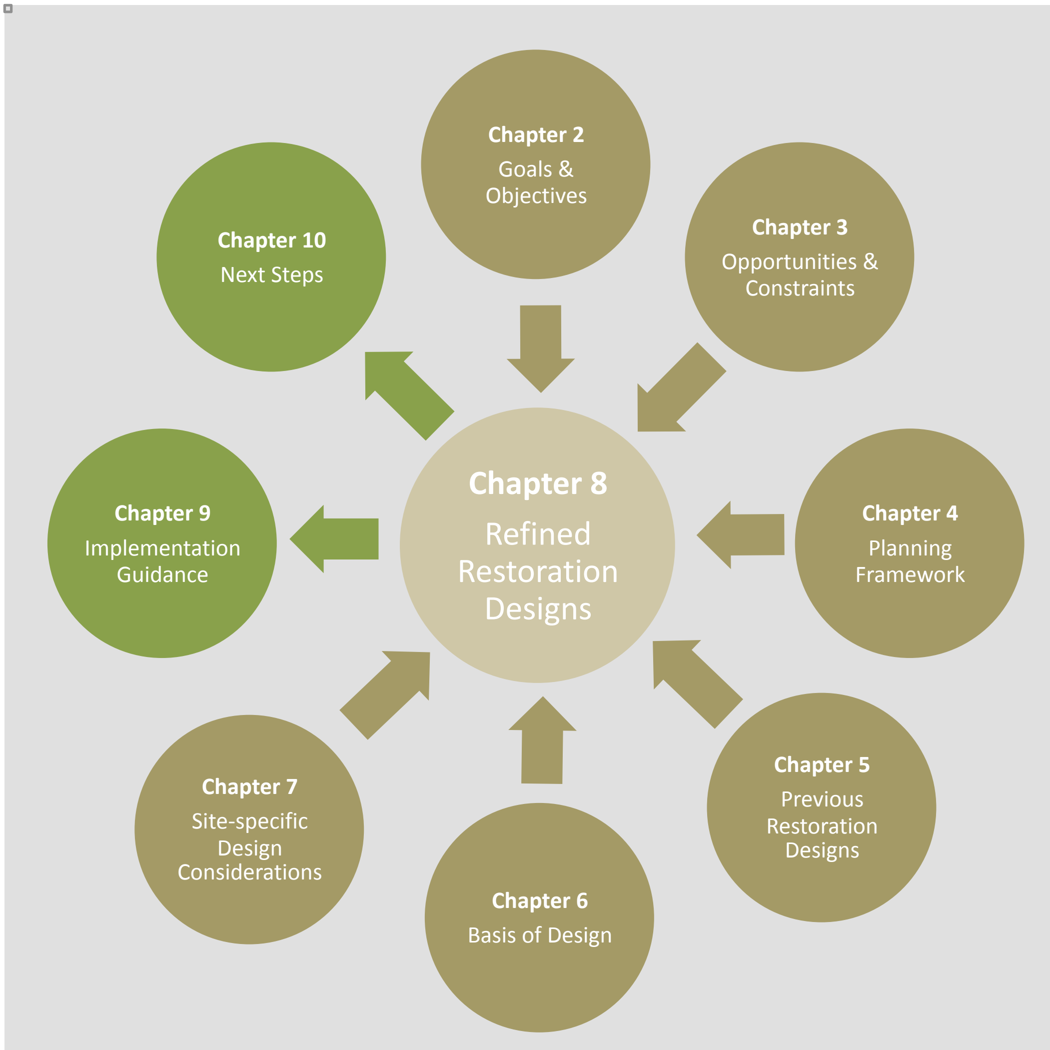
The draft PEIR was prepared in spring 2020 (ESA 2020a). It was developed to support environmental review and permitting for the projects described in this restoration plan. It is a programmatic environmental document that focuses on the overall effects of implementing habitat restoration in 503 acres of the LCW. This will make project-level environmental reviews, which will be needed for the restoration projects presented in this restoration plan, less intensive.

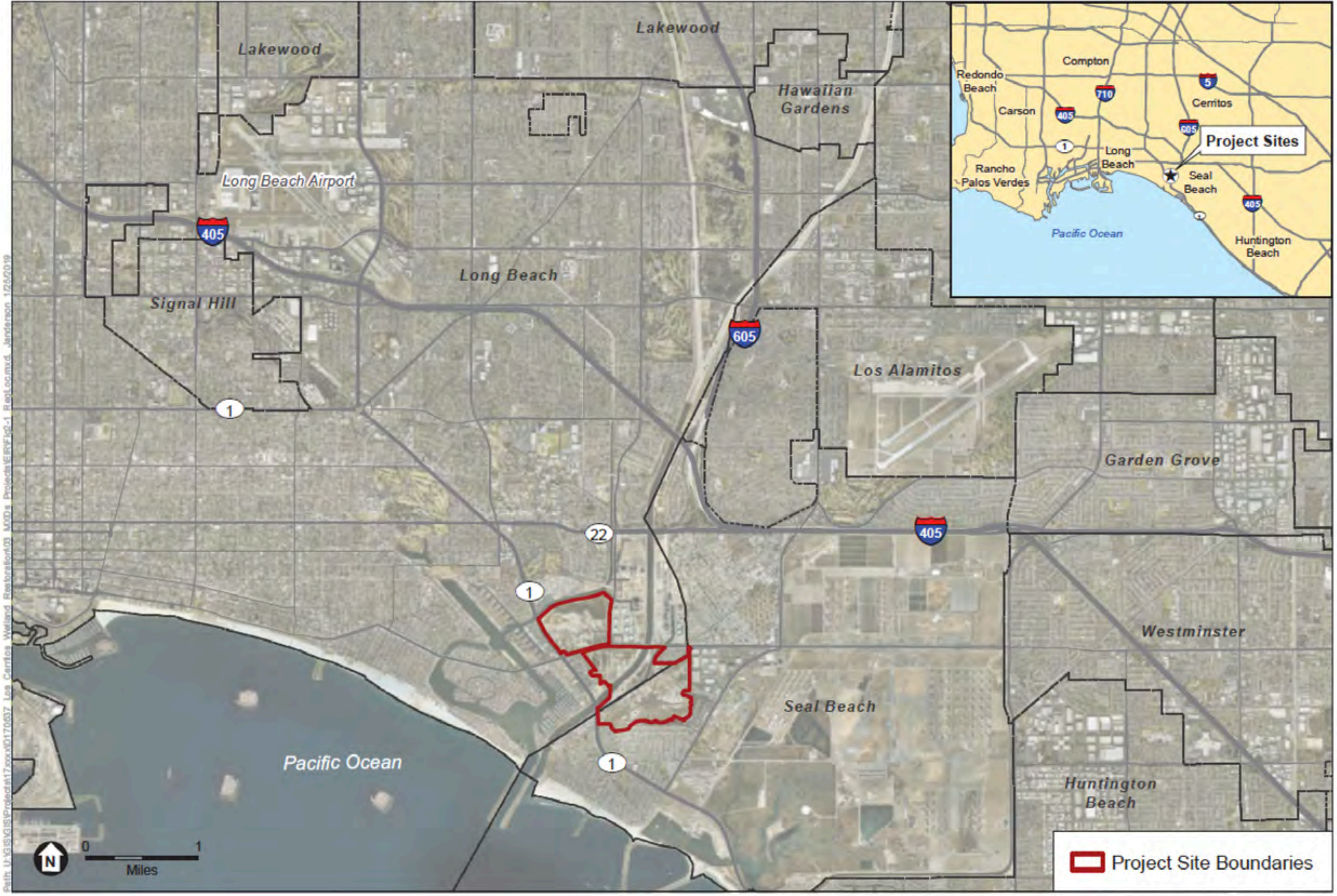
In some cases, the PEIR made assumptions that resulted in extensive impacts in order to provide flexibility for future project designs. Such designs would be covered by the analyses in the PEIR if they were less impactful. The refined restoration designs in this plan are intended to be less impactful than designs analyzed in the PEIR and include more details on different salt marsh habitats than the plans presented in the PEIR.

1.3 Organization of This Plan

This restoration plan includes considerable background information and technical details that provide the basis for refining the restoration designs presented in the PEIR. Readers with different interests may use the following guide to navigate quickly to the sections of the plan they are most interested in by clicking on any bubble in Figure 1-4. In general, Chapters 2-7 contain the detailed information that informed the development of the refined restoration designs presented in Chapter 8. Chapters 9 and 10 present guidance for successful implementation and further refinement of those restoration designs.

Figure 1-3. Readers guide to this restoration plan





SOURCE: ESRI

Los Cerritos Wetlands Restoration Plan Program EIR

Project Location

Los Cerritos Wetlands Habitat Restoration Plan

Figure 1-1

Coastal Restoration Consultants

Map Source: ESA

SOURCE: Mapbox, LCWA

Los Cerritos Wetlands Restoration Plan Program EIR

Los Cerritos Wetlands – Property Boundaries

Los Cerritos Wetlands Habitat Restoration Plan

Figure 1-2

Coastal Restoration Consultants

Map Source: ESA

Legend

- Sub-tidal
- Unvegetated Low Intertidal
- Intertidal Salt Marsh
- Sand Dunes
- Beach

Historical Extent of Wetlands

Los Cerritos Wetlands Habitat Restoration Plan

Figure 1-3

No Scale

N

Coastal Restoration Consultants

Map Source: Moffatt & Nichol

2 GOALS AND OBJECTIVES

The goals and objectives for restoration at the LCW were developed early in the CRP process with significant input from the LCWA Steering Committee and Technical Advisory Committee (TAC). The goals and objectives were then vetted through a public process at six public workshops. The goals are meant to be very high-level and each one has two or more associated objectives that give more detailed guidance on how restoration should be approached within the LCW. The goals and objectives presented below are mostly unchanged from the CRP, with a few additions made during the preparation of the PEIR.

It should be acknowledged that some of the goals and objectives seem to be or are in fact in conflict with others. This is generally inevitable on large complex projects like this. The goal of the design team and stakeholders then is to develop a final design that optimizes attainment of as many goals and objectives as possible – which was done in developing the basis of design and the Refined Restoration Plan for the South LCWA Site.

Goal #1: Restore tidal wetland processes and functions to the maximum extent possible.

Objectives:

1. Increase estuarine habitat with a mix of tidal channels, mudflat, salt marsh, and brackish/freshwater marsh and ponds.
2. Provide adequate area for wetland-upland ecotone and upland habitat to support wetlands.
3. Restore and maintain habitat that supports important life history phases for species of special concern (*e.g.*, federal and state listed species), essential fish habitat, and migratory birds as appropriate.
4. Solicit and address feedback on restoration design from members of the community, Native American tribes, and other interested parties.

Goal #2: Maximize contiguous habitat areas and maximize the buffer between habitat and sources of human disturbance.

Objectives:

1. Maximize wildlife corridors within the LCW Complex and between the LCW Complex and adjacent natural areas within the region.
2. Incorporate native upland vegetation buffers between habitat areas and human development to mitigate urban impacts (*e.g.*, noise, light, unauthorized human encroachment, domestic animals, wastewater runoff) and reduce invasion by non-native organisms.
3. Design the edges of the LCW Complex to be respectful and compatible with current neighboring land uses.

Goal #3: Create a public access and interpretive program that is practical, protective of sensitive habitat and ongoing oil operations, economically feasible, and will ensure a memorable visitor experience.

Objectives:

1. Build upon existing beneficial uses.
2. Minimize public impacts on habitat / wildlife use of the LCW Complex.
3. Design interpretive concepts that promote environmental stewardship and the connection between the wetlands and the community.
4. Solicit and address feedback from members of the community, Native American tribes, and other interested parties.
5. Encourage equitable access to the LCW as a regional resource.

Goal #4: Incorporate phasing of implementation to accommodate existing and future potential changes in land ownership and usage, and as funding becomes available.

Objectives:

1. Include projects that can be implemented as industrial operations are phased out and other properties are acquired over the near-, mid- and long-term (next 5-25-100 years).
2. Investigate opportunities to restore levels of tidal influence that are compatible with current oil leases and neighboring private land holdings.
3. Remove/realign/consolidate existing infrastructure (roads, pipelines, etc.) and accommodate future potential changes in infrastructure, to the maximum extent feasible.

Goal #5: Strive for long-term restoration success.

Objectives:

1. Implement an adaptive management framework that is sustainable.
2. Restore habitats in appropriate areas to minimize the need for long-term maintenance activities that are extensive and disruptive to wildlife.
3. Design habitats that will accommodate climate changes, *e.g.*, incorporate topographic and habitat diversity and natural buffers and transition zones to accommodate migration of wetlands with rising sea levels.
4. Provide economic benefit to the region.

Goal #6: Integrate experimental actions and research into the project, where appropriate, to inform restoration and management actions for this project.

Objectives:

1. Include opportunities for potential experiments and pilot projects to address gaps in information, (*e.g.*, effect of warm river water on salt marsh ecosystem) that are protective of sensitive habitat and wildlife and that can be used to adaptively manage the restoration project.
2. Include areas on the site, where appropriate, that prioritize research opportunities (such as those for adaptive management) over habitat sensitivities.

3 OPPORTUNITIES AND CONSTRAINTS

Opportunities and constraints related to restoration at the LCW were identified in the CRP. They are detailed in an Opportunities and Constraints Report prepared by Moffatt & Nichol (2012) and were summarized in the CRP and below. The opportunities and constraints were developed during the process of data collection on site, discussions with the Steering Committee and TAC, and review of previous LCW studies. Subsequent studies for the PEIR and other new information have led to the addition of a few new opportunities and constraints. These are included below as well in *italics* and more details can be found in the PEIR.

The opportunities and constraints were categorized and discussed under these general topics:

- Topography / Landforms / Soils
- Tidal Exchange / Local Watersheds / Hydrology
- Ecology
- Climate Change
- Infrastructure
- Human Interaction
- Regulatory / Implementation

3.1 Opportunities for Restoration

Numerous opportunities can be capitalized upon to increase the success and effectiveness of the project and minimize impacts and costs. These opportunities include topography and landforms supportive of wetlands habitat, proximity to potential tidal connections, already existing habitat areas (*e.g.*, Zedler Marsh and Steam Shovel Slough), utilization of future SLR, proximity to wildlife corridors, and future watershed improvements. Other opportunities include collaboration with efforts of government agencies (such as the Los Angeles County Significant Ecological Areas (SEA) program), local universities, community stakeholders, tribal groups, and the potential acquisition of additional land for restoration. The latter is a significant opportunity (and constraint) to enable the restoration of the entire LCW Complex. Opportunities have been identified as consisting of the items listed below.

Topography / Landforms / Soils

- Existing ground elevations suitable for coastal wetlands
- Existing landforms can be used to control water
- Existing roads can provide high tide refugia
- Soils suitable for wetlands and uplands habitat cover
- Site location provides opportunities for nearby soil disposal

- Site size provides opportunities for onsite remediation
- Presence of earthquake fault through site may be deterrent to other development

Tidal Exchange / Local Watersheds / Hydrology

- Site location provides tidal exchange enhancement opportunities
- Site location provides freshwater enhancement opportunities
- Altered geomorphology minimizes sedimentation-related maintenance
- Watershed activities will provide improved water quality

Ecology

- Already existing ecologically-valuable areas (*e.g.,* those on the LA County SEA program)
- Habitat potential for degraded land areas
- Already existing special status species
- Potential for freshwater habitat
- Conversion of upland areas to wetlands habitat areas
- Adjacency to wildlife corridors and connectedness

Climate Change

- Utilization of SLR for tidal exchange
- Existing Hellman site topography provides for habitat adjustment
- Potential to restore “natural” sedimentation
- Potential to accommodate upslope transgression of habitats
- Potential to increase flood protection

Infrastructure

- Lease agreements include reconfiguration of oil infrastructure
- LCWA-owned property includes the SGR levees

Human Interaction

- Public access to large open space area
- Synergy with the LCW Stewardship program (LCW SP)
- Active local stakeholders
- Cooperative efforts with local university
- Adjacent existing public use areas
- Limited visibility from housing developments
- Already existing infrastructure for public interpretation
- *Potential restoration of Tribal cultural Landscapes*

- *Important Tribal cultural resource*
- *Strong tribal cultural connect/history*

Regulatory/Implementation

- Potential for additional land acquisition
- Potential funding opportunities
- Potential for agency coordination

3.2 Constraints to Restoration

As is typical in most projects, there are also many constraints to restoration. The constraints to restoration also need to be considered and either avoided, remediated, or otherwise factored into the planning and design effort. The degree of constraint imposed by each factor varies. Some constraints will be difficult to avoid and thus must be incorporated into the restoration designs (*e.g.,* surrounding power plants, roads and neighborhoods, an earthquake fault through the site), some may be able to be modified to remediate the constraint (*e.g.*, reconfiguration of onsite oil infrastructure, construction of bridges along surrounding roadways, habitat transition zones for SLR, soil contamination and remediation). None of the identified constraints make restoration infeasible and there are abundant opportunities to optimize habitat restoration, public enjoyment, and other project goals and objectives. Constraints identified in the CRP are presented in the list below with new additions included in italics.

Topography / Landforms / Soils

- Historical and current land uses have altered natural topography
- Landform changes limit natural processes
- Existing soil quality limits restoration success
- Earthquake fault may constrain oil infrastructure reconfiguration and/or cause damage to the wetlands

Tidal Exchange / Local Watersheds / Hydrology

- Human disturbance has altered tidal exchange
- Human disturbance has altered freshwater hydrologic functioning
- Human disturbance has altered geomorphology
- Poor water quality (*e.g*., trash) can impair restoration success

Ecology

- Protection of existing sensitive habitat resources (*see* PEIR, CRP, and Los Angeles County SEA program)
- Simplified food webs

Climate Change

- Modification of habitat proportions with climate change
- Limited areas for upslope transgression of habitats as sea level rises
- Steep perimeters support only narrow habitat bands as sea level rises
- Limited natural sediment supply
- Flood protection with SLR

Infrastructure

- Incorporation of existing and future-remaining oil infrastructure
- Fragmentation and encroachment by roadways
- Protection of existing flood control systems
- Fragmentation and encroachment by utilities
- *New flood control structure needed if SGR levee is breached*

Human Interaction

- Habitat sensitivity to urban surroundings
- Habitat sensitivity to public access
- Onsite homeless encampments
- Maintaining positive public perception
- Potential impacts to surrounding neighborhoods
- Archaeological/*Tribal cultural* resource protection

Regulatory / Implementation

- Land ownership by other entities
- Easements by other entities
- Limited funding
- Compensatory mitigation restrictions
- Permitting and environmental reviews
- Compliance with the City of Long Beach Local Coastal Program and General Plan
- *408 permit from the USACOE likely needed if SGR levee is breached*
- *Compliance with the findings of the PEIR*

4 PLANNING FRAMEWORK

Ecological restoration is a process through which degraded landscapes are manipulated to improve the ecological integrity and sustainability of natural habitats. One of the major goals of the restoration planning process is to determine which habitats should be restored. Ideally, ecological restoration seeks to restore habitats that were present on a site before some (usually human-caused) disturbance altered or degraded them. While most projects start from the assumption that returning a site to some historical condition is preferred, this is an oversimplified view of the role of restoration and, in reality, is only rarely the case.

Most projects run into two general problems. First, humans have been altering the natural ecosystems in California in different ways for thousands of years. The obvious question becomes, which point in history do you choose as your target? Pre-human arrival? Pre-European arrival? Consistent with the earliest maps and historical descriptions? There is no universally agreed upon answer to this question. In fact, any one of these targets may be valid for a given site.

Second, even if one can satisfactorily decide on an historical target, it may be impossible to restore the important processes that are necessary for sustaining that habitat given current constraints. This is especially true in urban areas where issues like flood control, transportation and existing economically important uses often trump restorative actions like removing levees to restore hydrology, moving roads to restore ecological connectivity or removing infrastructure to increase the amount of area available for restoration. There is increasing consensus that, with changing climates and the increasing influence of non-native species, many biological communities and habitats are moving toward “no analog” conditions. With even the least altered sites shifting away from historical conditions as hydrology, nutrient and sediment dynamics change, native species ranges shift, and invasive species colonize, the need to maintain resilient ecosystems capable of supporting California’s natural heritage is as important as ever.

A more realistic goal for most restoration projects it to identify the extent to which important processes can be restored and, in turn, how those restored processes can support ecological communities with higher ecological functioning than current conditions provide. In most cases, the target biological communities for a site will be closely related to what was historically present on the site. In other cases though, a site may be so constrained by large-scale alterations within the landscape that returning the site to what is believed to be the historical condition, is no longer possible.

Since it is not sufficient to simply define the goals of an ecological restoration project by what types of habitat were present in the past, every project needs a plausible framework for making decisions about what types of habitats are appropriate. There are multiple frameworks available for making such decisions. One of the most common is a regulatory (mitigation) framework, where a target habitat is determined through a permitting process and then an appropriate site must be found where that habitat can be created, restored or enhanced. In contrast to that approach, this plan is using a biological framework.

Using a biological framework for determining appropriate restoration targets requires analysis of five primary factors. First, the historical ecology of the project site and surrounding area is analyzed. Depending on the amount of information available, this process should provide insight into the types of habitat the site supported in the past, which is typically a good starting point for determining the types of habitat it could support today. Second, the degree to which important ecosystem processes are intact or altered should be analyzed. The extent to which certain degraded processes can or cannot be restored will determine which, if any, of the historical habitats can be restored. Third, an analysis of local and regional needs can help fine-tune biological targets. Some of the needs might be biological, such as supporting locally or regionally rare and extirpated habitats and species, or socioeconomic, such as education, passive recreation, or water quality. Fourth, an analysis should occur of the resilience of restored habitats under future conditions. This can include somewhat predictable factors such as SLR as well as stochastic events that are difficult to predict and may be natural or man-made. Finally, an analysis of the existing conditions of the site can identify areas where different types of actions might be more or less appropriate.

The remainder of this chapter will provide a preliminary analysis of these five primary factors that have guided the approach to developing restoration alternatives for the LCW. While these factors are the most important in this planning phase, additional factors will need to be considered as more detailed restoration plans are developed in the future. These more detailed plans will rely on additional information about the sites, which may need to be gathered (*e.g.*, soil analyses, updated modeling, etc.) or may come from elsewhere over time (*e.g.,* updated guidance on SLR, changes in land ownership, etc.).

4.1 Historic Conditions

Historical ecology is a study of how natural landscapes change over time. The field tends to focus primarily on how humans drive changes in natural systems, but it is important to remember that not all changes are directly related to humans. Atmospheric, geological and climatological processes, for instance, drive ecological change free of human influence (until recent times at least). Nevertheless, once humans are part of a landscape, they almost invariably have profound effects on how ecosystems function.

A basic tenet of historical ecology is that different societies alter ecological landscapes in different ways. Societies in turn adapt their practices to the altered landscapes and, over time, societies and landscapes evolve together. In Southern California, there are generally three major shifts in human uses of the landscape: 1) early human arrival, 2) the Spanish and Mexican years, and 3) the population boom.

While it is not certain when humans first came to California, their presence in southern California by about 11,000 B.P. has been well documented (Byrd and Raab 2007). Over the ensuing millennia, the climate warmed and human societies interacted with the natural landscapes in many ways. During the early part of this period, the diverse megafauna that characterized much of California went extinct. The loss of these huge grazers probably had a significant impact on plant communities. These human societies manipulated landscapes with fire (intentionally or otherwise), moved species around (intentionally or otherwise), and employed various forms of agriculture. All in all, it is safe to assume that by the time the first Europeans arrived in California, the landscape looked very different than it did when humans first arrived.

The Portola Expedition of 1769 was among the first overland explorations of Southern California by Europeans. Journals from this expedition provide some tantalizing accounts of what the landscapes looked like and how the Native Americans lived and managed the land. The Spanish colonists, though, soon brought an end to most of the traditional hunting, gathering, and agricultural practices of the Native American societies in the region by establishing missions and forcibly relocating and converting native peoples. The natural landscapes of Southern California would undergo huge changes again. The Spanish introduced many plants (intentionally and unintentionally) and livestock to California. Agriculture expanded using Native American slave labor and ranching became the backbone of the new economy. The first Spanish Ranchos were established in 1784 in what are now Los Angeles and Orange Counties. The 167,000-acre Rancho Los Nietos (granted in 1784) stretched along the coast from the Santa Ana River to the Los Angeles River, and included present-day Long Beach and Seal Beach. Cattle ranged throughout the landscape and had devastating impacts on natural communities. During droughts, cattle would eat almost anything that was green, leaving vast tracts of land totally unvegetated. In the winter of 1861-62, a 43-day-long storm battered California, causing catastrophic flooding and severe erosion (Dettinger and Ingram 2012, Ingram 2013). Significant amounts of the eroded soil surely wound up in the coastal wetlands.

A well-documented example of how the coastal wetlands were altered during these times is found at Goleta Slough near Santa Barbara. Early European explorers in the 1600s sailed large ships into what was then an open bay. Cattle and sheep denuded the surrounding hillsides throughout the 1800s and, by the time the area was mapped in the 1870s, the bay had almost completely filled in with sediment and converted to an intertidal marsh. This example is probably an extreme case compared to most other coastal wetlands in Southern California, however it is important to remember that by the time the first detailed maps were made of the coast in 1873, there had been over 100 years of major modifications to the landscapes of Southern California by European colonists.

It is also important to remember that Southern California's landscapes have never been static. They respond in dramatic ways to droughts, floods, geologic shifts (uplift or subsidence), tsunamis, and large wave events, among other natural forces. This is especially true along the coast from Pt. Fermin to Newport Bay, an area commonly referred to as the San Pedro Bay (Wiegel 2009). This stretch of coast is a vast delta formed by the Los Angeles, San Gabriel, and Santa Ana Rivers (Wiegel 2009). The rivers repeatedly shifted course over the last several hundred years in response to these forces (Wiegel 2009, Stein, et al. 2007). River-mouth estuaries formed on the sediment deposited by these rivers wherever their mouths happened to be over many hundreds or thousands of years (Wiegel 2009). The result was a vast complex of coastal wetlands that were intermittently connected to rivers.

Individual wetland systems probably functioned differently during periods when they were connected to riverine inputs compared to periods when river mouths shifted elsewhere. For instance, for some period prior to the 1860s Alamitos Bay was not the location of the mouth of the SGR. It was in response to the great floods of the 1860s that the SGR changed course and established (re-established?) its mouth at Alamitos Bay. Prior to this, it was a tributary of the Los Angeles River (Stein, et al. 2007) for an unknown number of years. Historical accounts even indicate that during large floods in the early 1900s, the Santa Ana River shifted course and joined the SGR to flow out through Alamitos Bay (Wiegel 2009).

There is also evidence to suggest that during prolonged dry periods, these rivers probably didn't even have defined channels all the way to the estuaries, but rather ended as distributaries on the vast coastal plain (Wiegel 2009). It is important to remember that choosing a point in time to define a restoration target, no matter how carefully researched, ultimately yields an arbitrary result. The lesson of the historical ecology of the area is that dynamic natural processes should be restored in order to create resilient natural ecosystems. Unfortunately, most of the dynamic nature that characterized the SGR and the estuary at Alamitos Bay has been irrevocably lost over the last hundred years or so due to urbanization, flood control infrastructure, and water supply infrastructure.

The earliest detailed maps of the area were produced in 1873 as part of the Coast Survey. The large tidal wetland that was mapped in this area was called New River Slough and the river that flowed into it, was called the New San Gabriel River (Figure 4-1). The wetland included vast areas of sub-tidal, mud flat, and intertidal marsh habitats. At the time of this mapping, the South LCWA Site was more or less entirely intertidal (Figure 4-2), with large tidal channels (including part of the New San Gabriel River), extensive smaller sinuous tidal channels, and all elevations of intertidal marsh. Interestingly, even at this early date, there was a road or path bisecting the marsh through this area (Figure 4-2).

By 1900, the population of Los Angeles was over 100,000 people. In 1921, oil was discovered in the Long Beach Oil Field and soon after in the Seal Beach Oil Field. During the first decades of the 20th century, parts of what was now known as Alamitos Bay were being filled for development or oil extraction or dredged to create marinas and harbors. According to Wiegel (2009) the lower SGR was channelized starting in about 1932. Early aerial photos of the area, which date to the late 1920s, show a partially channelized SGR and significant loss of wetlands due to filling, blocking of tides, and clearing of vegetation (Figure 4-3). This trend continued through the ensuing decades (Figures 4-4 and 4-5) as the SGR channel was widened and dredged and taller levees were built. These actions likely led to less tidal action in the project area as open channels were gradually replaced with culverts. By 1961, construction had begun on the HCC. Some of the dredged material was used to fill wetlands in areas closest to the channel (Figure 4-6). Construction of the HCC looks complete by 1965 and there is more filling of wetlands evident compared to 1961 (Figure 4-7). Aerial photos from the first half of the 1960's (Figures 4-6 and 4-7) show the SGR to be shallow and at least partially intertidal. By 1968, the SGR channel looks deep and there is significant filling of wetlands evident (Figure 4-8). It is likely that this fill came from dredging of the SGR channel. By 1972, almost all of the formerly tidal wetlands in the southern and eastern parts of the project area had been filled, probably to their current elevations (Figure 4-9). The last of the historic marsh in the southwest part of the project area was filled sometime between 1968 and 1972 (Figure 4-9). The final obvious fill disposal in the site is seen in the late 1970's (Figures 4-10 and 4-11)

Uncovering the historical ecology of the region and the project site are key pieces of the restoration planning process. The historical evidence suggests that this area supported a large intertidal wetland, probably for millennia. To the extent feasible, the restoration designs will seek to bring back many of the lost ecological functions that the wetland complex once supported. Restoring ecological functioning will require working within the opportunities and constraints of the site. The restoration design will not necessarily try to replace historical features, like tidal channels, in the exact location where they appear in historical maps or photos. Rather, the goal of this restoration project is to restore important biological and physical processes in order to create self-sustaining ecological communities that are resilient to changing conditions.

4.2 Restoring Ecosystem Processes

A unique suite of ecosystem processes structures each native plant and animal community in Southern California. Trying to restore communities in areas where important ecosystem processes are missing will lead to failure. Through the process of ecological restoration, one may substitute man-made manipulations for some natural processes (*e.g.*, removal of invasive plant species, irrigation, controlled burns, etc.). These tools can be used successfully to help establish and maintain native plant communities. To be successful, ecological restoration must take into account the restoration of all the ecosystem processes that are important for the long-term persistence of the target community.

Ecosystem processes are a result of the interaction of physical and biological factors. How these processes interact to structure vegetation communities is fairly well understood in Southern California, but often ignored when planning ecological restoration projects. When the proper suite of ecosystem processes is restored on a site, the result must be the eventual establishment of the target community. The goal of ecological restoration is to speed up the establishment through restorative actions. Understanding the ecosystem processes at a site also allows the restoration team to use these processes to make the restoration projects economical, successful, and self-sustaining.

Successful restoration of coastal salt marsh in Southern California requires especially close attention to several physical and biological processes. Important physical processes include those related to hydrology, landform, sedimentation and erosion, and soil biogeochemistry. The most important biological processes are related to vegetation composition and structure, and food web dynamics. The physical processes control, to a large extent, the biological processes, so most of the planning emphasis should be placed on getting physical processes restored effectively.

There is no “correct” way to restore these processes for most projects. For example, at the LCW, there are several potential hydrological regimes that could be restored, any of which might lead to higher functioning of the site. Usually, there is a trade-off though: higher functioning (*e.g.*, fully tidal areas) typically means more cost and complexity. Simpler and less expensive options often lead to lower functioning habitats (*e.g.*, freshwater dominated wetlands or muted tidal salt marsh). The crux of the restoration planning process is to determine the most cost-effective way to restore important ecosystem processes within the opportunities and constraints of the site while still achieving self-sustaining target habitats.

4.2.1 Hydrology and Hydraulics

The most obvious and crucial physical process that needs to be restored at the LCW is hydrology. The combination of levees, raised roads, fill placement, and tide gates have severely restricted or eliminated tides from the majority of the complex. Since a primary goal of this project is to restore tidal salt marsh habitat, restoration will require re-introduction of tides to large areas of land. There are three main approaches for reconnecting tides through levees and raised roads, culverts, notches, and levee setback/road removal.

Culverts are relatively inexpensive to install but can restrict flows during extreme tides or runoff events depending on the design. Restriction of tides (tidal muting) leads to narrower vegetation zones and generally lowers ecological functioning. Appropriately sized (large) or multiple culverts can avoid this problem, but this may raise the cost considerably. Culverts with control structures can be used to lessen the risk of flooding of infrastructure, though such mechanisms are costly, may not always operate predictably, and require periodic maintenance. Culverts may also require regular maintenance to keep them free of sediment and debris if they do not sufficiently self-scour, adding to long-term costs. If culverts are not maintained and they cannot self-scour, they may eventually fill with sediment or debris and fail to convey water at all, leading to a return to non-tidal conditions (however, this has not yet occurred at several local wetlands relying on culverts to connect marshes to seawater sources such as Inner Bolsa Bay). If a culvert or flood control structure were to fail while the marsh is full of salt water, the system can become hypersaline and/or anoxic in a relatively short period of time, leading to floral and faunal die-offs.

Open connections can be made through notches in levees or raised roads. Notches are preferable to culverts in most cases since they are typically inexpensive, have less of a tendency to mute tidal flows, and require little or no maintenance (though they can become clogged where there is high sediment transport). The freer flow of water through notches allows for higher ecological functioning but more care must be taken to protect infrastructure from flooding during extreme events. Conveying extreme tidal and flood events into and out of a salt marsh is a benefit to the ecological functioning of the salt marsh. A drawback of open connections is the need to bridge the channel with any transportation route that crosses the channel. Bridges are typically expensive and also require maintenance. Culverts are often installed to prevent the need for bridges. At channel locations away from transportation routes, open channels are often the preferred type of hydraulic connection.

Setting back of levees or removal of raised roads can lead to the most natural hydrological functioning. This can come at great expense, though in many cases the ecological benefits make it justifiable. Removal of levees along the SGR would allow for a much more dynamic hydrograph for the restored wetlands. Levee setback along the SGR would create other challenges though. The SGR carries large amounts of floating trash and debris; keeping it out of restored wetlands would be more difficult with wider connections compared to notches or culverts.

In general, the greatest ecological benefits come from restoring hydrologic connections that yield the most dynamic interactions between land and water. While it may not be feasible from a cost or regulatory perspective to set back major levees at the LCW, it is important to study the benefits of such actions. Some benefits might include: 1) seasonal freshwater and saltwater mixing in the marsh during rain events could help create low salinity gaps in the high marsh, which help *Lasthenia glabrata* ssp. *coulteri* and *Chloropyron maritimum* ssp. *maritimum* and other rare annual salt marsh species germinate; 2) extreme high tides and flood events are also important for sustaining the salt marsh-upland ecotone as a unique community; and 3) fine sediments brought in during flood events can help the marsh accrete slowly to keep pace with SLR. A drawback of open connections to the SGR is that the perimeter of the project site would need to be "flood-proofed" to prevent high water levels during storm flows or high tides from flowing into neighboring areas. Where culverts and notches are the only feasible approach, preferred designs should balance restoration of dynamic hydrologic functioning with a reduction of flood risks, which would therefore decrease the extent of flood protection needed.

4.2.2 Landform Conditions

Intertidal salt marshes are typically characterized by broad, nearly flat marsh plains dissected by dendritic tidal creek networks (Zedler 1999). Features, such as mudflats and salt flats, may be found in poorly drained or depressional areas. These geomorphic features of salt marshes are in dynamic equilibrium, controlled by erosion and accretion due to tidal flux and freshwater floods. In certain cases, tectonic uplift or subsidence can play a role as well. The complex landforms seen in reference wetlands have typically developed over many thousands of years. It can be extremely difficult or impossible to accurately design and construct these features in restored marshes. A more realistic goal is to get the elevations and drainage close enough to “natural” so that the marsh can evolve toward its own dynamic equilibrium as conditions change over decades and centuries.

Elevation relative to tidal inundation is the most important factor and one that can be planned for with reasonable accuracy. The elevation ranges of most salt marsh plants are fairly well known for fully tidal systems. In muted tidal systems, it may be more difficult to predict the elevation zones for different species or communities. Accurate modeling of tidal inundation frequency is essential to developing accurate grading plans.

For restored marshes to flood and drain naturally, the marsh plain needs to have very subtle slopes toward tidal creeks. Steeper slopes will limit the width of different vegetation zones and hasten soil drainage. Flat areas will not drain and may become too wet or too saline for salt marsh vegetation to establish (it may be desirable to have some flat or depressional areas to support salt flats and tidal ponds, both of which naturally occur in marshes).

Tidal creek networks provide valuable habitat for fish, birds, and invertebrates and play an important role in the hydrologic functioning of a salt marsh. Natural creek networks are typically dendritic in nature. Small low-order creeks (at higher elevations) are typically intertidal and may have shallow cross sections. Larger high-order creeks (closer to the mouth) often have steep banks and are always at least partially flooded (*i.e.*, sub tidal). In natural systems, tidal creeks develop and evolve in response to topography and hydrology through erosion and sedimentation. These same processes can lead to the development of natural tidal creek networks on restoration sites without having to design and construct all the channels.

Transition zones between the high marsh and uplands come in many different forms. The marsh may transition abruptly to upland at the base of bluffs or sand dunes or very gradually in flatter areas. There are very few examples left of natural salt marsh-upland transitions in Southern California, primarily due to development. Until recently, most salt marsh restoration projects have ignored this important habitat. Gradual transitions provide important habitat, increase the functioning of the marsh, and provide an area for up-slope migration of the marsh as sea level rises. For these reasons, it is preferable to include transition zone habitat as part of the overall plan for wetland restoration.

4.2.3 Sedimentation and Erosion

Coastal salt marshes in Southern California are generally formed where sediment deposition and erosion are in equilibrium. Coastal salt marshes can receive sediment from the ocean via littoral processes and/or from upland areas via fluvial processes. Tidal and freshwater flows suspend sediments and can redistribute them within a marsh or carry them to the ocean.

When sedimentation and erosion are out of balance, salt marsh habitats can be altered and degraded.

Some coastal salt marshes in Southern California are sediment-starved due to dams and debris basins that capture sediment from upper watersheds before they can reach the marsh. The alteration of natural upland habitats adjacent to marshes (by filling and development) has removed another natural source of sediment for most marshes. Over time, sediment-starved systems may be subject to increased inundation of salt marsh zones, causing a shift in habitat distributions. The tidal prism of these systems will begin to increase as well and the resulting higher velocity flows, especially on ebbing tides, could lead to higher rates of erosion, resulting in a sort of positive feedback loop that can alter habitats severely over time.

In cases where landscapes have been denuded of natural vegetation, by agriculture for instance, sediment rates can be much higher than natural. This can lead to decreased inundation of salt marsh zones and conversion of wetland to upland in extreme cases. The resulting decrease in tidal prism could potentially lead to more accretion, channel and mouth closures, and large-scale changes in vegetation and wildlife composition in another feedback loop.

Before development, natural fluvial processes interacted with littoral processes at the mouths of Southern California estuaries in patterns that varied with tides, precipitation, and waves. The interactions among flows generated by runoff and the tidal prism within the estuarine basins tend to maintain inlet channels, while waves, tides, and long-shore currents move sand that can build barriers across inlets. Generally, estuaries experience more regular tidal influence when littoral sediment is scoured from the inlet not only by tidal flows, but seasonally by winter and spring runoff. In estuaries that are connected to littoral processes during the dry season, wave energy along the shoreline becomes relatively stronger, building beach berms, pushing sand across inlets, and enhancing the formation of flood tide deltas within the estuary inlets. The inlets of smaller estuaries are more likely to be completely closed than larger systems.

Because of the setting of the LCW, very low rates of sediment delivery are expected under any of the restoration scenarios. The sites are isolated from coastal processes by extensive infrastructure and their distance inland. The upper watershed is subject to considerable management by flood control and water supply infrastructure. The wetland complex is largely removed from the riverine processes of the SGR by levees in its current configuration so any sediment that makes it down the river is likely not making it into the wetlands.

4.2.4 Soil Biogeochemical Processes

Soils form the foundation of biological communities. Most plant communities are adapted to certain soil conditions. The most important aspects of soil include texture (grain size distribution), structure (compaction, porosity), and chemistry (nutrients, salinity, and redox potential). All these factors are closely interrelated with one another and can be difficult to restore on highly disturbed sites.

There is some variability in natural salt marsh soils within and between different coastal marsh systems. Some marsh habitats, primarily those dominated by littoral sedimentation processes, have coarse-grain (sandy) soils with relatively low levels of organic matter. However, the majority of salt marsh soils in Southern California are comprised of fine-grains (silt and clay) with relatively high levels of organic matter and low redox potentials. Failure to restore proper soils usually leads to problems establishing desired levels of diversity and productivity in vegetation communities. Inadequately restored soil is a common reason that restoration projects fail.

Soil texture is a description of the relative proportions of sand, silt, and clay in soil. Salt marshes are generally depositional areas with low water velocities. This favors the deposition of very fine particles; silt and especially clay. The high proportion of clay in salt marsh soils is important for nutrient cycling. High clay content reduces drainage and makes soils more anaerobic than well-drained (*i.e.*, sandy) soils. This slows the breakdown rate of organic matter, leading to its accumulation in the soil. As the organic matter is broken down very slowly under anaerobic conditions, a continual low level of nutrients is available to plants. Clay soils also slow the leaching of nutrients out of the soil, again, making the nutrients more available to plants. Many salt marshes have been restored or created on dredge spoils, which tend to be sandy and lack clay (Zedler 2000). The result is often poor plant growth (Boyer and Zedler 2000), which leads to poor wetland functioning. The limited productivity of these marshes will probably persist for many years (Boyer, et al. 2000). Preliminary analyses of the soils in the LCW properties as part of the CRP suggests that much of the soil is dredge spoils and may be too sandy for salt marsh restoration. In-depth analysis of soil texture will need to be done in the next steps of planning to determine whether soil amendments may be necessary in some areas. This soil testing should also seek to establish if native marsh soils (which would have appropriate texture) are present and if so, at what depths in different areas.

Soil structure describes the way in which the mineral and organic constituents of soil aggregate together and form voids or pores within the soil profile. In natural soils, structure develops over centuries or even millennia. In restoration sites, it is difficult, if not impossible, to restore natural soil structure in the near-term. The most important aspect to consider in most restoration sites, including salt marshes, is compaction. Compacted soil that inhibits root growth and drainage generally has an adverse effect on plant growth. During salt marsh restoration, heavy equipment used to grade sites can cause severe compaction, which is known to effect vegetation establishment (Zedler 2000). To minimize compaction, grading should be done on dry soils whenever possible. Ripping or disking can improve growing conditions in compacted soils. Working in wetlands “in the dry” may require dewatering, which can be difficult and may not be effective or economical under some conditions. The use of low-pressure construction equipment can minimize compaction and avoid the need to dewater wet areas.

Several aspects of soil chemistry are especially important in salt marshes. In addition to nutrient cycling (outlined above), soil salinity and pH also play an important role in vegetation growth and diversity. High soil salinities are a prerequisite for salt marsh vegetation. Freshwater inputs can result in salt marsh vegetation being replaced by brackish or freshwater species. Seasonal drops in soil salinity associated with rainfall are natural in Southern California salt marshes. However, year-round freshwater inputs (augmented stream flows or point-source inputs) are detrimental to salt marsh habitats. Elevations regularly inundated by tides tend to have soil salinities very close to seawater (~34 ppt). Less frequently inundated areas, specifically high marsh habitats, are much more dynamic. Evaporation after tidal inundation can lead to very high soil salinities (>100 ppt), which inhibit establishment and growth of even native high-marsh species. Heavy rainfall can drop soil salinities to near zero, allowing invasion by annual non-native weeds. It is important to avoid very high salinity levels during plant establishment on restoration sites. This can be done with soil augmentations and/or irrigation (Zedler 2000). Natural salt marsh soils are generally neutral to slightly acidic. Restoration sites on dredge spoils have been known to become overly acidic due to the conversion of sulfates to sulfuric acid (Zedler 2000). In some cases, tidal flushing can ameliorate the problems; however, in some cases, soil amendments such as lime may be needed to raise soil pH.

4.2.5 Processes Related to Vegetation Composition and Structure

The native vegetation communities within coastal salt marshes provide, directly and indirectly, most of the ecosystem functions and values associated with these systems. Wetland plants (including vascular plants and algae) provide a matrix that supports wildlife and microbial communities (Zedler 2000) and they play an important role in nutrient cycling and soil chemistry (Mitsch and Gosselink 2007). Establishing self-sustaining vegetation communities quickly is, therefore, a primary goal of virtually all restoration projects.

Setting targets for vegetation communities is best done by selecting reference sites that have desirable levels of diversity, productivity, stature, and functioning. Steam Shovel Slough provides one obvious reference site for restoration at the LCW. Other nearby marshes, including Anaheim Bay, Upper Newport Bay, and Mugu Lagoon, are good choices that contain more habitat diversity than Steam Shovel Slough alone (*e.g.*, tall cordgrass marshes and extensive tidal channel networks). The specific site characteristics of restored habitats (soil, hydrology, slope, etc.) should be matched to similar abiotic conditions at reference sites.

There are several characteristics of reference sites that will be desirable to try to replicate on restoration sites. First, there should be no invasive plant species on the site. Invasive species are almost never a concern in low and mid marsh elevations (though non-native cordgrasses, *Spartina alterniflora* and *S. densiflora*, are exceptions). High marsh habitats are prone to invasion by annual weeds following winter rains. Of more concern though are perennial invaders such as *Limonium ramosissimum*, which occurs at Upper Newport Bay and Carpinteria Salt Marsh currently. Managing topsoil contaminated by non-native propagules and conducting grow-kill cycles early in projects can limit problems with invasive plant species on restoration sites. Over-irrigating can promote non-natives, so this should be managed as well.

Second, reference sites tend to have high species diversity and measures should be taken to assure that a diverse assemblage of native salt marsh plants becomes established at restoration sites. Higher species diversity is correlated with a broad range of important ecosystem functions (Zedler 2000). Assuring high diversity in salt marsh restoration projects typically means: 1) limiting the amount of perennial pickleweed (*Salicornia pacifica*) at the site in the near-term; and 2) introducing a large diversity of plants from seed and nursery stock. Perennial pickleweed is easy to propagate and establish on most salt marsh restoration sites; however, it can quickly dominate large areas and decrease overall plant diversity (Lindig-Cisneros and Zedler 2002). This is generally undesirable. While Southern California salt marshes are relatively species-poor compared to many other plant communities, there is good evidence to suggest that each species may play an important role in overall functioning. For example, arrow grass (*Triglochin concinna*) is a somewhat inconspicuous mid-marsh species that is often overlooked in restoration plantings. Nevertheless, it has been shown to have important effects on nitrogen pooling and may decrease the dominance of perennial pickleweed and favor other species, especially annuals (Zedler, et al. 2001). Similarly, the parasitic plant salt marsh dodder (*Cuscuta salina*), which is rarely included in restoration projects, can subdue perennial pickleweed and allow colonization by other species (Callaway and Pennings 1998). Re-vegetation techniques are fairly well established for a wide diversity of species (Zedler 2000), though we still recommend pilot and experimental plantings in most cases and limiting or avoiding introducing perennial pickleweed since it often establishes on its own from seed.

Third, the structure (*e.g.*, height, stem density, and canopy architecture) of the vegetation community is important to certain functions. For instance, the federally and state endangered light-footed Ridgway's rail successfully nests primarily in pacific cordgrass (*Spartina foliosa*) in fully tidal salt marsh systems. The cordgrass must be tall enough to support the birds floating nest on the highest tides (Massey, et al.1984). On restoration sites, achieving cordgrass of sufficient height to support Ridgway's rail nesting has been difficult where soil and nutrient conditions are not adequate (Boyer, et al. 2000). Vegetation structure is probably also important for Belding's savannah sparrow nesting (*see* Keer and Zedler 2002). Vegetation structure is primarily a function of productivity and species diversity. The best way to achieve desirable structure is to assure soil processes (especially nutrient cycling) are restored and by introducing a variety of plant species by seed and/or nursery plants.

4.2.6 Processes Related to Invertebrates, Fish, and Salt Marsh Food Webs

Salt marsh food webs include many trophic levels, inputs from terrestrial, marine and freshwater sources, and are necessarily complex. Invertebrates are an integral part of salt marsh food webs and are an especially important food source for birds and fish. Invertebrates serve other important ecosystem functions as well. Benthic invertebrates have strong influences on soil properties such as compaction, water content, and texture.

Fish function as an important vehicle for nutrient cycling and energy transfer within salt marsh food webs (Allen 1982, Kwak and Zedler 1997). Different species of fish use virtually all areas of estuaries at different tides, from deep sub-tidal areas and eelgrass beds to high marsh habitats during high tides. The wide variety of resident fishes in salt marshes provides food for birds, including endangered California least tern and light-footed Ridgway’s rail. Some fish that spend at least parts of their lives in salt marshes are commercially important in Southern California and provide energy transfers between terrestrial, wetland, and near-shore systems.

Some recent large-scale estuarine restoration projects in Southern California have been funded primarily by mitigation for destruction and disturbance of sub-tidal habitat. These projects placed considerable emphasis on sub-tidal habitat, perhaps as a trade-off for other types of habitat, and potentially at the possible expense of overall wetland functioning (as argued by some). To this end, it is important to remember that fish are part of complex food webs that involve algae, microbes, vascular plants, terrestrial and estuarine invertebrates, and a host of birds and other vertebrates. It follows that in order to restore high-quality fish habitat in salt marshes, a holistic view, which places emphasis on a wider range of estuarine habitat types, must be taken.

In restoration projects, the plant part of the food web is often addressed with re-introductions, while the fish and invertebrate components are often expected to take care of themselves through colonization (Zedler 2000). This may be a reasonable approach for some species; however, given the importance of these groups to the food web and to overall wetland functioning, development of re-introduction protocols for some species may be warranted.

4.3 Regional and Local Needs Analysis

After considering the range of habitats that occurred on the site historically and analyzing the extent to which important ecosystem processes are either intact or could be restored, some practical decision making must be used to focus the goals of the restoration project. These decisions should be made using the most current understanding of how different restoration scenarios can address both regional and local biological and socioeconomic needs. Regional needs address issues with necessarily broad geographic scales (in this case, Southern California) such as endangered species recovery, loss of certain types of wetlands, and near-shore fisheries. The Southern California Wetland Recovery Project (WRP) completed a regional needs assessment in 2018[1]. The following analysis is broadly similar in regards to tidal wetlands. Local needs include issues that affect the site itself and the communities immediately adjacent to the site (in this case, the Long Beach and Seal Beach areas) such as locally extirpated species, public access, and education/interpretation.

The goal of this section is to identify the most important regional and local needs that may be addressed by restoration of the LCW Complex. In many cases, these needs may seem to be, or may actually be, in conflict with each other, and this is by no means unique to the LCW (*see* Needles, et al. 2013). Nevertheless, acknowledging these issues and weighing the importance of different needs is an important step toward developing a restoration project that provides a wide variety of both biological and socioeconomic functions and values.

This section provides an outline of important needs as they relate to restoration at the LCW. Many of the regional and local needs that have been identified here have been broadly outlined by Zedler (2000), and this section of the plan borrows heavily from that text. Additionally, the TAC and the Steering Committee identified many of these needs during a series of eight quarterly meetings during development of the CRP. A series of six public meetings during the CRP process led to identification of many of the local socioeconomic needs as well. One additional TAC meeting and two additional public meetings were held during development of the PEIR as well. There was not always consensus on which needs are of greater importance than others and none have been explicitly ranked here. The goal in developing the restoration designs in this habitat restoration plan was to broadly address as many of these needs as possible within a feasible design.

4.3.1 Regional Biological Needs

The LCW Complex sits approximately midway along the Southern California bight, which runs more or less from Point Conception in the north to the international border in the south. Coastal wetlands within this region, and farther south into Mexico as far as Bahia de San Quintin, share broad biological similarities. All of these wetlands have a subset of the distinct plant and animal communities that characterize the region's estuarine habitats. Many salt marsh plant and animal species reach their southern and/or northern range limits within this region. Though there are exceptions, these wetlands tend to share similar physical characteristics as well, including climate, water temperature, substrate, and age. Despite the broad similarities, there are a range of different types of coastal wetlands wthin the bight (*see* SCWRP 2018). All the coastal wetlands in Southern California have been adversely impacted by land use changes since the first European visitors arrived in the area and by development in the last hundred or so years. In fact, about 90% of the historical coastal wetlands in the region have been lost due to filling (generally for development) or dredging

[1] https://scwrp.databasin.org/

(for harbors). What is left today is a patchwork of remnant systems, many of which have drastically altered hydrology (generally a loss of fully tidal areas) and have suffered a severe loss of biodiversity.

The cumulative effect of this region-wide loss of habitat and ecosystem functions and values can be addressed where there are opportunities to conduct salt marsh restoration. Some of the most important regional biological needs that can be addressed include: 1) restoration of high intertidal and associated upland habitats, which are especially rare throughout the region; 2) expansion of populations of special status species; 3) mitigation of the effects of SLR on long-term conversion of habitat types within the region; 4) restoration of dynamic natural processes that facilitate spatial and temporal heterogeneity within the wetland; 5) connectivity to other wetlands and open space; and 6) implementation of facilitated migration for species that are threatened by climate change and habitat fragmentation. Each need is discussed in more detail below.

4.3.1.1 *Habitat Diversity and Salt Marsh Restoration*

Considering the severe loss of coastal wetlands in Southern California, it is obvious that all the habitat types associated with these systems are in need of restoration. However, with the limited opportunities for restoration, it may be appropriate to prioritize some habitat types that have been most severely impacted and/or received less attention in past restoration projects.

Generally, priority should be given to restoring fully tidal systems as opposed to periodically tidal systems (Zedler 1982). Fully tidal systems support greater diversity of plants and animals. Most of the special status estuarine species that are threatened with extinction occur only in tidal systems. Belding's savannah sparrow and Coulter's goldfields do occur in non-tidal salt marsh remnants, but generally have healthier populations in tidal systems. Restoring periodically tidal habitats in smaller estuaries with unstable inlets that cannot support fully tidal conditions, such as Malibu Lagoon, is desirable and will benefit other listed species such as tidewater goby and southern steelhead. Excepting these smaller systems, it is always desirable to restore fully tidal salt marsh whenever feasible (Zedler 1982). More recent work (SCWRP 2018) has highlighted the need to restore a broader range of coastal wetland types with different hydrologic regimes (*e.g.,* intermittently tidal lagoons). However, the Los Cerritos Wetlands complex has a deep-water connection to the ocean so it is not under the threat of seasonal closure by sand bars. Therefore, comparisons with sites and conditions at seasonally closed/open coastal lagoons may not be as applicable for this site as they may be for other sites.

High marsh (including salt panne) and upland transition habitats are extremely limited in most of our remaining wetlands compared to their historical extent. This is primarily due to the fact that small amounts of fill could be added to the driest/highest portions of marshes in order to make areas suitable for development. The majority of coastal wetland restoration projects have given little or no attention to restoration of the highest areas of tidal influence (steep slopes and very narrow habitat bands were the norm, primarily due to mitigation needs and in some cases space limitation). Nevertheless, these areas support high biodiversity, including unique species (James and Zedler 2000), support higher functioning in low and mid marsh habitats (Parsons and Zedler 1997, Zedler 2000), provide high-tide refuge for salt marsh wildlife (Zedler 2000) and will serve a critical role in adaptation to SLR.

Brackish marshes were probably once fairly common along the upper edges of salt marshes located on the large alluvial plains where groundwater reached the surface and mixed with tidewater. Historically, this included many of the marshes from Long Beach south to Newport Beach (Wiegel 2009). Extraction of groundwater for agricultural and municipal uses, along with channelization of streams and rivers, has lowered the water table and probably limited the opportunity to restore natural hydrology. Urban runoff into salt marsh habitat can support areas of brackish marsh, though pollutants in this runoff may make this approach undesirable. Brackish marshes support many unique plant species including the rare southwestern spiny rush (*Juncus acutus ssp. leopoldii*) and areas of bulrushes can support nesting for light-footed Ridgway's rail.

Eelgrass (*Zostera marina*) beds occur primarily in shallow sub-tidal areas within embayments and other areas protected from wave action or scouring. Eelgrass beds provide important habitat for a large range of fish, invertebrate, and other vertebrate species. In California, the most significant patches of this habitat type occur in our larger embayments (Humboldt, San Francisco, Morro, Newport and San Diego bays). A total of perhaps 200 acres of this habitat remains in small but ecologically important patches near the LCW complex (within the Ports of Long Beach and Los Angeles, San Pedro Bay, Alamitos Bay, Anaheim Bay, Huntington Harbor, Seal Beach NWR, Bolsa Chica, and the Huntington Beach Wetlands). Ongoing studies in San Diego Bay suggest that future SLR will greatly reduce the area of eelgrass in that system (by as much as 90%). Many other areas that support eelgrass currently may be at even greater risk due the limited opportunities to migrate upslope (especially in marinas and harbors). Elevations that support salt marsh at current sea level (be they natural marshes or restored marshes) may come to support much of the eelgrass habitat in southern California in the future.

Estuaries provide important habitat for many species of fish. Southern California's estuarine-dependent fish have been severely impacted by numerous types of activities in coastal wetlands, including filling, continual dredging, water quality impairments, loss of wetland and eelgrass habitat, and invasive species. Restoration of estuarine habitat in Southern California can benefit recreationally and commercially important species, endangered species, and certain fish species that occur mostly or only in estuarine habitats. Estuaries are important nursery grounds for some commercially and recreationally important fisheries species such California halibut and other flatfish. Endangered tidewater goby and southern steelhead are generally more closely associated with periodically tidal lagoons; however, they can and do occur in tidal systems where conditions are appropriate. Estuarine specialists such as longjaw mudsucker, California killifish, and topsmelt rely on tidal salt marshes. Fish play an important role in estuarine food webs, especially in moving energy between different habitats and trophic levels (Zedler 2001). Fish rely on sub-tidal habitat within estuaries during low tides and, therefore, sub-tidal areas should be included in restored systems. However, intertidal areas provide important refuge for smaller fish and provide habitat for invertebrate prey species. Therefore, designs that include some balance between lower and higher salt marsh habitats should provide the most functional diversity and support the widest variety of species (Zedler 2001).

It is probably not desirable to make any of these habitats the sole focus of any coastal restoration project. However, inclusion of these habitats in the design of large-scale salt marsh restoration projects, where feasible, will lead to higher overall functioning of the ecosystem. This will, in most cases, mean less total area of mid and low marsh habitats, which are often seen as the most desirable habitats to restore. Importantly though, restoring topographically higher habitats will provide areas for salt marsh to establish in the future as sea level rises.

4.3.1.2 *Special Status Species*

Coastal wetlands in Southern California are home to several rare, threatened and endangered plant and animal species. The total list of special status plants and animals that could occur in salt marsh and adjacent upland habitat is truly impressive. Restoration and mitigation projects have focused at least some efforts on several of these species including plants found in high marsh habitats such as salt marsh bird's beak (*Chloropyron maritimum* ssp. *maritimum*), Coulter's goldfields (*Lasthenia glabrata* ssp. *coulteri*), and estuary seablite (*Suaeda esteroa*) and salt marsh-upland transition habitats such as California boxthorn (*Lycium californicum*), woolly seablite (*Suaeda taxifolia*) and Ventura marsh milk vetch (*Astragalus pycnostachyus* var. *lanosissimus*). Many special status birds benefit from restoration projects, and two endangered resident species, light-footed Ridgway's rail and Belding's savannah sparrow, which rely on healthy stands of cordgrass[2] and pickleweed respectively, have received much attention in the past. This likely due to the fact that the Belding's savannah sparrow is listed as an endangered species by the State, and the light-footed Ridgway's rail is listed as endangered by both the State and Federal governments. Nesting areas for California least tern have been included in some coastal wetland restoration projects as well.

The long-term recovery of these species will depend on healthy populations within multiple wetland systems. Introducing special status species to new systems, such as a restored LCW, can aid in species recovery and protect them from future extinction. If special status species

[2] Light-footed Ridgeway's rails can also nest in other grass-like species in coastal wetlands, including cattails and tules (San Elijo Lagoon), spiny rush (Mugu Lagoon), and saltmarsh bulrush (Carpinteria Salt Marsh).

will be introduced on-site, then all reintroductions will be consistent with the appropriate approved recovery plans. For example, light-footed Ridgway's rails were introduced into San Elijo Lagoon in San Diego County with success. It is highly desirable to restore habitat that can support healthy, self-sustaining populations of these target species. Caution should be exercised, however, when setting expectations for any specific species at a restoration site. For instance, the degree to which a population can be expected to be self-sustaining should be carefully assessed. Least tern nesting habitat (large unvegetated areas) has been created in the past but these areas often require continual maintenance to keep them free of vegetation. Without regular maintenance, these areas will become weed patches that have very little habitat value to any native species, let alone least terns. Other lessons have been learned while trying to restore new light-footed Ridgway's rail nesting habitat where predator assemblages are not in balance. Essentially, in systems without high-level predators (coyote, bobcat, etc.), mesopredators (red fox, raccoon, skunk, etc.) can reach high densities. These mid-level predators tend to prey on Ridgway's rail nests and young birds and can severely limit breeding success. Mesopredator control has been used successfully, but again this is a long-term maintenance issue that may need to continue in perpetuity in order to support a stable population. Restoring special status plants can be somewhat more straightforward as long as appropriate growing conditions are present. It should be remembered though that the populations of annual species will fluctuate greatly between years so careful setting of goals is essential.

With the limited area available for restoration at the LCW, there will be a tradeoff between restoring different types of habitats that might support different special status species. For instance, large areas of cordgrass could be restored in hopes of supporting Ridgway's rails. But this would almost certainly come at the cost of less pickleweed habitat that might support Belding's savannah sparrow. Given the rather specific habitat requirements for almost all the special status species that occur in coastal wetlands, attempting to restore areas for each one in the near-term, at one site, might lead to areas of appropriate habitat that are too small to support self-sustaining populations of any of the species. Therefore, a careful analysis should be done to determine which species might not do well at the site, even if appropriate habitat was restored. At the LCW, this might include species that are especially sensitive to anthropomorphic disturbances or predation by mesopredators.

There is also an important temporal aspect to restoring special status species habitat. As has been described elsewhere in this plan, SLR will drive conversion of intertidal habitats. As areas are inundated more frequently and vegetation communities migrate up-slope (where possible), the available area of appropriate habitat for target species will change. This should be considered during fine-tuning of grading designs. Further, a region-wide analysis of how current populations of special status species will be affected by SLR would help set longer-term priorities for restoration projects.

Restoration of coastal wetlands can be of great benefit to migratory birds, especially waterfowl and shorebirds. Though not necessarily classified as special status species, these groups of migratory birds can benefit especially from restoration of mudflats and open water areas. Birds will invariably find and use appropriate habitat for resting during migration and overwintering as long as there is food (invertebrates, fish, or plants, depending on the species and habitat).

4.3.1.3 *SLR Resilience*

As sea level rises over the next century, Southern California's salt marshes will undergo dramatic changes. The inundation frequency of a given elevation will increase, causing elevations that currently support, for instance, mid marsh, to convert to low marsh, mudflat and eventually sub-tidal habitat (depending on the amount of SLR). This will lead to a net loss of marsh habitat and an increase in mudflat and sub-tidal habitat. High marsh and transition zone habitats, which typically abut developed areas, will, in many systems, be squeezed virtually out of existence. Additionally, there will be increasing pressure to protect built environments from flooding; those strategies could have further impacts where development abuts tidal marshes.

Recent analyses are predicting how the distribution of estuarine habitats will shift with SLR. In Southern California, an estimated 800 acres of salt marsh would be lost with 24 inches of SLR and 3,700 acres would be lost with 66 inches of SLR (SCWRP 2018). Thorne et al. (2018) analyzed 14 estuaries along the Pacific Coast-wide and found that all the Californian tidal wetlands in the study would convert to unvegetated sub-tidal areas by 2110. In systems with appropriate rates of sedimentation, accretion may keep pace with SLR, allowing habitats to remain more or less stable over time. However, sedimentation rates are anything but natural in almost all of Southern California's coastal watersheds. They are too low where sediment is impounded behind dams. Conversely, where land uses leave large areas of bare soil, they can be unnaturally high. Without watershed level studies of each system, it remains unclear how our estuaries might or might not stay in equilibrium with SLR. In a few systems, adjacent uplands will provide areas where habitats can transgress upwards. The general trend will be toward more low-intertidal habitat and less mid marsh, high marsh, and transitional habitats.

Without some scheme for adding sediment to marshes being developed and permitted in the future, the region will have proportionally more low-intertidal and sub-tidal habitat and, it may be desirable to include less of these areas in coastal wetland restoration projects. Similarly, since proportionally less high-intertidal and adjacent upland habitats may occur in the future, it is desirable to include areas that can support these types of habitats even in the face of SLR. At the LCW, natural sedimentation rates are likely too low to keep pace with SLR.

4.3.1.4 *Restoration of Natural Dynamics*

The plants and animals that live within Southern California's estuaries have evolved over many thousands of years to tolerate, and even take advantage of, small and large scale disturbance events. Natural disturbances are important for creating both spatial and temporal heterogeneity within salt marshes. Heterogeneity is associated with higher levels of diversity of plants, birds, fish, and invertebrates (Zedler 2000).

A common type of disturbance is burial of plants by sedimentation. This can happen on large scales during floods and dune over-wash events or on very fine scales by burrowing mammals. In any case, the result is bare soil where opportunistic species that are not common in stable marshes can become established (Zedler 2000). Sedimentation rates are generally out of balance in Southern California. Too much sedimentation (usually due to poor soil management in the watershed) ultimately leads to conversion of tidal habitats to non-tidal habitats. Lack of sediment deposition (usually due to damming and/or channelization of rivers) can lead to overly stable marshes with lower plant and animal diversity. Region-wide, the loss of the natural dynamic nature of some ecosystem processes has undoubtedly led to estuaries with lower diversity than they might otherwise support and a general scarcity of species specifically adapted to these types of disturbance.

Extreme hydrologic events can also be important to sustaining salt marsh communities. These include fluvial floods, storm surge, and extreme tides associated with El Niño events (*see* Flick 1998). These events are especially important for maintaining dynamics in transition zone habitats.

Where natural disturbance regimes cannot feasibly be restored, it is desirable to build large amounts of heterogeneity into restoration sites. Heterogeneity is desirable at multiple scales. Creating habitat diversity within a system means including sub-tidal, mudflat, low marsh, mid marsh, high marsh, and transition habitat. At smaller scales, restoration projects should seek to include substantial numbers of tidal creeks and small depressions and mounds. This type of diversity will increase the chances that at least some areas within the restoration site will be suitable for a wide variety of species.

4.3.1.5 *Connectivity*

Southern California's remaining coastal wetlands are more isolated from each other than they were historically. This is especially true in the San Pedro Bay where estuarine habitats backed dunes and sandy beaches almost continually from Long Beach to Newport Beach. Today, these wetlands have been fragmented by development and are much less biologically connected to each other than in the past. This has important implications for populations of many species and on colonization rates for restored habitat.

In general, a population of a given species is prone to extirpation in proportion to its size and isolation from other populations. Many species that are limited to estuarine habitats have had their size reduced due to loss of habitat and are more isolated than ever from other populations due to fragmentation. This puts them at much greater risk of experiencing local extinctions. Indeed, many smaller marsh systems support fewer species of salt marsh plants and animals than the larger systems (Zedler 2000). One way to help bolster the health of existing small populations and encourage establishment of new populations is to increase connectivity between estuarine systems. Existing populations will benefit from increased gene flow with other populations. A group of geographically separated populations that are tenuously connected (a metapopulation) is less prone to extinction over time. Even if one population disappears due to stochastic events, other populations can support re-colonization of that habitat.

Connectivity to other natural habitats is especially important for restoration sites. While many species of plants, and, in some cases, a few animals, are reintroduced to sites through the restoration process, most species are expected to arrive via natural colonization. In estuarine restoration sites, this is much more likely to happen where there are good aquatic and terrestrial connections to existing estuarine habitats. The connections can be to high-functioning areas within a complex (*e.g.*, Steam Shovel Slough) or to other nearby systems (*e.g.*, Anaheim Bay).

“Connectivity” will mean different things to different suites of species. Fish and many invertebrates need aquatic connections. Mammals and herpetofauna need terrestrial connections, preferably wild lands without road crossings. Plants use many different strategies, though generally, shorter distances are easier to travel for seeds and pollen.

As explained above, local coastal wetlands are not as connected to each other as they once were. This will pose a challenge to plants and animals as they attempt to adapt to a changing climate and habitat conversion due to SLR. As habitats convert in one system, appropriate habitat for a given species may be reduced or lost all together. Appropriate habitats for that species may become available within other systems where they do not currently occur. Ideally, species will move between systems on their own; however, this may be difficult or impossible for some species given the distances between systems and the lack of migration corridors. This could lead to local extirpations or even extinction of some species.

4.3.1.6 *Facilitated Migration*

The idea of facilitated migration in the face of climate change is a relatively new one (McLachlan, et al. 2007). The idea is somewhat controversial because it encourages introduction of species beyond what is understood as their historical range (generally toward higher latitudes and/or elevations in the face of warmer conditions). There are legitimate concerns about species becoming invasive in new areas and having detrimental effects on indigenous species. In many cases, these risks are probably outweighed by the threat of a species going extinct where there is little or no opportunity for it to migrate on its own. Until the science is better understood, the current focus should be on rare species that are most at risk. In these cases, introduction of certain species to areas that were not known to support them in the past may not only be appropriate, but encouraged.

4.3.2 Regional Socioeconomic Needs

There is a wide array of socioeconomic values associated with wetlands and wetland restoration in Southern California. The majority of socioeconomic values are mostly of benefit to the local communities where the wetlands occur. There are some regional socioeconomic needs that can be addressed through estuarine restoration at the LCW.

First, estuarine wetlands are well known as rearing grounds for several species of fish that are important to near-shore commercial and/or sport fisheries. Expansion of tidal and sub-tidal habitats at the LCW will benefit these fisheries region-wide. Having sub-tidal habitat is necessary to provide fish a low tide refuge. Deeper waters are important for larger fish and shallow waters provide refuge for juveniles. At the LCW, there is already considerable, mostly deep, sub-tidal habitat in channels and in the adjacent marinas. While these areas surely support some commercial and sport fish, the diversity and number of fish could probably be increased by expanding the area of adjacent salt marsh habitat (Kneib 1997). Salt marshes provide habitat for a distinct assemblage of smaller fish that can become prey for larger more economically important species. Allen, et al. (2006) and Zedler (2000), among others, have argued that tidal salt marsh and tidal creeks should be included adjacent to sub-tidal habitats in mitigation and restoration projects seeking to benefit bay-estuarine fishes.

The history of salt marsh restoration in Southern California includes a broad mix of successful and unsuccessful projects. Much has been learned over the years about how to design and implement better projects by including hypothesis-driven research and monitoring at both natural marshes and as part of the restoration process. The volumes of work done in the field over the last several decades have led to great advances in the state-of-the-art in coastal wetland restoration and, today, successes seem to be outnumbering failures. Nevertheless, there is still a lot that is not known about how restoration sites function and how to design projects to function better. It is, therefore, important to include opportunities for research and monitoring in all estuarine restoration projects. This will not only benefit scientists throughout the region who specialize in this type of research, but the knowledge gained will benefit future restoration projects as well.

In Southern California, there is a more or less continual need for sites where estuarine mitigation can be conducted. This is driven in large parts by dredging and filling at ports and harbors, though other agencies, including the California Department of Transportation, are expected to need mitigation credits in the future. Sites for estuarine restoration in the region are limited and the LCW is one of the best opportunities for large-scale restoration that could be funded by mitigation.

4.3.3 Local Biological Needs

The LCW Complex includes 503 acres of open space within what was once part of a tidal estuary. As with most degraded coastal estuaries, only a limited picture exists of what the biological resources of the site were before human disturbance. Major hydrologic changes to the system and residential, commercial and industrial development around, and in some cases within, the complex, have certainly reduced the functioning of the site for plants and animals that use estuarine habitat. Restoration of salt marsh and associated habitats has the potential to address several important local biological needs associated with returning more natural functioning to the site.

The current native biodiversity of the LCW Complex, while impressive, is surely only a fraction of what it once was. Restoration of estuarine habitats will provide opportunities to re-introduce species that have been extirpated and expand populations that have been reduced from historical levels. This includes many special status species along with other plant and animal species that rely on tidal estuarine ecosystems. Chapter 6 of this plan includes an analysis of opportunities to target restoration actions that benefit some of these species.

Virtually all the remaining open space within the LCW Complex was once tidal salt marsh. Most of this has been converted to other habitat types by alterations to hydrology and topography. Most of the tidal area that remains is highly degraded. However, there are certain areas that have: 1) retained high salt marsh functioning; and 2) converted to non-salt marsh habitat types that are providing ecological functions and values. It is desirable to protect high-functioning areas and assess opportunities to preserve and enhance ecosystem functions of non-salt marsh habitats within the system.

Steam Shovel Slough is a fairly pristine remnant of the tidal salt marsh once known as Alamitos Bay. This remnant has a broad mix of estuarine habitats and high plant diversity. It is connected to full tidal conditions through the Los Cerritos Channel. This restoration plan does not include Steam Shovel Slough or areas directly adjacent to it because these areas are expected to be restored through the Upper Los Cerritos Wetlands Mitigation Bank. However, the Steam Shovel Slough area should be recognized as extremely valuable and restoration actions elsewhere in the LCW complex should not impact it negatively.

Non-salt marsh wetlands have developed on large areas of the LCW Complex that are no longer tidal. The current habitats fall in to two general categories, brackish marsh and seasonal saline ponds. Brackish marsh habitat has developed (most notably at Marketplace Marsh) where urban freshwater runoff is directed via storm drains onto the salty soils of formerly tidal areas. The historical Alamitos Bay ecosystem probably supported brackish marshes fed by stream flow and ground water. All or most of the historical brackish areas have been lost due to development or converted to other habitats due to loss of hydrology. This habitat currently only occurs where urban runoff provides the necessary hydrology. Brackish marsh is a productive and rare habitat in Southern California and worthy of restoration where conditions allow. However, urban runoff can deliver nutrients and other pollutants into the ecosystem, making it a generally undesirable source of water where habitat is the primary focus. It is probably better to develop bioswales or other storm water treatment wetlands off-site that do not have a habitat focus or develop a mechanism that allows urban runoff to enter the restored marsh after contaminants have been reduced, ideally in a way that mimics the frequency and magnitude of storm events.

Shallow basins (some bermed in by oil roads) retain rainwater and can pond for several months, but only in wet years. They can go five years or more without ponding during prolonged droughts. When ponded, these areas are used by waterfowl and shore birds. Reintroduction of tides will cause these habitats to convert and/or be reduced in area. While these ponds are currently providing occasional ecosystem functions, it is probably not desirable to protect these habitats from conversion to tidal salt marsh in place. There may be opportunities to recreate some of the lost functions in different areas of the complex.

In the last several years, a thriving riparian forest has established in a bioswale just east of the South LCWA Site , outside of the LCWA's Program Area. Riparian forests, historically present along the SGR, are now extremely rare in the area. The bioswale site is supporting rare nesting birds and intercepting stormwater runoff before it gets to saline wetlands. Restoring riparian habitat in strategic areas within the LCW complex would provide water quality benefits for tidal wetlands and have high habitat value as well.

The remaining open spaces within the LCW Complex are highly fragmented by roads, berms, and levees. The overall ecological functioning of the complex could be improved by restoring connectivity between different areas. These connections should be both hydrological and terrestrial to the extent feasible. For instance, restored salt marsh habitat would benefit from a hydrological connection to existing tidal marsh habitat. This would allow invertebrates and plant propagules to move into restored areas and colonize the new habitat. Connections to the SGR would allow periodic pulses of freshwater to more easily enter the salt marsh. These flood pulses are important for marsh functioning and may encourage growth of some marsh species such as cordgrass (*Spartina foliosa*). Terrestrial connections such as wildlife bridges could encourage larger predators (*e.g.*, coyotes) to use the site more often. These higher-level predators will help suppress mesopredators, which are especially detrimental to several nesting bird species in salt marshes.

Of special local biological interest is the population of Pacific green sea turtles that have recently become resident in the lower SGR channel. Genetic studies indicate these turtles are probably most closely related to eastern Pacific/Mexican breeding populations. Telemetry and tag/recapture studies indicate that the turtles are visiting other local estuaries seasonally (Anaheim Bay, Seal Beach NWR and Alamitos Bay) but suggest the warm water in the river channel (caused by power plant cooling water discharges) is the primary reason for the presence of this generally tropical species (Banarjee et al. 2019). Others have argued that the infrastructure in the SGR (*e.g.,* bridge footings, culverts, and rock armoring) is helping to provide sufficient conditions for their presence there (Craer et al. 2017). There have been Pacific green sea turtles present in San Diego Bay for at least a couple decades. These turtles were present in San Diego Bay before the operation of the South Bay Power

Plant, but were known to spend considerable time in warm-water effluent from the power plant and feed in nearby eelgrass beds (Madrak et al. 2016). The warm water discharges ended there in 2010 and their long-term presence is in question, though so far, the turtles do not seem to have abandoned the bay and have been able to locate natural warm water areas within the Bay (Madrak et al. 2016). Warm water discharges from the power plants on the SGR are expected to cease by 2029, meaning the long-term presence of this species is in question here as well. Therefore caution is recommended in emphasizing restoration of habitats (*e.g*., eelgrass beds) with the explicit goal of supporting this species. Nevertheless, restoration of eelgrass beds and sub-tidal habitat within the LCW complex would benefit this species (and others) and therefore may be desirable.

4.3.4 Local Socioeconomic Needs

Many of the local benefits of a restoration project, such as that proposed in this restoration plan, are socioeconomic. Direct and indirect economic benefits of restoration projects (*e.g.*, jobs created, increase in visitors and economic activity, increases in adjacent property value, etc.) are difficult to calculate and, doing so, is well beyond the scope of this plan. However, there are important benefits to the local community that are clear even if monetizing them is difficult.

Restoration projects that include trails, viewpoints and other types of access provide opportunities for passive recreation. This can include bird watching, walking, running, biking, painting, dog walking, kayaking, etc. While some of these activities may be disruptive for some wildlife species, creating responsible passive recreational opportunities, especially in urban areas, can be a major amenity to the community. It is usually possible to balance human uses with concerns about wildlife disturbance.

Trails through restored areas can also provide people with new foot and bike connections between their homes and retail or work areas. Traveling on dedicated trails through natural spaces is generally more enticing than traveling along busy roads. New connections may encourage less car travel and better health, both benefits to the local communities. Unfortunately, trails and other park amenities can also result in gentrification in areas that previously lacked access to open space. Restoration projects that will offer public recreational amenities and are located in or near low-income areas should consider including Parks Related Anti-Displacement Strategies to reduce this impact (*see* Rigolon and Christensen 2019).

Along with public access to restored habitats, there is an opportunity to provide educational opportunities for visitors. There are many ways to provide interpretive and educational material, including signage along trails, visitor centers (preferably not located within restorable areas), interactive exhibits, and so forth. These can be used by visitors on their own, via docent led tours, or by organized tours for school groups and the like. These types of amenities not only bring visitors to the area (an economic benefit to area businesses), but also increase the level of appreciation and awareness of natural habitats in the general public. This hopefully leads to increased public support for other conservation and restoration activities in the future.

Restoration in urban areas often takes place on degraded lands that the public is using for various types of recreation. Conflicts can arise when habitats are restored and recreation patterns are expected to change. In the case of the LCW, there has been very limited public access to the vast majority of the site for many years. Therefore, the probability of such conflicts is expected to be low. Most of the current public access to the site is via the LCWA's Stewardship Program, which leads wildlife viewing walks and involves volunteers and school groups in small-scale restoration activities. The Los Cerritos Wetlands Land Trust leads land tours and the El Dorado Audubon Chapter also leads regular bird walks within the area. Continuing these uses will be important as restoration projects are implemented and completed since those involved undoubtedly feel a sense of ownership of the LCW.

A "sense of place" is a term that refers to "the complex interactions people have with the environments they encounter" (Soini, et al. 2012). Many types of environments that people in Southern California encounter are "placeless," that is, they could be anywhere and have no relevance to Southern California. Examples include shopping malls, parks with lawn and playgrounds, and chain stores and restaurants. By this definition, much of the area immediately adjacent to the LCW is rather placeless. Allowing people to access restored natural habitats within urban areas is an ideal way to encourage a sense of place. Many studies have shown the value of an increased sense of place to communities and individuals. People become more likely to interact with neighbors and create new social bonds (Sullivan, et al. 2004) and are more likely to actively seek protection of other natural areas (Adamic 2012). Natural open spaces are important spiritually as well, and are known to instill increased senses of wonder, action, and freedom, especially in children (Brook 2010). Southern California's habitats are unique, especially our estuaries. To experience these natural areas is a quintessential part of what it means to live here.

Restored coastal wetlands can provide other benefits to people even if they are not engaged in visiting the site. Coastal wetlands can effectively take up nutrients in plant material and trap other pollutants in anoxic soils, leading to improved water quality in adjacent channels, marinas, and beaches. Coastal wetlands can also act as a buffer that protects developed areas from storm surges, flooding, and SLR. It is not yet clear the extent to which restored estuarine habitat at the LCW can serve these functions, though different designs could optimize these types of benefits.

4.4 Ecological Resilience and Restoration

Ideally, restored habitats should be resilient to near-term disturbances and changing conditions over time. In the ecological sense, resilience is a measure by which an ecosystem retains or quickly recovers its ecological functioning and biodiversity after some stochastic event, which may be natural (fire, flood, drought, etc.), human caused (oil spill, invasive species introduction, etc.) or some combination of the two (algal blooms). When systems are not resilient enough, such events will lead to major shifts in the ecological functioning and biodiversity of an area. This is commonly referred to as "regime shift," where the habitat types, species assemblages, and other measures of ecological functioning change, more or less permanently. If restoration sites are to meet their habitat targets over the long run, restored systems must be resilient or else the intended habitats will usually convert to less desirable ones.

Southern California's estuaries are adapted to many types of natural disturbance, including periodic mouth closures, fluvial floods, invasive species, sedimentation events, and drought. These natural disturbances can severely affect certain species and alter ecosystems in many ways. However, natural systems have been shown to be surprisingly resilient to these types of events and, in fact, they are probably important for maintaining biodiversity within estuarine systems (Zedler 2000). Systems without natural functioning or low biodiversity are probably less resilient in the face of these types of events.

Coastal wetland restoration projects should seek ways to maximize the resilience of restored habitats to natural and human caused stochastic events. There is no consensus on how to accomplish this for most natural habitats, and there is a lack of studies addressing this issue for Southern California salt marshes (Callaway 2001). General ecological theory suggests that increased diversity leads to increased resilience (Elmqvist, et al. 2003). Building many types of diversity into restoration projects is probably the best way to maximize resilience. For coastal salt marshes in Southern California, restoration projects should look to provide a wide range of diversity in at least native species (plant and animal), functional groups, habitats, and elevations.

SLR of at least 1.3 to 3.3 feet over the next century is considered likely (66% probability, Table 4-1) by the State of California (Ocean Protection Council 2018). Resilience of salt marsh restoration sites to SLR may be even more difficult to deal with. Since substantial SLR has yet to occur (8 inches since 1927) (Moffatt & Nichol 2013), most hypotheses about how salt marsh habitats will respond have been based on areas where the land is subsiding (and, therefore, effectively sea level is rising). Some evidence suggests that, given sufficient sediment supply, marshes will naturally accrete with SLR. When tidal flows were restored to subsided salt ponds that were once salt marsh habitat along the margins of San Francisco Bay, rapid natural accretion raised the soil surfaces to elevations appropriate for supporting vegetated salt marsh again (Callaway, et al. 2009, Williams and Orr 2002). The wave climate within the bay probably has a lot to do with the rapid sedimentation rates and it is not clear if this same result might be expected in Southern California systems. Another possible answer to long-term resilience in the face of SLR may be to add sediment to systems in some controlled way. Sediment additions have been shown to increase resilience of subsiding coastal marshlands on the Gulf Coast (Stagg and Mendelssohn 2011) and sediment augmentation is being used at Seal Beach National Wildlife Refuge, near the LCW. There will likely be considerable loss of certain types of estuarine habitat over the coming decades without human interventions.

While the best ways to restore resilient estuarine systems in Southern California may not yet be known, there are certain practices that are generally detrimental to the process. First, many restoration and mitigation projects are designed to achieve certain results in a very short amount of time (often five years or less), leading to short-sighted decision making, such as planting a site with a few species of “super plants” that will grow quickly and reach cover targets by a certain year, but often at the cost of biodiversity. Second, restoration sites with fine-scale topographic diversity support more diverse plant and animal assemblages in salt marsh habitats (Zedler 2000), though they are often not included on construction drawings due to the practical challenges of building them in the field. Third, habitat diversity is often compromised by either a desire to maximize wetland area (at the cost of transition and upland habitats for instance) or meet some rigid mitigation criteria for certain types of habitat. Fourth, some project designs are driven by budgetary limitations rather than biological concerns, leading to projects that cut corners on things like planting diversity, fine-scale grading, and long-term monitoring and maintenance. Finally, many of our regulatory structures, especially permit conditions, have simplified performance criteria that do not encourage designs that are diverse and resilient.

Many of these pitfalls can be avoided. Structural reforms to how mitigation projects are designed and regulated would obviously be helpful. Building different types of diversity into restoration designs from the earliest stages of planning will help in developing realistic budgets. Of course, restoration planners and practitioners need to acknowledge that resilience is an important ecosystem attribute, especially in light of climate change and SLR. In developing the restoration designs detailed in this plan, the LCWA has carefully considered what it will take to restore an ecosystem that will truly be resilient over the next several decades or more.

4.5 Current Conditions

Careful assessment of the current conditions of the restoration site is crucial to the planning process. In general, this type of assessment provides baseline data that help guide restoration designs and are critical for refining restoration plans that are sensitive to existing high-functioning habitats, maximize ecological lift, minimize regulatory and permitting challenges, and increase the chances of achieving restoration success. The CRP and PEIR both contain considerable detail on current conditions related to land use and ownership, biological resources, soil conditions, hydrology and hydraulics, cultural resources, and regulatory boundaries. This plan includes a high-level overview of these conditions, with a focus on how they have driven decision-making in the development of the restoration designs in this plan.

4.5.1 Current Land Management on LCWA Properties

Since the early part of the 20th Century the majority of the land within the project area was managed as oil fields and for other industrial uses. This management focus shifted slightly in 2006 when the LCWA purchased the first 66-acre portion of the LCW for the purpose of wetlands conservation and restoration. Currently, the LCWA manages approximately 166 acres of land for this purpose. The LCWA's main land management objectives are to protect existing sensitive habitat and associated species, provide safe and controlled public access, and maintain safe working conditions for mineral rights owners to access and operate their equipment. The LCWA has an agreement with the current oil lease operators on their property in the Central LCWA Site that allows operators to remove vegetation from around their mineral extraction equipment as required by the Fire Department and the Department of Oil, Gas and Geothermal Resources. The oil operator compensates for this impact by providing the LCWA with an annual endowment fee to be used for wetlands habitat restoration. Neighboring land-owners manage their properties for a variety of different purposes including mineral extraction, flood management, power plant cooling systems, and as potential sites for commercial or residential developments.

One of the main ways that the LCWA meets its objectives for land management is through their Stewardship Program. The LCWA's Stewardship Program was founded in 2008 and began community-based programming in September 2009. The Mission of this program is to promote community involvement with environmental education, maintenance, restoration, and monitoring of the wetland areas owned by the LCWA. The Stewardship Program puts forth guidelines to ensure volunteers, visitors, partners, easement holders, and other guests use the LCWA properties appropriately and perform safe and lawful services. Currently, four non-profit partners have Memorandums of Agreement with the LCWA to be a part of this program and perform management, restoration, and educational services on the LCWA's properties. This program is coordinated by consultants in cooperation with LCWA staff. The majority of the Stewardship Program's actions have been focused on a 10-acre restoration project at Zedler Marsh on the Isthmus. The Zedler Marsh restoration project has attracted thousands of participants who have provided over thousands of hours of service worth hundreds of thousands of dollars in in-kind volunteer services according to the independent sector. This work was funded by nearly $100,000 in competitive grant funding that paid for the installation of nearly 5,000 native plants, and removal of over 50,000 pounds of trash and debris. Identifying an appropriately sized role for the stewardship program in the on-the-ground restoration process will be important component.

4.5.2 Habitats and Vegetation Communities

There have been three somewhat recent efforts by the LCWA to map and classify the habitats and vegetation communities at the LCW. Habitats were mapped using the Holland system (Holland 1986) for the CRP in the South, Central, North, and Isthmus Areas and some smaller outlying properties. Vegetation types were mapped using the Manual of California

Vegetation (Sawyer et al. 2009) for the PEIR in the Southern, Central, and Isthmus Areas. These mapping efforts provide two slightly different, yet complimentary, assessments of existing habitats on the site. Vegetation mapping was done in the north area as part of the Los Cerritos Wetlands Oil Consolidation and Restoration Project.

Twelve coastal habitat types were identified within the 537.71 acres of the LCW studied for the CRP Habitat Assessment (Tidal Influence 2012). Of those, six plant communities were identified: southern coastal salt marsh, southern coastal brackish marsh, southern willow scrub, mule fat scrub, alkali meadow, and eelgrass beds. The other habitat types identified are: intertidal mudflats, salt flats, rip-rap, sub-tidal marine water (tidal channels and basins), ruderal wetlands, and ruderal uplands. Ruderal areas are mostly dominated by invasive non-native plants. Additionally, vegetation free zones (levees, dirt roadways, perimeters around pumps and pipes, exclusive oil lease easements) and developments (asphalt roadways, abandoned concrete foundations, and active mineral extraction facilities) exist on the site. These vegetation free zones and developments were not considered as habitat types, but are indicated in the habitat maps (Figure 4-12).

For the PEIR, the existing vegetation was mapped using the vegetation alliance system (Sawyer et al. 2009) in the Central, Isthmus, and South Areas. The mapping reveals a complicated mosaic with multiple parcels divided by channelized tidal waterways and roads (Figure 4-13). It supports oil production, open space, and related land management and restoration activities. Overall, the mapped area includes more than 50 acres of open water, 78 acres likely to be considered as wetland by at least some agencies plus 12 acres of tidal salt marsh and salt flats, 8 acres of upland with native species dominant, 68 acres of weedy upland habitat, 17 acres under restoration, and 37 acres of disturbed or managed upland.

Both of these mapping efforts highlight the fact that there are considerable areas where restoration actions that bring in tides and restore more natural landforms would lead to very large functional lift. Filled areas that are now uplands hold enormous potential for restoration of tidal wetlands with moderate to extensive grading. Lower-lying areas that are cut off from tides have potential to support tidal wetlands with minimal grading. Finally, virtually all areas, including those that get muted tides now, would benefit from better tidal connections.

4.5.3 Special Status Species

A few studies have documented special status species at the LCW. The PEIR includes the most up to date accounting of known observations of special status plants and wildlife (CRC 2019). The presence of special status taxa on the site needs to be considered when designating restoration actions for at least two reasons.

First, altering conditions in areas that support rare species should be carefully considered within both a regulatory and conservation framework. Any impacts that do occur should be mitigated on-site. For example, southern tarplant (*Centromadia parryi* ssp. *australis*) is a rare annual plant that prefers disturbed soils with little to no competition from other plants. It is common in small to medium patches along roads and other disturbed sites in non-tidal wetlands and uplands in all three Areas (Figure 4-14). For a variety of reasons, it will be desirable to remove some of the roads and and/or change the hydrology in areas where this species occurs in order to accomplish the larger goals and objectives of this restoration project. The overall restoration design then must account for mitigating those impacts at appropriate ratios elsewhere within the project footprint. In the case of southern tarplant, there are several examples of successful mitigation for impacts to this species, including some within the LCW complex. Two other annual plant species, Lewis' evening primrose (*Camissoniopsis lewisii*) and Coulter's goldfields (*Lasthenia glabrata* ssp. *coulteri*) occur in limited locations in the South LCWA Site (Figure 4-14) and will need to be considered in the same way. Potential impacts to other species such as Belding's savannah sparrow, an obligate salt marsh resident known to nest in the Southern Area, should be minimized by limiting or avoiding actions that will significantly alter their current habitats. Habitats used by Pacific green sea turtle and California least tern (the open waters of the SGR and HCC adjacent to the South, Central, and Isthmus Areas and beyond) will not be altered and both species are expected to primarily benefit from restoration actions that increase the area of tidal wetlands.

Second, if on-site mitigation is not feasible, impacts to populations of sensitive species should be avoided. This may mean that certain areas are either not altered or are only altered to support the existing special status species. The fill area that supports the larger patch of Lewis' evening primrose in the South LCWA Site (Figure 4-14) is one such area.

For this project, off-site mitigation should only be considered as a last resort. Mitigating at other sites within the complex may be feasible. However, establishing mitigation areas in the Central LCWA Site, for instance, would constrain future restoration actions and should therefore be avoided. Mitigating impacts at other sites within the region may be feasible, but careful consideration must be given to things like expected costs, rationales for success, and long-term monitoring and stewardship.

4.5.4 Soils

Restoring soils that will support target plant communities is among the most important aspects of successful ecological restoration. Understanding existing soils at the site will be important as restoration planning moves to the next phases. Aspects that are critical to understand at this site are grain size and chemistry/contamination.

4.5.4.1 *Grain Size*

Salt marsh restoration will be most successful on soils that have a high proportion of silt and clay. Sandy or better-drained soils in upland areas would support coastal sage scrub or dune scrub habitats. Heavy soils in upland areas might support native grasslands or even vernal pool habitats. The following passages from the CRP summarize what little is known about the grain size composition at the site. While the data is limited and more studies are needed, the finding of soils with high silt/clay content in each of the studies is generally encouraging for salt marsh restoration.

> *"A large proportion of the LCW has been impacted by use as landfill for disposal of clean construction materials, disposal of dredged material associated with excavation of the cooling water intake channel for the Haynes Power Plant and the San Gabriel River Channel, and waste products from drilling operations were stored in sumps located throughout the property. Very little of the historic surface of the wetlands is exposed at the surface. Records suggest that the entire area has been subjected to some degree of fill. Core logs associated with sampling conducted in the Hellman Ranch parcel indicate that soils are predominantly silts and silty-clays with some layers of clay at depth and some sands near the surface [Kinnetic Laboratories, Inc. 2012 and 2013 in Appendices F and G, respectively of the CRP].*
>
> *Additional grain size data were obtained by conducting a reconnaissance survey at five different sites within the LCWA Phase 1 [Central LCWA Site] parcel (Moffat and Nichol 2015). Soil texture was assessed for the upper 10 feet at each location. Although many strata were identified at each site, grain size composition consisted primarily of silts, sandy-silts, and clayey-silts. Clays were present in thin layers at most sites. Odors of hydrocarbons were recorded in three of the five soil cores. The three cores with oil odors were all located along the western edge of the parcel. Previous soil cores taken in the LCWA Phase 1 parcel and the LCWA Phase 2 [South LCWA Site] parcel were found to have similar grain size characteristics.*
>
> *As concluded by CSULB (2009), soils at the LCWA Phase I property are highly layered and were comprised primarily of clays, clay loam, and loam. As expected, soils along each core profile were relatively low in organic carbon and had slightly elevated levels of zinc near the surface. Although zinc concentrations were higher in the surface of the cores, concentrations were well below NOAA Effects Range Low and would not be considered to be of concern."*

4.5.4.2 *Chemistry and Contamination*

The LCW Complex has been used for oil exploration and recovery for the past 90+ years. In addition, certain areas were used as landfill for disposal of clean construction materials. Other areas, such as Area 18 in the South LCWA Site (usually referred to as LCWA Phase 2 in previous studies) parcel, were used for disposal of dredged material associated with excavation of the cooling water intake channel for the Haynes Power Plant and the SGR. Oil sludge presumed to be from a nearby tank farm was also disposed at Area 18. Sumps are located throughout the property. The sumps were used for waste products associated with drilling operations.

A large number of investigations have been conducted in the LCW over the past 25 years. These include studies in the South LCWA Site property (Anchor 2004a; 2004b), the Central LCWA Site (usually referred to as LCWA Phase 1 in previous studies) property (CDM 1991), and other areas (CH2MHILL 2004, U.S. EPA 2009, Ecology and Environment 2010). These and other studies are summarized in the CRP (Kinnetic Laboratories, appendices F and G). Metals have not been emphasized in any of the studies conducted to identify contaminants in LCWA properties (Moffat and Nichol 2015). Studies that incorporated some analyses of metals indicated that metal concentrations are mostly within the range of typical background concentrations found in California soils. A few metals such as such as arsenic, vanadium, barium and chromium also tend to be elevated in the sumps and are associated with some drilling muds. Anchor (2004b) found that high concentrations of lead, in particular, were strongly correlated with high concentrations of TPH in sumps. One of the earlier studies (BCL 1987) reported elevated levels (~2 to 9 mg/kg) of mercury at sites near the Area 18 landfill in the South LCWA Site.

Chlordane compounds, DDT compounds and their derivatives and dieldrin were the most common pesticides found in this region. Although large numbers of analyses have not been conducted, these compounds tended to be most common in surface soil samples. In the South LCWA Site, these compounds tended to occur along an access road and were not frequently encountered in the sumps (Moffat and Nichol 2015). More details on soil contamination can be found in Appendix J of the PEIR (ESA 2019).

The next round of restoration planning will need more complete soil testing *(i.e.*, Phase 2 testing). For the purposes of this plan, we assumed the mapping of sumps and other areas of known contamination in the South LCWA Site from the CRP (Figure 4-15) represented the most likely areas of contamination. These include sites contaminated by old oil sumps, a sludge disposal site, a landfill, and other unknown sources. In general, samples to date have shown that not all (and maybe just a few) of the contaminated areas meet Hazardous Waste Criteria. However, many more samples exceed ecological criteria and human health criteria (ESA 2019). There is likely considerable contamination in the Central and Isthmus Areas as well. The PEIR (Section 8 of the Soils and Water Quality Technical Report) provides guidance on handling, use, and spoiling of contaminated soils during grading. Excavating in areas of known contamination will require management and/or remediation depending on constituent concentrations and regulatory actions levels (PEIR 2020). The cost of disposing polluted soils off site has been estimated at $77-$82 per cubic yard ($108 - $115 per ton) versus about $20 per cubic yard for clean soil. Clean construction debris (likely what is in the landfill area) was estimated at $50 per ton (Everest International Consultants 2012a).

4.5.5 Watershed Conditions

The SGR runs through the LCW but connections between the river and the LCWA-owned parcels are severely restricted. The South and Isthmus Areas are connected to the river via culverts with leaky flap valves that allow limited tidal flows. The Central LCWA Site is connected to the river by a culvert (assumed to have no flap valve in the PEIR) that allows only the highest tides to flow into a limited part of the site. Restoration in all three Areas will likely include improving connections to the SGR (new connections would be the main hydrologic driver in the Central and Isthmus Areas). Activities that occur in the SGR watershed that affect water quality and quantity will be important to consider in designing restoration project in all areas, but especially in the Central and Isthmus Areas.

A watershed analysis was prepared as part of the CRP (Everest International Consultants 2012b). It identified heavy metals, bacteria, Ammonia, toxicity, Diazinon, Dioxin, and trash as water quality related concerns for restored wetlands. TMDL's are being developed for much of the watershed, so many of these threats are expected to lessen over time.

Of all the pollutants, trash is probably the most worrisome for restoration. It is estimated that 3,000 – 10,000 cubic yards of trash flow out the mouth of the SGR every year (Everest International Consultants 2012b). Trash is cleaned up regularly at Zedler Marsh. Larger connections to the river will allow much greater quantities to enter restored marshes. Trash is an aesthetic concern, but it can also smother plants where it is deposited at high tide lines and have negative impacts on wildlife. Managing trash inputs to sites and/or regular clean ups will be needed for any area connected to the SGR.

The Alamitos and Haynes Generating Stations, just upriver from the LCW, can discharge over 2,000 MGD of heated seawater from once through cooling into the SGR, raising the temperature of the river by several degrees Fahrenheit. It is unknown what effects the heated water might have on restored marshes. The once-through cooling is scheduled to stop within the decade so it might not be a cause for concern vis-a-vis tidal marsh restoration.

The South LCWA Site receives very little in the way of stormwater inflows from neighboring lands. The CRP's watershed analysis (Everest International Consultants 2012b) states that: "The LCWA Phase 2 parcel currently does not receive significant runoff from any source". It seems possible that there may be stormwater inflows near the eastern end of Gum Grove Park, though the amounts are likely small. This is the only area of the South LCWA Site where the restoration design may need to be sensitive to very local watershed effects.

The Central Area receives stormwater and year-round runoff from local developed areas (Marketplace Shopping Center and some adjacent business parks). Most or all of the flows are onto City of Long Beach property, where they are sufficient to support cattail (*Typha* spp.), tule (*Schoenoplectus* spp.), and willows (*Salix* spp.) at Marketplace Marsh. At least one other storm drain empties on to this parcel, though it was not analyzed in the CRP's watershed analysis (Everest International Consultants 2012b). Restoration designs will need to take these freshwater inputs in to account in the Central Area.

4.5.6 Hydrology and Hydraulics

Different aspects of the hydrology and hydraulics of the LCW and vicinity have been studied and modeled in a fair amount of detail (Moffat & Nichol 2011, ESA 2020b). The most important aspects to understand for restoration planning are current tidal conditions in different areas and fluvial flooding, especially in the SGR.

The SGR and HCC are both fully tidal water bodies (*i.e.,* their tides are essentially the same as the ocean). The SGR is connected to the ocean about one-mile downstream. Jetties on both sides of the river at the mouth help maintain the continual tidal connection (Moffat & Nichol 2011) with no muting of tides, (ESA 2020b). The HCC is connected to Alamitos Bay via a set of large siphons running under the SGR. The Alamitos Bay is connected to the ocean by a maintained deep-water connection with Jetties. Restored wetlands connected to either the SGR or HCC could have either muted tides or a full range of tides depending on the design of the connection.

Currently, parts of the South LCWA Site receive about four feet of tide range. High tides enter the site via a 48-inch diameter storm drain with a 0-foot NAVD invert[3] connected to the SGR with a one-way flap gate at the river that is partially stuck open. If the flap valve were repaired, tides would likely be eliminated from the South LCWA Site. Removal of the flap valve would allow slightly more tidal action (ESA 2020b). Modeling of fluvial flooding on the SGR shows very little effect on water levels in the South LCWA Site either now or with removal of the flap gate due to the limited nature of the connection (ESA 2020b). Local watershed inputs from Gum Grove Park are not well understood but are not thought to be significant (Everest International Consultants 2012b).

The Isthmus Area has two culvert connections to the SGR, one each for Zedler and Callaway Marsh. These connections provide muted tides to these small marshes. Similar to the South LCWA Site, the Callaway Marsh culvert has a leaky flap gate that allows limited water into the marsh. The Zedler Marsh culvert does not have a flap gate. Fluvial flooding on the SGR is expected to flood the entire Isthmus Area through the Zedler Marsh culvert (ESA 2020b). There are no substantial local watershed inputs to the Isthmus Area wetlands.

The Central LCWA Site has a very tenuous connection to the SGR via a culvert that allows small flows of water to enter the site only on the highest of high tides or flood events (ESA 2020b). Local watershed inputs from the Marketplace Shopping Center and adjacent business parks support wetlands via seasonal stormwater flows and, to some extent, year-round “urban drool”.

[3] As-built drawings for the culvert (Moffatt & Nichol 2011) show a 4-foot diameter at the SGR and 3.5-foot diameter at the marsh with an invert at -1.1-feet MSL (*i.e.,* about 1.5-feet NAVD). ESA (2020b) confirmed that the as-built drawing does not reflect the actual culvert at the site via field measurements.

4.5.7 Oil Operations

This project is located within the Seal Beach Oil Field. The South LCWA Site currently has no active oil operations. The oil operator north of South LCWA Site, the Hellman Retained site, has an access easement along 1st Street through LCWA property so this road will need to be maintained in some form.

The Central and Isthmus Areas still have active oil leases, including Signal Hill Petroleum, which has wells in both the Isthmus and Central Areas. This imposes a significant constraint on restoration on these properties especially in the Central LCWA Site. Access to the wells will need to be maintained and infrastructure will need to be protected from flooding when tides are reintroduced. In addition to wells, there is a network of pipelines and overhead power lines along roads and through existing wetland areas. Oil operation regulations dictate a vegetation clearance of at least 50 feet in diameter around well sites, a 20-foot perimeter around pipelines, and a 6-foot diameter around power poles. (Moffatt & Nichol 2015).

4.5.8 Native American/Cultural Resources

The project area contains archeological resources and it remains the focus of important cultural activity today, especially by the Tongva/Gabrieleno culture. The CRP was developed with this in mind and the LCWA charged its consultants with doing all that is ethically, legally, and professionally proper to protect local Tribal Group interests through all phases of restoration planning and in the future, implementation. The following overview is taken largely unchanged from the CRP.

The project area figures prominently in the creation story of the Tongva/Gabrieleno people, and is adjacent to the currently identified Puvungna site on the campus of Cal State Long Beach. Given the proximity of the wetlands to this site, and the oral histories of the Tongva/Gabrieleno locating the birthplace of the people at the mouth of the SGR system, the entire LCW Complex is a cultural site of great significance within the larger homeland of the Tongva/Gabrieleno. The LCWA recognizes that they are working at the place of origin; literally the mother-land of the Tongva/Gabrieleno people.

The following is from the CRP, lightly edited for clarity:

> *"The design alternatives generated in the CRP and the Optimized Design presented in this plan, recognize and address the importance of the project site within the context of Gabrileno -Tongva culture. Not only does the project site contains archaeological resources (identified in separate documents to protect these resources), but remains the focus of important cultural activity in the present day. The project area figures prominently in the creation story of the Tongva people, and is adjacent to the currently identified Puuvugna site on the campus of Cal State Long Beach. Given the proximity of the wetlands to this site, and the oral histories of the Tongva locating the*

birthplace of the people at the mouth of the San Gabriel River system, the entire LCW Complex is a cultural site is of great significance within the larger homeland of the Tongva. The LCWA recognizes that they are working at the place of origin; literally the mother-land of the Tongva nation.

The LCWA's recognition of the cultural significance of the site has led to two tracks in the design process. First, at the legal and regulatory level, all applicable federal and state laws are acknowledged and addressed. At the federal level (Nation to Nation), the Native American Graves Protection and Repatriation Act (NAGPRA) covers federal lands specifically, and at the state level Senate Bill 18 is its companion legislation guiding work at the site in both the design and construction phases.

Within this legal framework, the ongoing work at the site will require the development of a Discovery Plan, which is particularly important for the discovery of ancestral human remains, but also for cultural artifacts of any kind, and a Monitoring Plan, to ensure that Native Americans qualified to identify such remains and artifacts are fully and effectively engaged in all phases of the site preparation and restoration construction process. While the project is not at the stage where these Plans can be developed, the conceptual work recognizes that these Plans will be developed at the appropriate time.

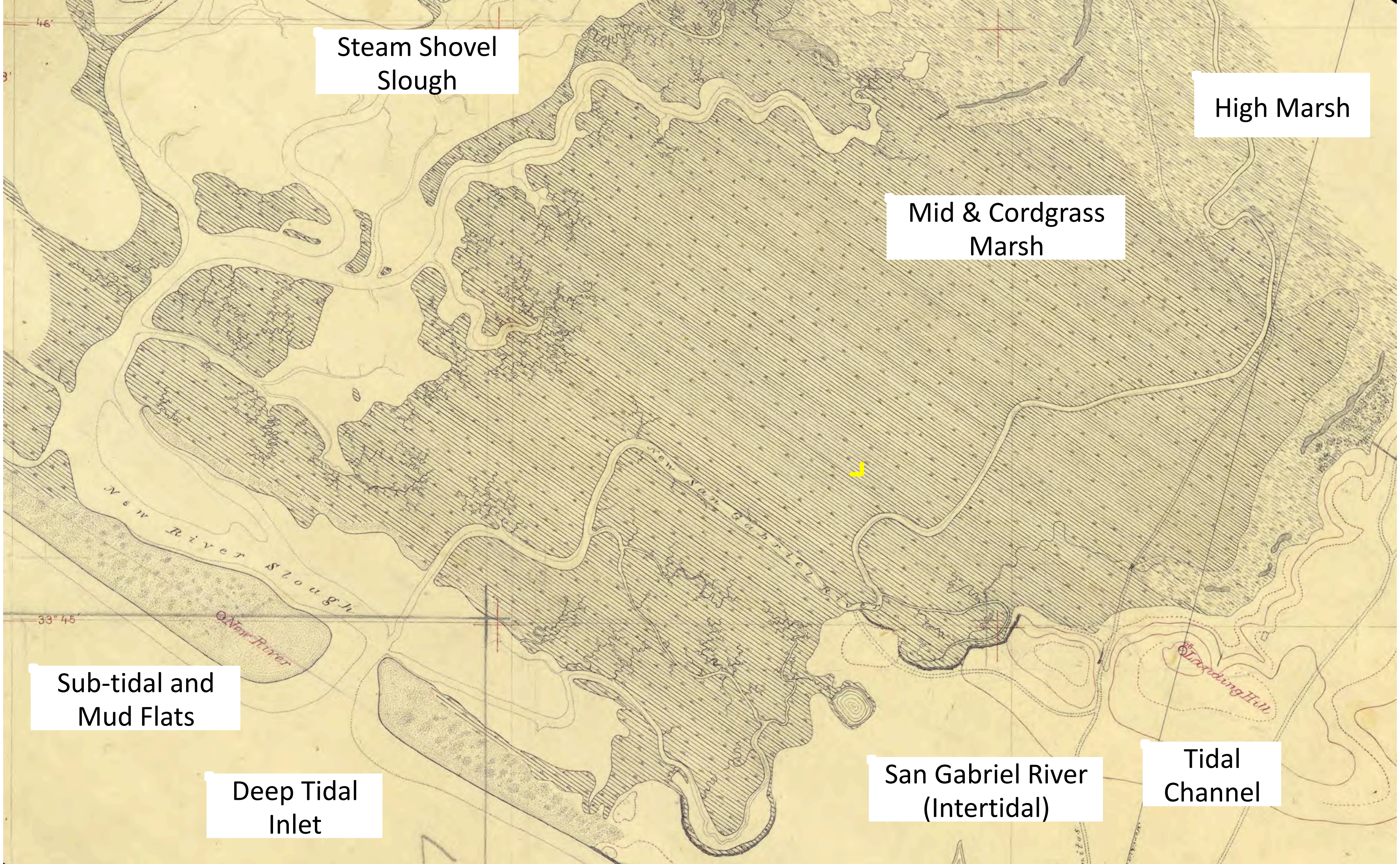
Beyond these legal considerations, the process to date has proactively engaged the public, with particular invitations extended to state-identified representatives of the Gabrileno -Tongva community. In addition to the extensive public input process, an individual meeting was held with Julia Bogany of the Gabrileno -Tongva San Gabriel Band of Mission Indians, who came recommended to us by the Los Angeles City/County Native American Commission. The Bureau of Indian Affairs also recognizes the Gabrileno -Tongva San Gabriel Band of Mission Indians as the historical group, which according to the Commission, has a water right on the San Gabriel confirmed by the BIA and MWD. This group was also involved at the direction of the BIA in the set-aside of lands at Puuvunga.

Julia Bogony is a Tongva language expert and has advised on other cultural resource issues on behalf of her Tongva group. Regarding historical conditions at the wetlands Julia noted that records indicate that the Tongva likely had a "salt works" in the region, and that salt was a primary trade item for them, and was once produced in the tidal flats area. The Tongva would have modified the wetlands to create salt pannes, a habitat type that should be considered as a potential part of the "teaching wetland" at the isthmus or near marketplace marsh, at the upper end of the tidal zone nearest the proposed interpretive center site, or perhaps elsewhere if conditions are appropriate and ecological function is enhanced. Salt panne brings brine flies and some specialist birds. Future phases of wetland and interpretive program design might consider this habitat type as a more substantial part of an interpretive program, perhaps even including actual "harvest" of the salt as a cultural and educational activity.

Ms. Bogany suggested that in future phases, all of the various Tongva "family" groups, could be invited in the physical and interpretive design so long as it is made clear that inter-tribal politics will not be discussed or allowed as a condition of participation. At the recommendation of Ms. Bogany, the LCWA also made contact with Cindi Alvitre at Cal State University, Long Beach, who was involved with the set aside of campus land for Puuvunga, in order to identify how activities, access and interpretation at the wetlands should be integrated with the Puuvunga site.

4.5.9 Potential Jurisdictional Wetlands and Potential ESHA

As part of the PEIR, Coastal Restoration Consultants mapped potential state and federal wetlands and waters and potential Environmentally Sensitive Habitat Areas (ESHA) in the South, Central and Isthmus Areas (Figures 4-16 and 4-17). These mapping efforts were not a formal delineation of waters of the US or state or a detailed analysis of potential ESHA and the mapping is not sufficient to support permitting. The goal of these efforts was to do very conservative mapping of these areas in order to provide support for restoration planning in at least two ways. First, the potential change in jurisdictional/ESHA areas can be estimated for post-restoration conditions. Generally, the acreage should increase post-restoration and should never decrease. Second, the restoration design can be sensitive to existing jurisdictional/ESHA areas and focus grading on non-wetlands/ESHA to minimize impacts to existing sensitive areas. With regards to the wetland mapping, this analysis did not explicitly identify the "quality" of the wetland habitats in different areas, so decision-making related to which areas to preserve and which could be altered should not be based entirely on this mapping.



Legend

Approximate Outline of LCWA South Site

1873 Coast Survey Map

Los Cerritos Wetlands Habitat Restoration Plan

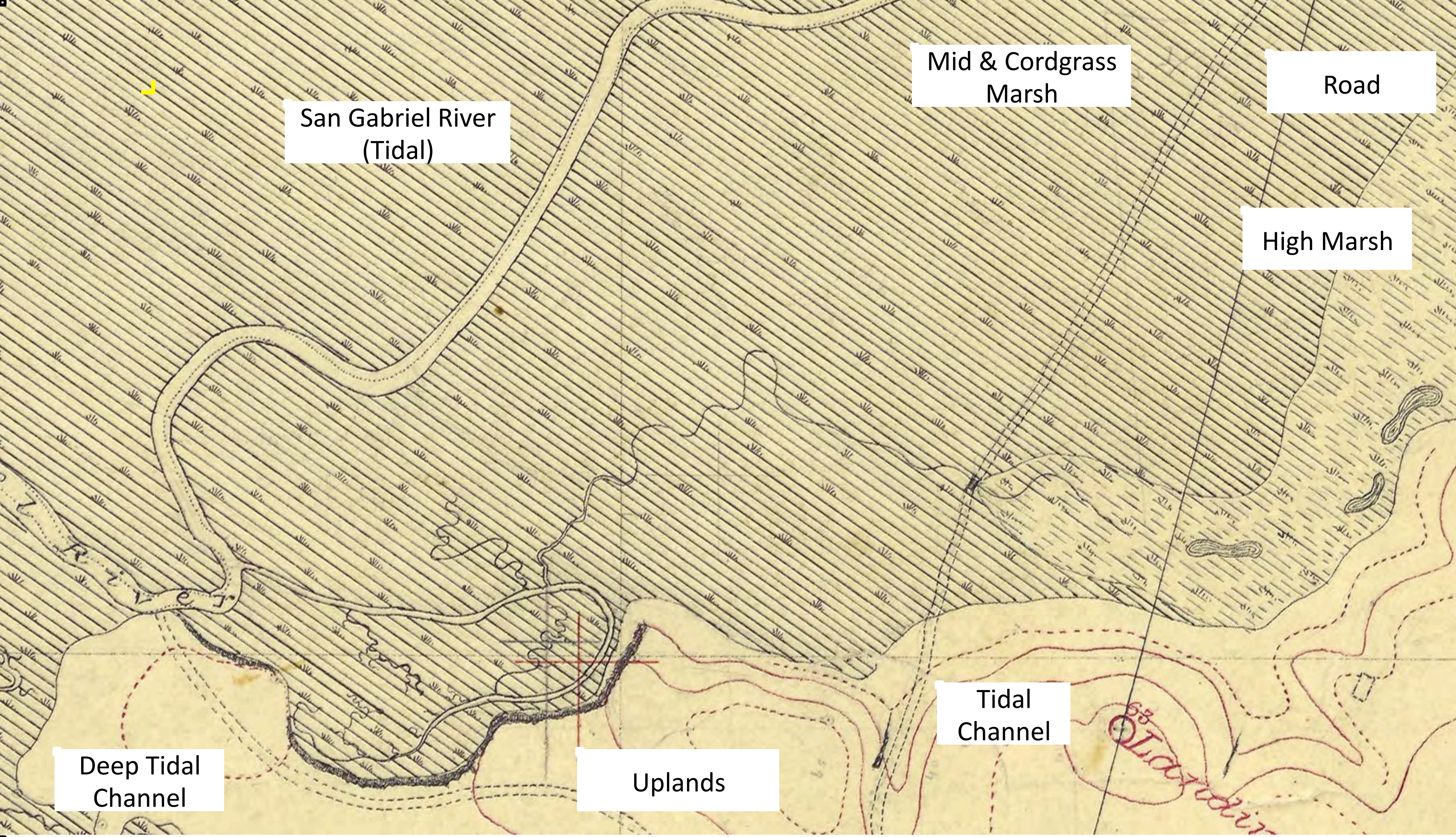
Figure 4-1

No Scale

N

Coastal Restoration Consultants

Map Source: NOAA



Legend

Approximate Outline of LCWA South Site

1873 Coast Survey Map

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-2

No Scale

N

Map Source: NOAA

Coastal Restoration Consultants

Legend

Approximate Outline of LCWA South Site

1928 Aerial of South Area

Los Cerritos Wetlands Habitat Restoration Plan

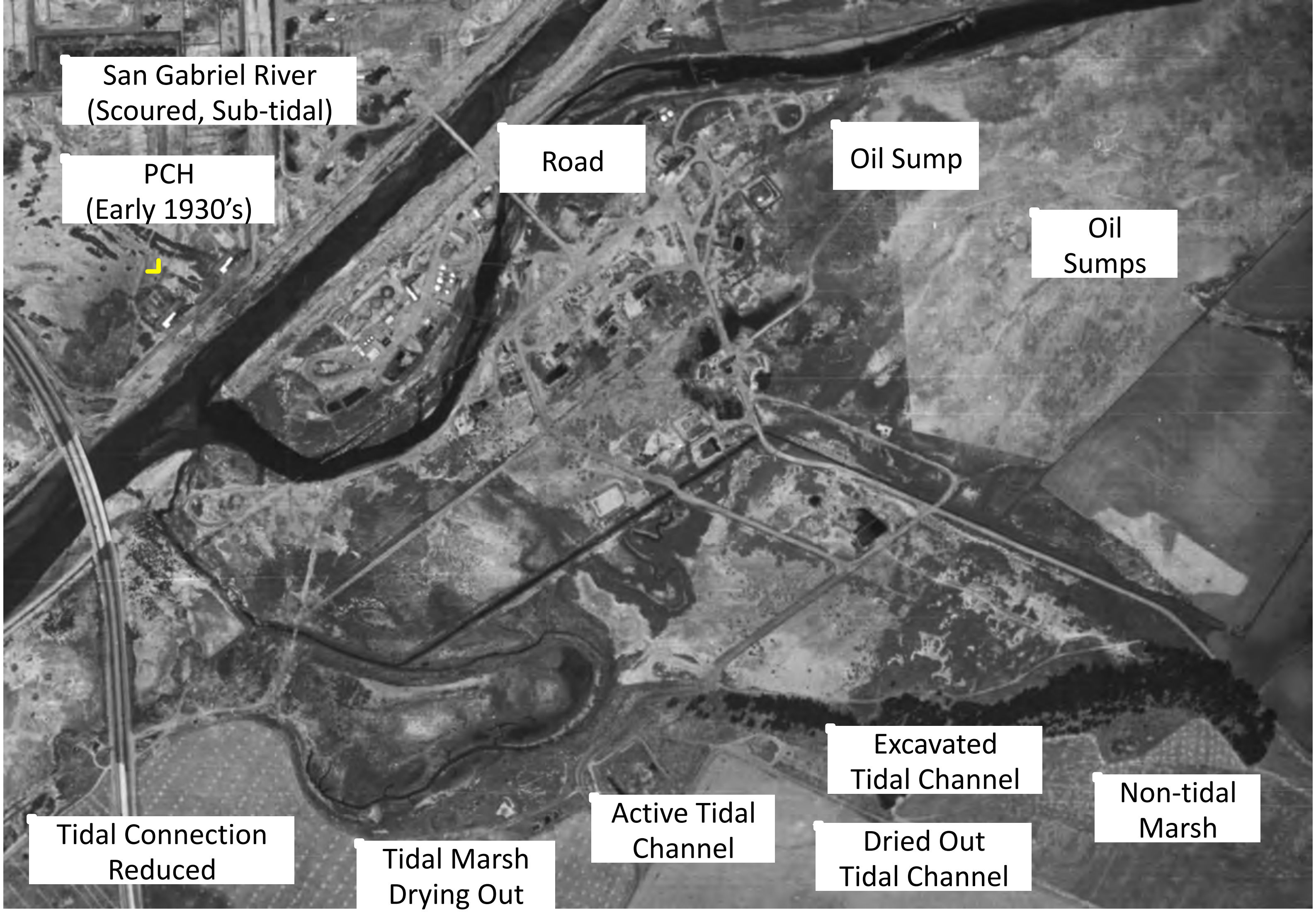
Figure 4-3

No Scale

N

Coastal Restoration Consultants

Photo Source: UCSB Maps and Imagery



Legend

Approximate Outline of LCWA South Site

1938 Aerial of South Area

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-4

No Scale

N

Coastal Restoration Consultants

Photo Source: UCSB Maps and Imagery

Legend

Approximate Outline of LCWA South Site

1954 Aerial of South Area

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-5

No Scale

N

Coastal Restoration Consultants

Photo Source: UCSB Maps and Imagery

Legend

Approximate Outline of LCWA South Site

1961 Aerial of South Area

Los Cerritos Wetlands Habitat Restoration Plan

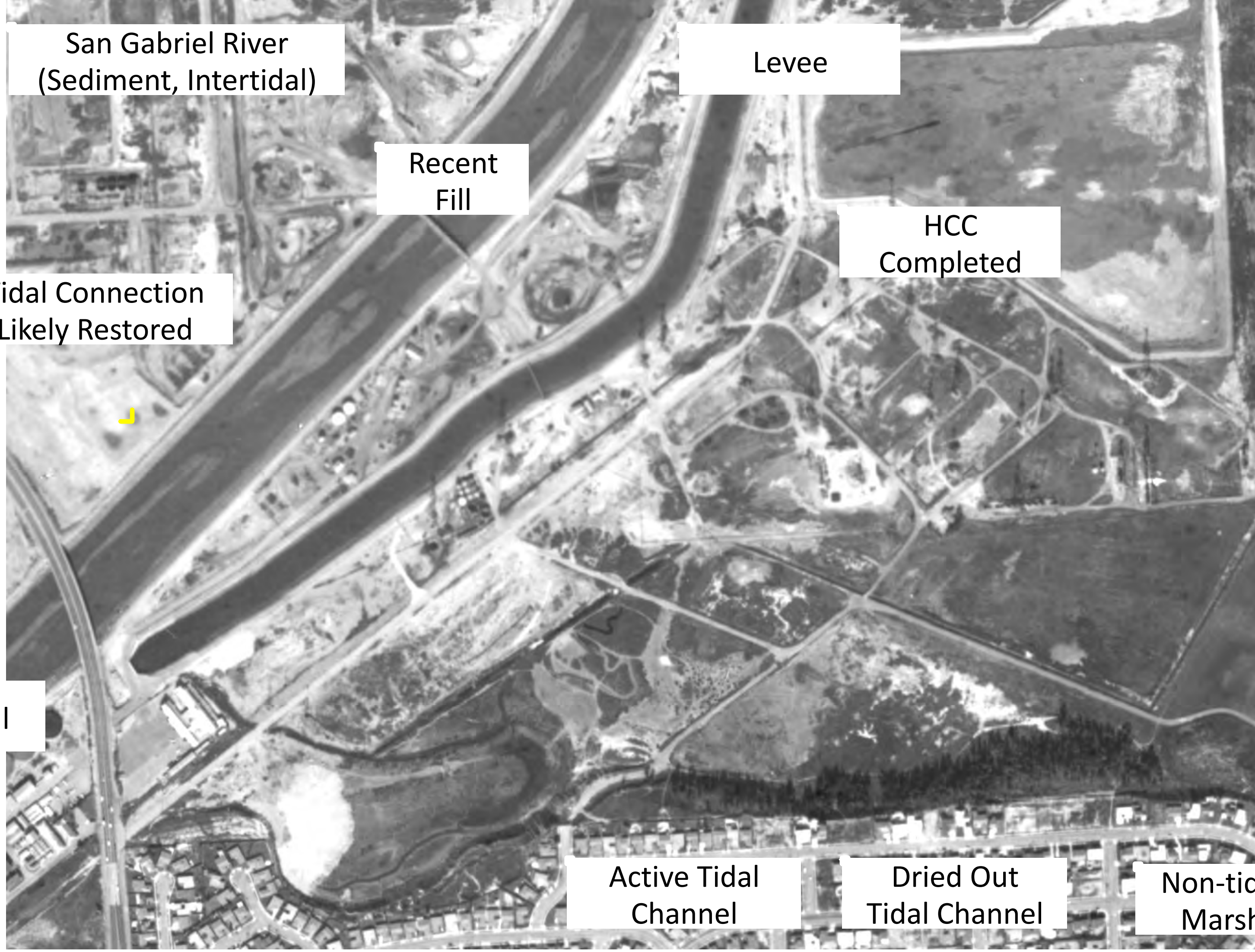
Figure 4-6

No Scale

N

Coastal Restoration Consultants

Photo Source: UCSB Maps and Imagery



Legend

Approximate Outline of LCWA South Site

1965 Aerial of South Area

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-7

No Scale

N

Coastal Restoration Consultants

Photo Source: UCSB Maps and Imagery

Legend

Approximate Outline of LCWA South Site

1968 Aerial of South Area

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-8

No Scale

N

Coastal Restoration Consultants

Photo Source: UCSB Maps and Imagery

Legend

Approximate Outline of LCWA South Site

1972 Aerial of South Area

Los Cerritos Wetlands Habitat Restoration Plan

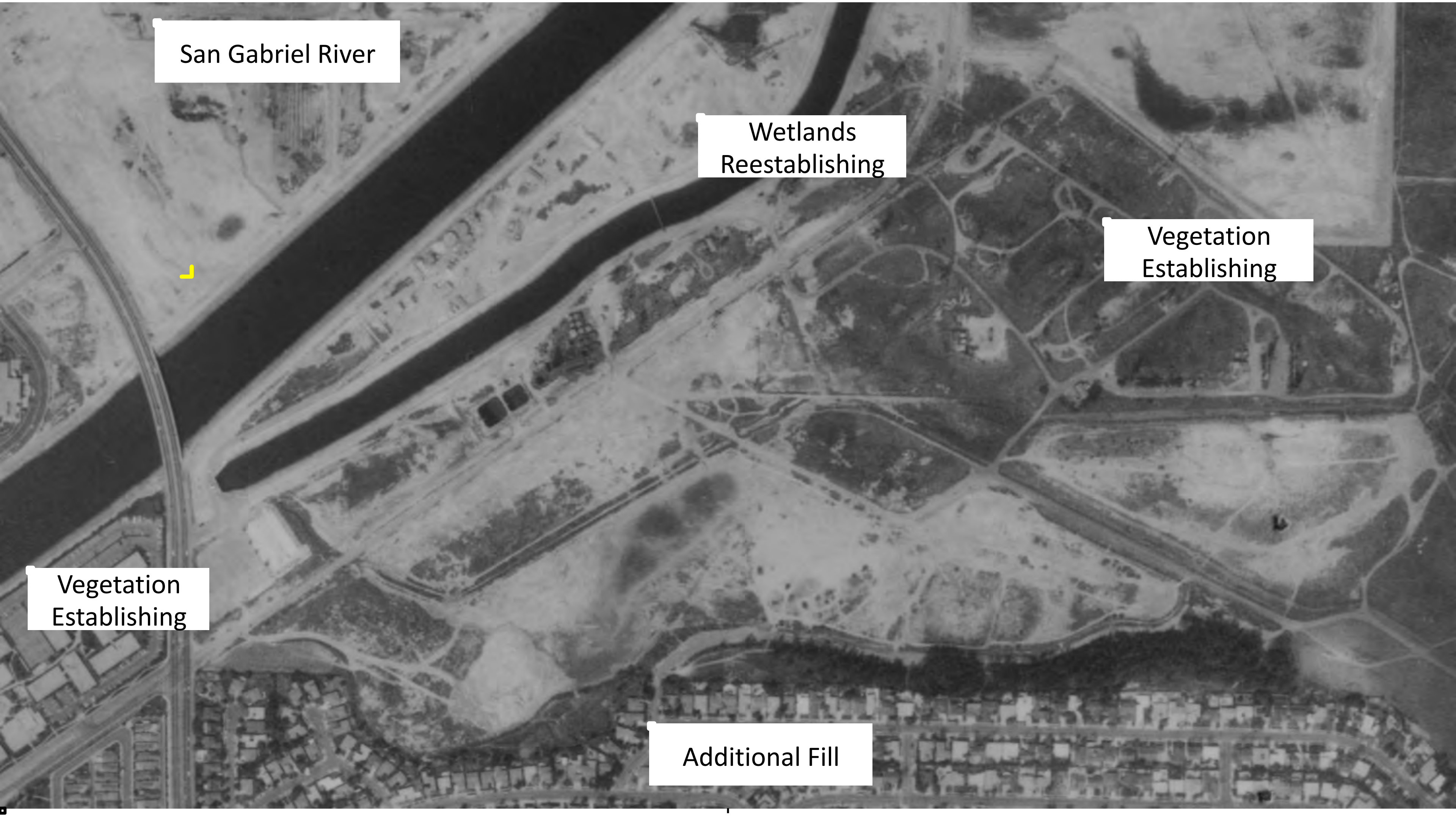
Figure 4-9

No Scale

N

Photo Source: UCSB Maps and Imagery

Coastal Restoration Consultants



Legend

Approximate Outline of LCWA South Site

1976 Aerial of South Area

Los Cerritos Wetlands Habitat Restoration Plan

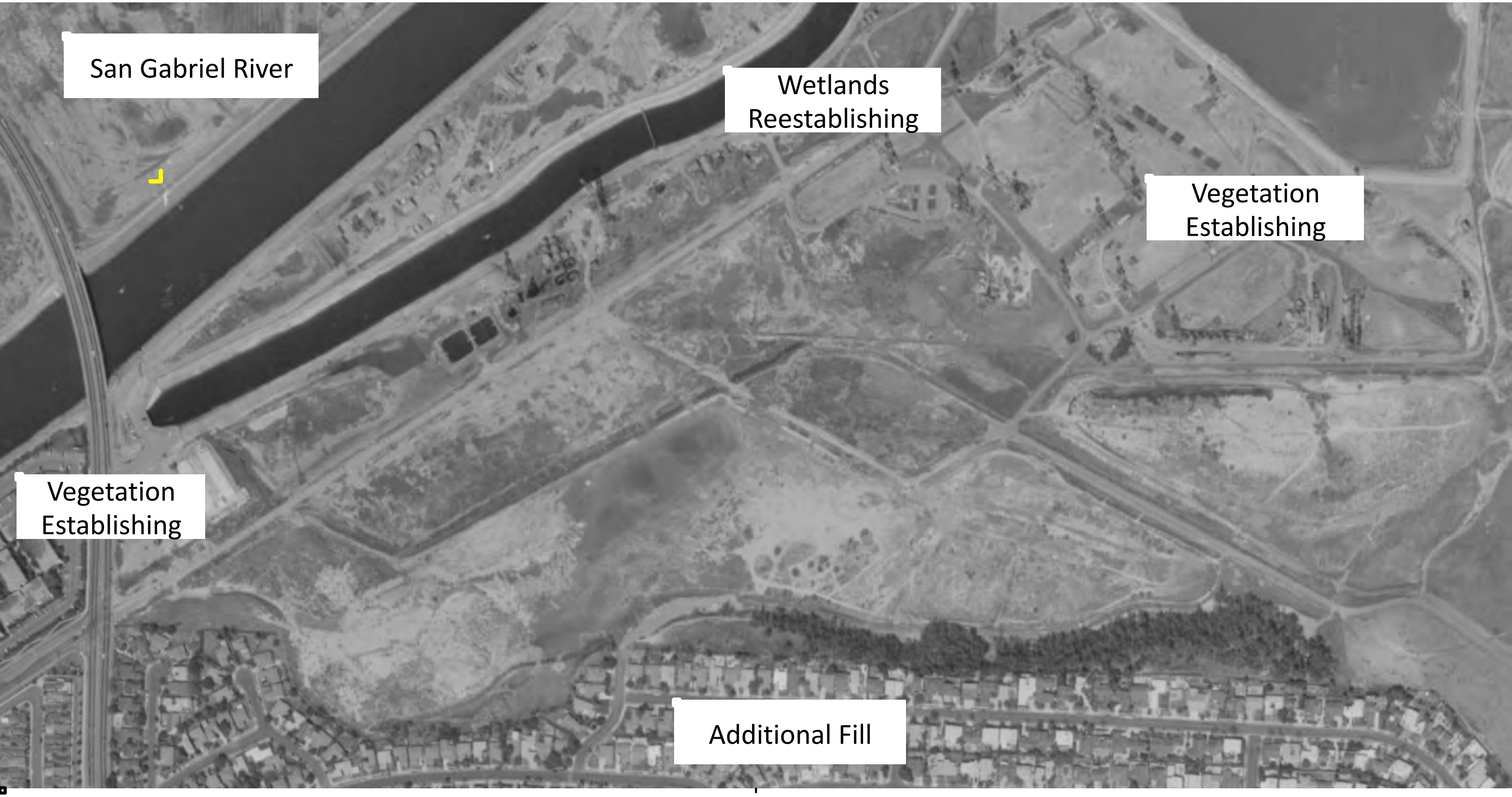
Figure 4-10

No Scale

N

Coastal Restoration Consultants

Photo Source: UCSB Maps and Imagery



Legend

Approximate Outline of LCWA South Site

1977 Aerial of South Area

Los Cerritos Wetlands Habitat Restoration Plan

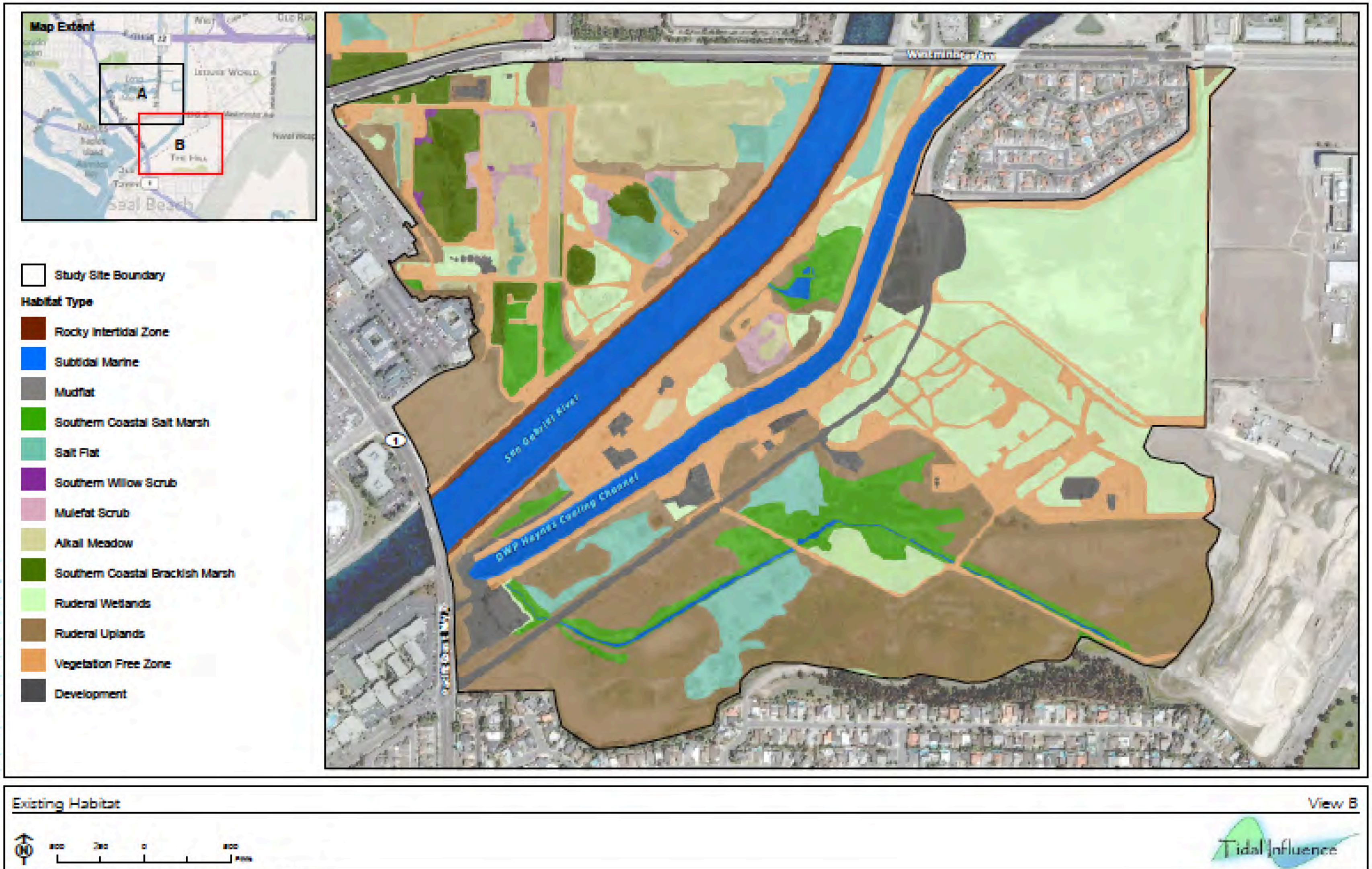
Figure 4-11

No Scale

N

Photo Source: UCSB Maps and Imagery

Coastal Restoration Consultants



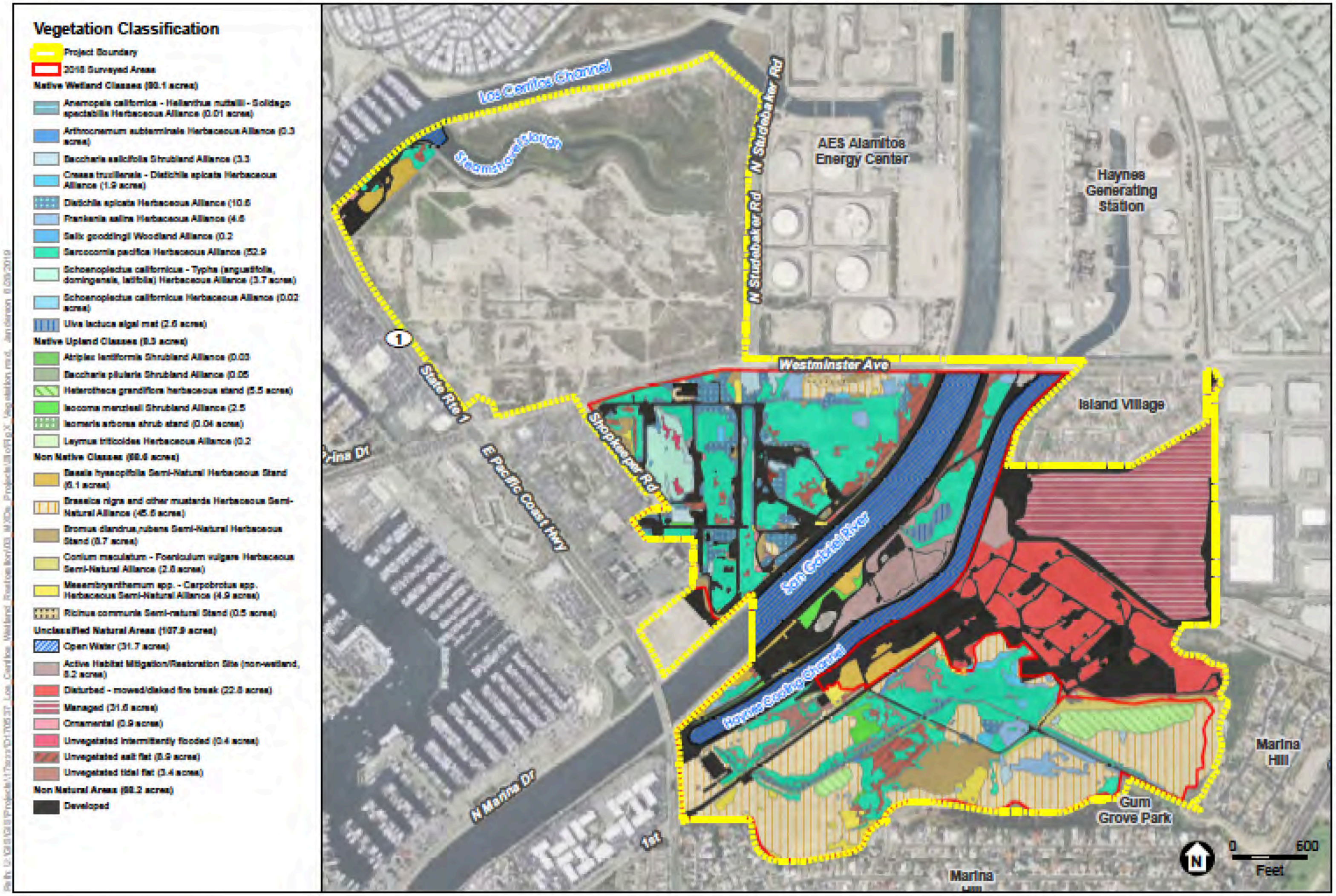
Habitat Mapping From the CRP

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-12

Coastal Restoration Consultants

Map Source: Tidal Influence



SOURCE: Mapbox, LCWA, CRC

Los Cerritos Wetlands Restoration Plan Program EIR

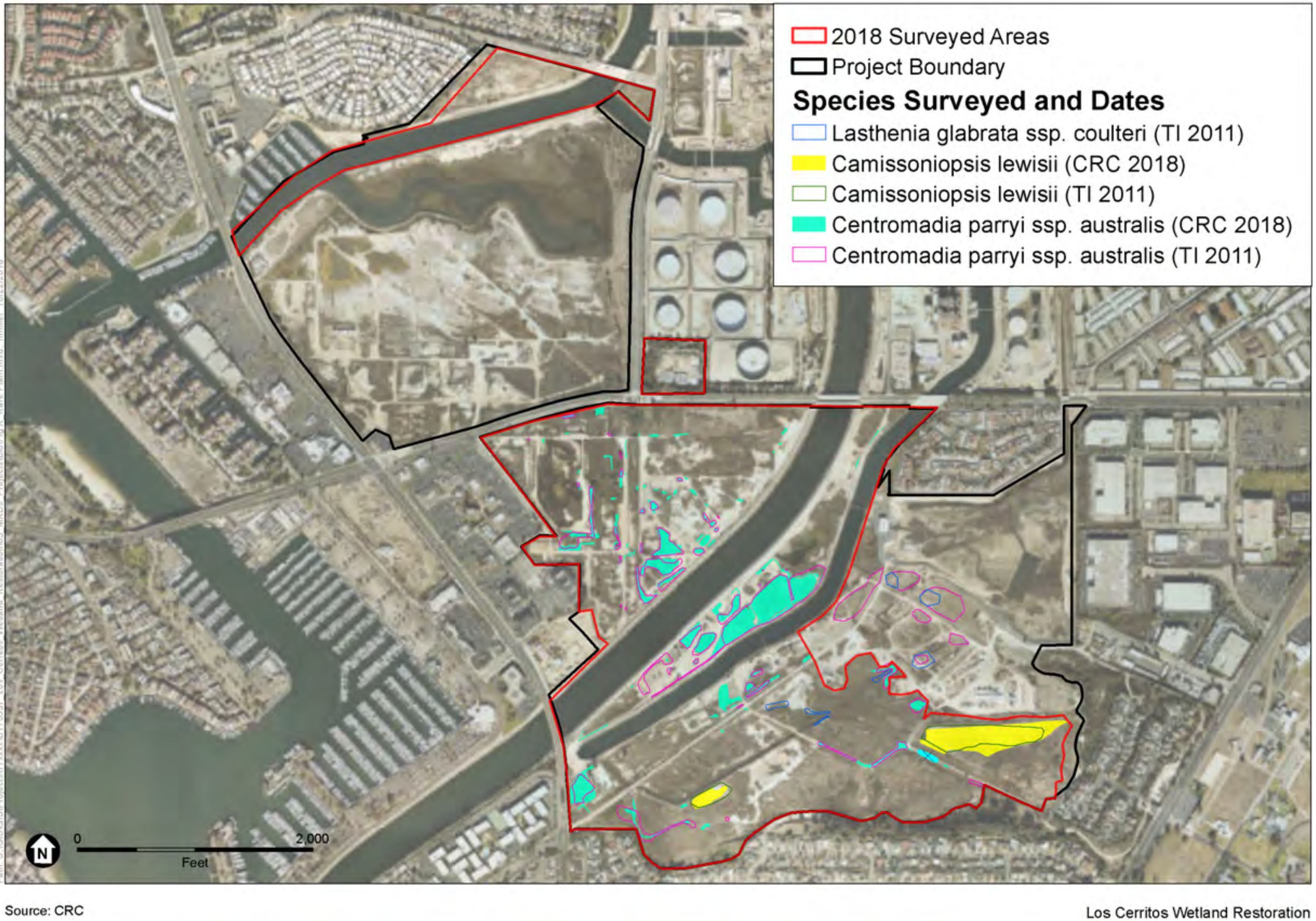
Vegetation Mapping From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-13

Coastal Restoration Consultants

Map Source: CRC



Rare Plant Mapping From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-14

Coastal Restoration Consultants

Map Source: CRC

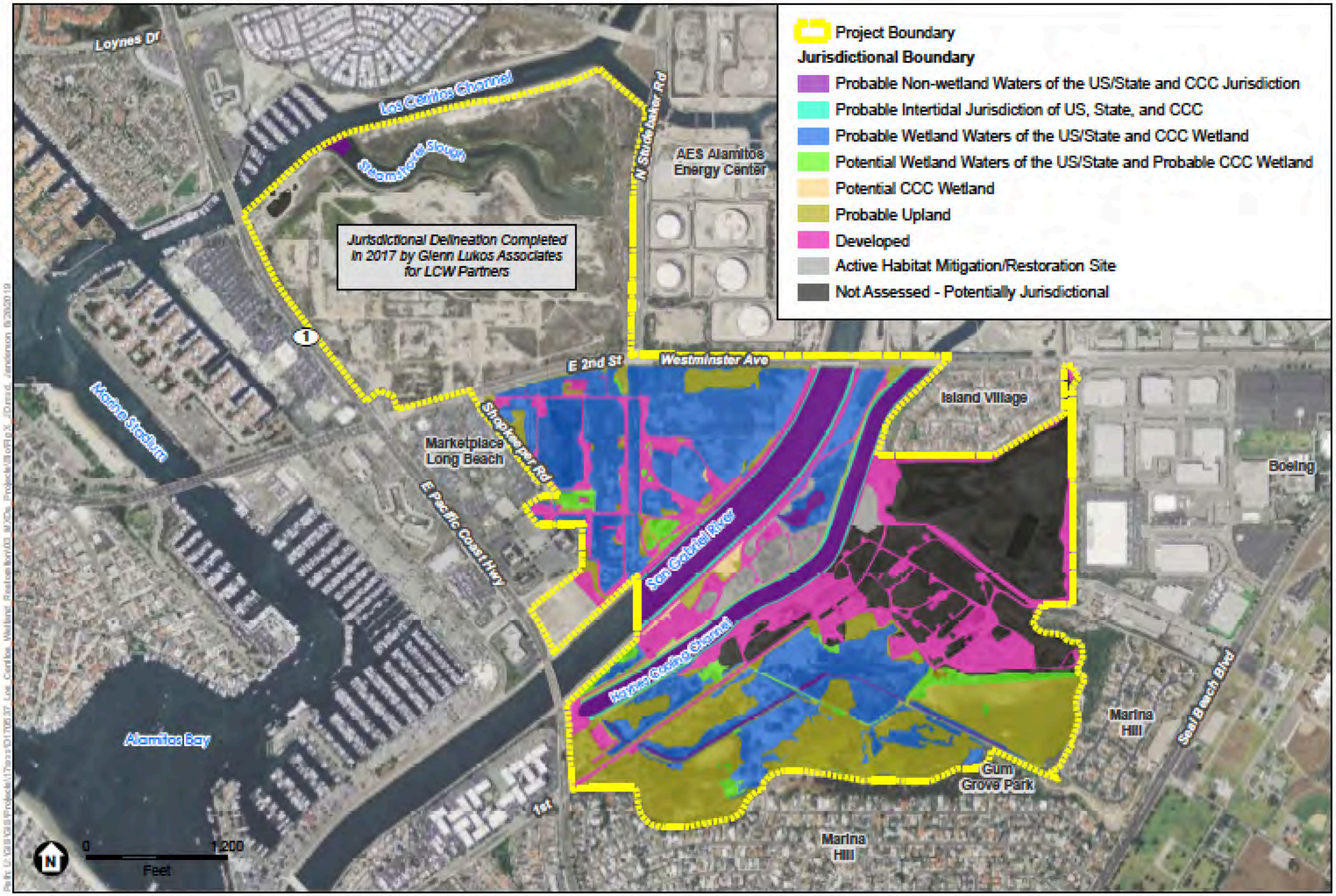
Contaminated Soils Mapping From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-15

Coastal Restoration Consultants

Map Source: Kinnetic Laboratories, Inc.



SOURCE: Mapbox, LCWA, CRC

Los Cerritos Wetlands Restoration Plan Program EIR

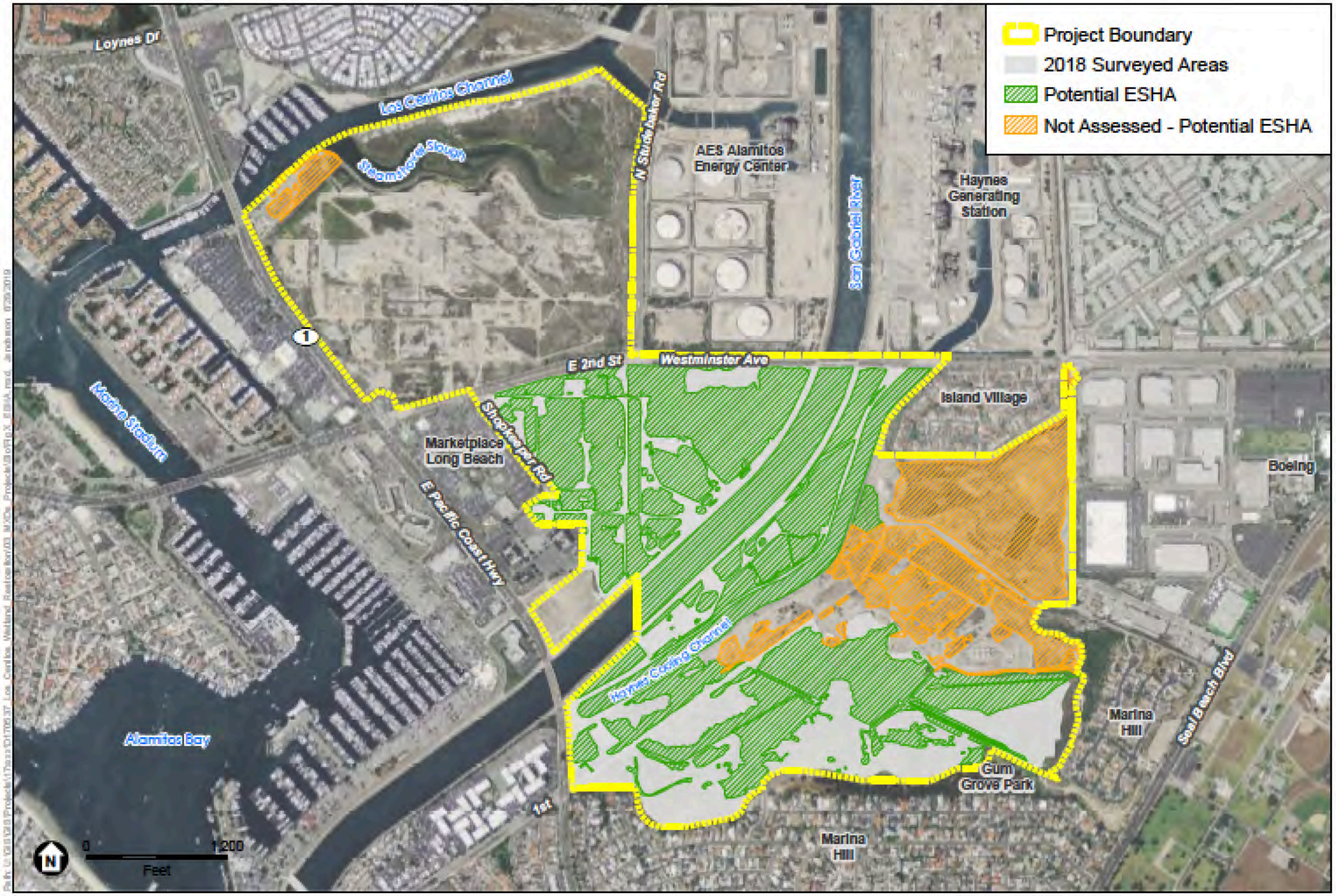
Potential Wetlands and Waters From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-16

Coastal Restoration Consultants

Map Source: CRC



Los Cerritos Wetlands Restoration Plan Program EIR

Potential ESHA From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 4-17

Coastal Restoration Consultants

Map Source: CRC

Table 4-1. Sea level rise projections from the California Ocean Protection Council

		Probabilistic Projections (in feet) (based on Kopp et al. 2014)					H++ scenario (Sweet et al. 2017) *Single scenario
		MEDIAN	LIKELY RANGE		1-IN-20 CHANCE	1-IN-200 CHANCE	
		50% probability sea-level rise meets or exceeds…	66% probability sea-level rise is between…		5% probability sea-level rise meets or exceeds…	0.5% probability sea-level rise meets or exceeds…	
				Low Risk Aversion		Medium - High Risk Aversion	Extreme Risk Aversion
High emissions	2030	0.3	0.2 -	0.5	0.6	0.7	1.0
	2040	0.5	0.4 -	0.7	0.9	1.2	1.7
	2050	0.7	0.5 -	1.0	1.2	1.8	2.6
Low emissions	2060	0.8	0.5 -	1.1	1.4	2.2	
High emissions	2060	1.0	0.7 -	1.3	1.7	2.5	3.7
Low emissions	2070	0.9	0.6 -	1.3	1.8	2.9	
High emissions	2070	1.2	0.8 -	1.7	2.2	3.3	5.0
Low emissions	2080	1.0	0.6 -	1.6	2.1	3.6	
High emissions	2080	1.5	1.0 -	2.2	2.8	4.3	6.4
Low emissions	2090	1.2	0.7 -	1.8	2.5	4.5	
High emissions	2090	1.8	1.2 -	2.7	3.4	5.3	8.0
Low emissions	2100	1.3	0.7 -	2.1	3.0	5.4	
High emissions	2100	2.2	1.3 -	3.2	4.1	6.7	9.9
Low emissions	2110*	1.4	0.9 -	2.2	3.1	6.0	
High emissions	2110*	2.3	1.6 -	3.3	4.3	7.1	11.5
Low emissions	2120	1.5	0.9 -	2.5	3.6	7.1	
High emissions	2120	2.7	1.8 -	3.8	5.0	8.3	13.8
Low emissions	2130	1.7	0.9 -	2.8	4.0	8.1	
High emissions	2130	3.0	2.0 -	4.3	5.7	9.7	16.1
Low emissions	2140	1.8	0.9 -	3.0	4.5	9.2	
High emissions	2140	3.3	2.2 -	4.9	6.5	11.1	18.7
Low emissions	2150	1.9	0.9 -	3.3	5.1	10.6	
High emissions	2150	3.7	2.4 -	5.4	7.3	12.7	21.5

SOURCE: OPC 2018

5 PREVIOUS RESTORATION DESIGNS

The first major step in the LCWA's restoration planning effort was the development of the Los Cerritos Wetlands Final Conceptual Restoration Plan (CRP; Moffatt & Nichol 2015). The refined restoration designs presented in this plan and in future planning should be consistent with the general approaches analyzed in the CRP for habitats and public access. In 2017, the LCWA began the next phase of restoration planning, which involved the preparation of the PEIR. The PEIR included restoration and public access designs developed primarily to support environmental review and hydrologic and hydraulic modeling. The refined designs presented in this plan will have less environmental impact than the PEIR designs.

5.1 Alternatives From the CRP

The CRP developed and analyzed a wide range of restoration designs for the entire LCW complex. These designs included habitat-based concepts that looked at different proportions of different habitat types, a range of tidal connections for each area, and varying levels of earthmoving. The CRP also included conceptual public access designs for each of the final four habitat-based designs.

5.1.1 CRP Restoration Designs

The CRP is a restoration alternatives analysis report that provided the LCWA with a roadmap for habitat restoration and improved public access for the Los Cerritos Wetlands Complex. Adopted by the LCWA Board of Directors in August 2015, the CRP includes substantial background information on the site, identifies goals and objectives, opportunities and constraints, and developed and analyzed a range of restoration designs and is supported by 8 technical reports that provide baseline information for numerous topics including hydrology and hydraulics, soils, watersheds, and habitat. The CRP design process included development of screening alternative designs developed around three themes: SLR resilience, habitat connectivity, and habitat diversity. With multiple rounds of input from the LCWA Steering Committee (made up of staff representing agencies of the LCWA joint powers authority), a Technical Advisory Committee (comprised of representatives of 20 resource and permitting agencies, and research groups covering federal, state, regional, and local jurisdictions), and the public (based on input during 6 community workshops), the screening alternatives were combined to create three conceptual restoration design alternatives with varying degrees of alterations to existing site conditions (minimum alteration, moderate alteration, and maximum alteration) (Figures 5-1, 5-2, and 5-3). The CRP analyzed these alternatives at current sea level and under a range of SLR scenarios. The CRP did not identify a preferred alternative; rather it identified the next step in the restoration design process as:

> *Further concept development of a hybrid alternative may occur at some point in the future to maximize benefits and minimize impacts of restoration. This work may*

> *include "mixing" and "matching" certain footprints of particular alternatives with those of different alternatives to create more alternatives that may provide more overall benefit than any of these individual concepts (pg. 7).*

5.1.2 CRP Public Access Designs

The CRP also considered a range of public access improvements for each restoration alternative. The access design for the minimal touch alternative included pedestrian bridges across the HCC and SGR and primarily access around the perimeter of South LCWA Site (Figure 5-4). The moderate touch alternative added more access through the restored wetlands (Figure 5-5). The maximum touch alternative had three access plans. The Perimeter Concept avoided access through restored wetlands (Figure 5-6). The Loop Concept and Urban Connectivity Concepts had more access through the wetland areas (Figures 5-7 and 5-8).

5.2 PEIR CEQA Design and Alternatives

In 2017, LCWA received funding to move to the next step in the restoration planning process: to complete environmental review of a program-level restoration design (*i.e.*, the PEIR). The restoration designs for the South LCWA Site and the Central Area in the PEIR were developed primarily to support further flood modeling and to show the proposed maximum impact designs so that the CEQA analyses will be applicable to refined designs, which are expected to be less impactful. The restoration designs in the PEIR therefore need to be refined using the principles of ecological restoration laid out in this plan.

5.2.1 PEIR Restoration Designs

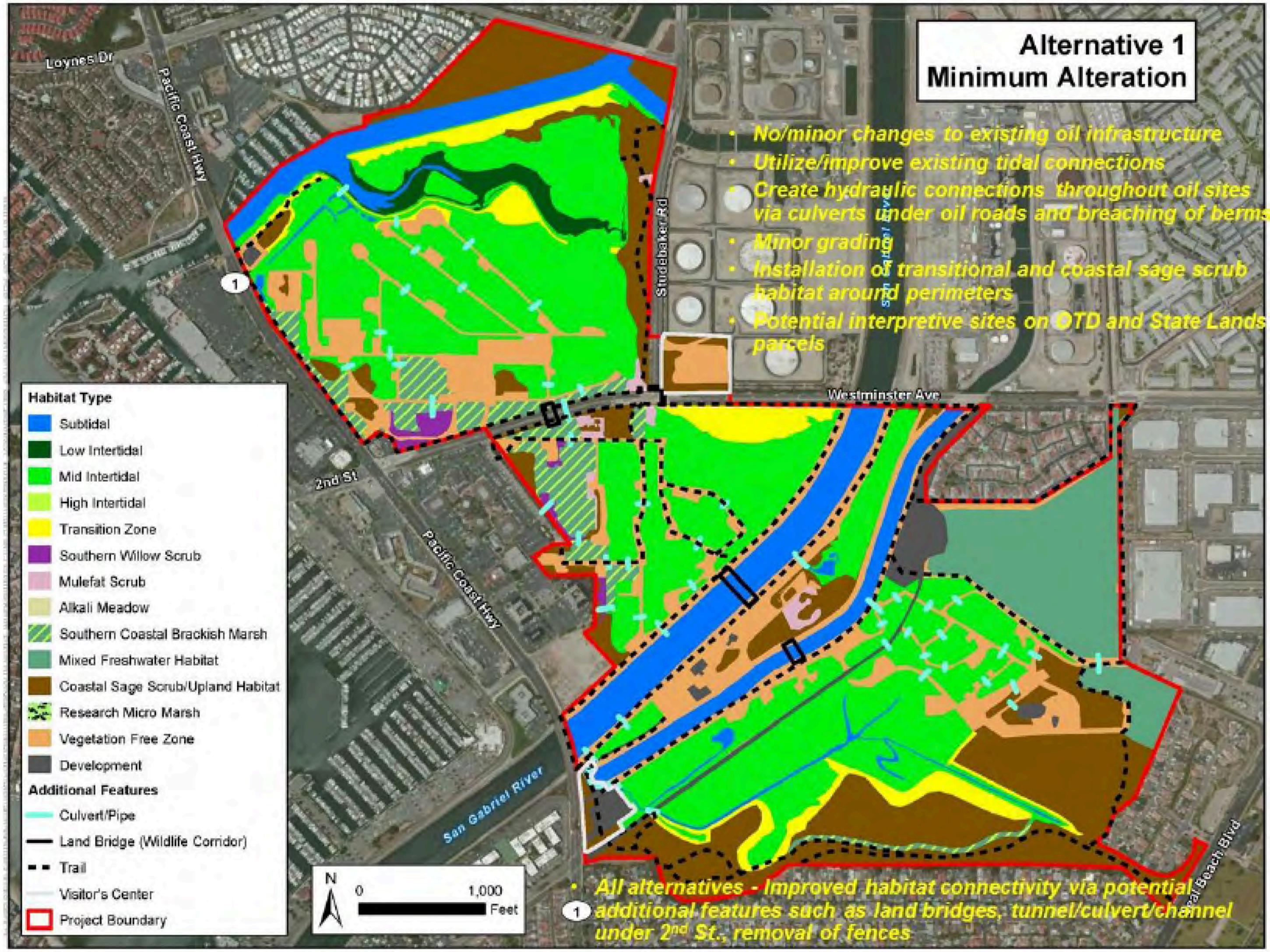
The analyses of the PEIR designs inform the types of flood control structures that will be needed in the South and Central LCWA sites and new design elements not included in any of the CRP alternatives. For the South LCWA Site, the PEIR design has a near-term project that avoids grading in most of the existing tidal areas and an upland area in the southwest part of the property (Figure 5-9). Other features include a relatively high proportion of high marsh compared to mid marsh and wide tidal channels with wide transition zones. The design does not explicitly include cordgrass marsh, unvegetated low intertidal habitats, or salt panne habitats, though the former two could occur along tidal channels and the latter could be an element of high marsh areas. A flood control berm/flood wall set at 10 feet NAVD protects the Hellman Retained site from potential flooding (Figure 5-9). The tidal connection is via the existing culvert to the SGR with the flap gate removed, which provides muted tides to the site. The mid-term plan includes removing the berm along the HCC and adding a channel connection to the HCC to bring a full range of tides to the site (Figure 5-10).

The PEIR near-term design for the Central Area includes removal of a large section of the SGR levee and construction of large interim and permanent levees along the Central LCWA Site property lines and around the remaining oil wells (Figure 5-11). Fully tidal salt marsh would be restored on the LCWA Central Site and would include mostly high and mid marsh habitats. The long-term design includes removal of the interim levee and construction of new levees around the perimeter of the City of Long Beach site (Figure 5-12). Restoration would include mostly mid and high marsh. Neither phase includes substantial areas of cordgrass marsh, unvegetated low intertidal, transition zone, or salt panne habitats.

The PEIR also included near, mid and long-term designs for the Isthmus Area (Figure 5-13). In general, these include some expansion of Zedler Marsh in the near-term, restoration of Callaway Marsh in the mid-term, and eventually more tidal restoration over time. Tidal connections are via existing culverts.

5.2.2 PEIR Public Access Designs

The PEIR includes public access designs for the three areas. In the South LCWA Site, most access is focused around the perimeter of the property and is a mix of open and restricted access trails (Figure 5-14). Public access would remain the same for the Isthmus Area and would be limited to existing limited-access trails (Figure 5-15). The access plan for the Central Area focuses on trails along the levees (Figure 5-12).



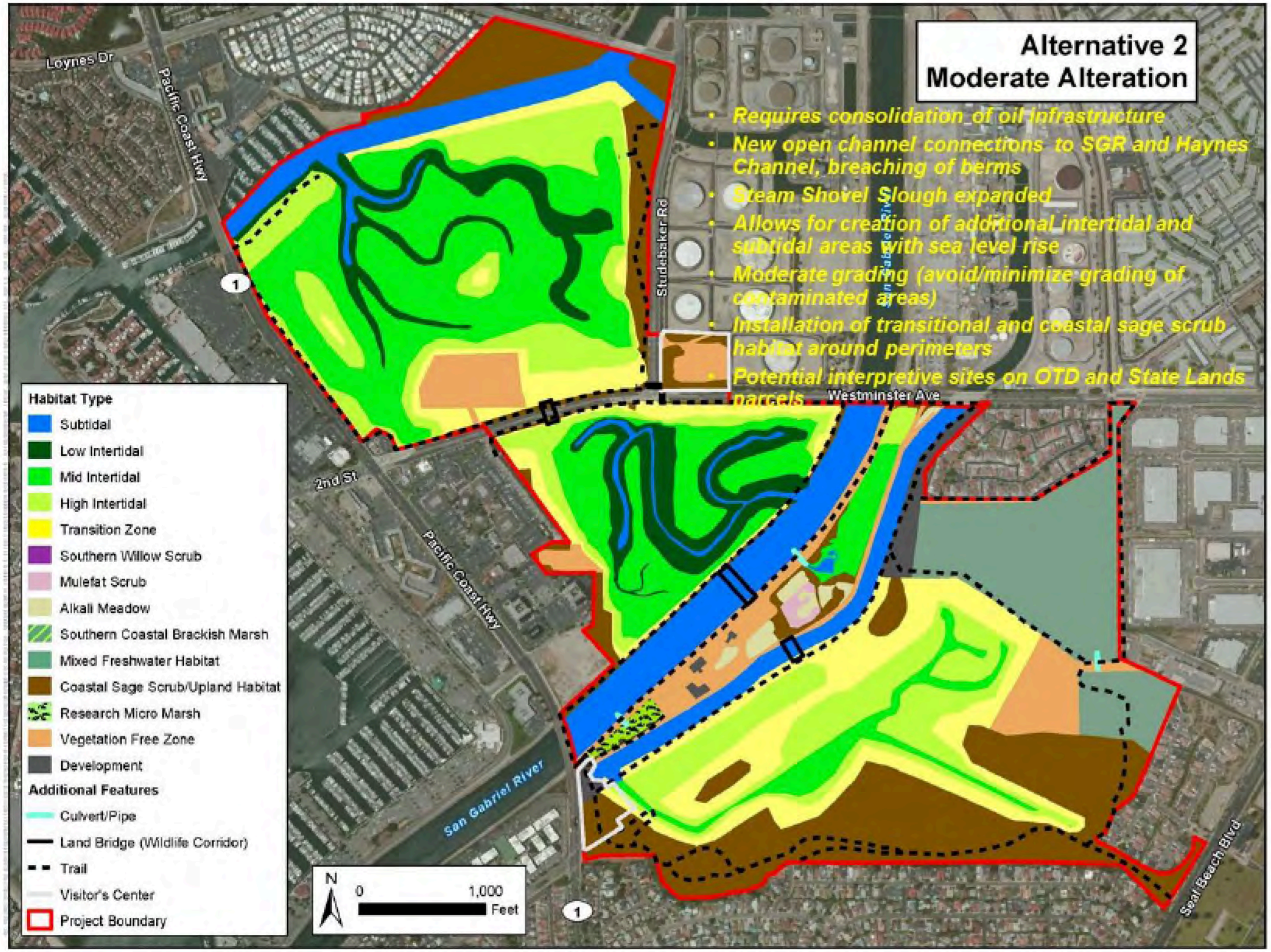
Minimum Touch Alternative From the CRP

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-1

Coastal Restoration Consultants

Map Source: Moffatt & Nichol, CRC



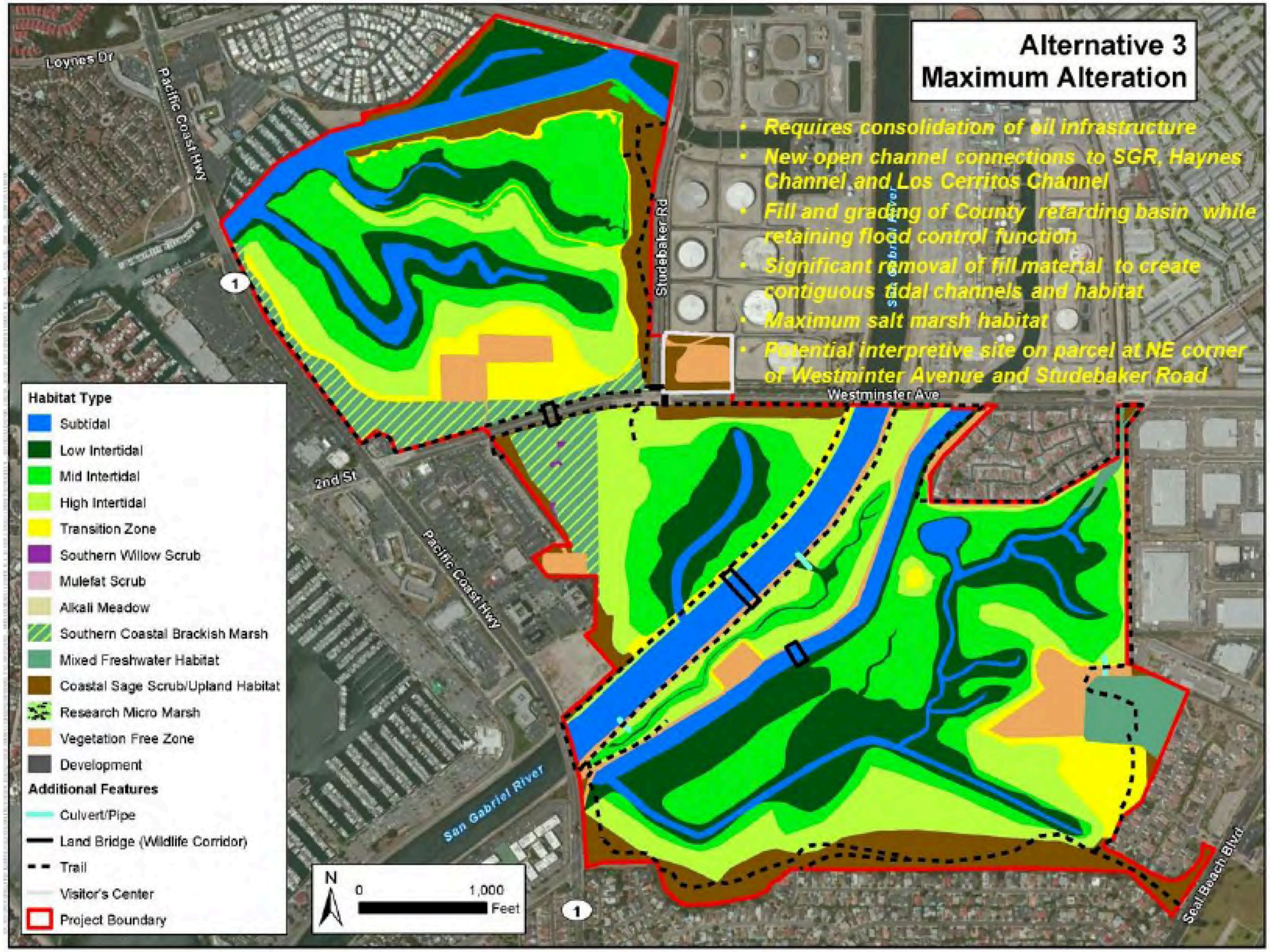
Moderate Touch Alternative From the CRP

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-2

Coastal Restoration Consultants

Map Source: Moffatt & Nichol, CRC



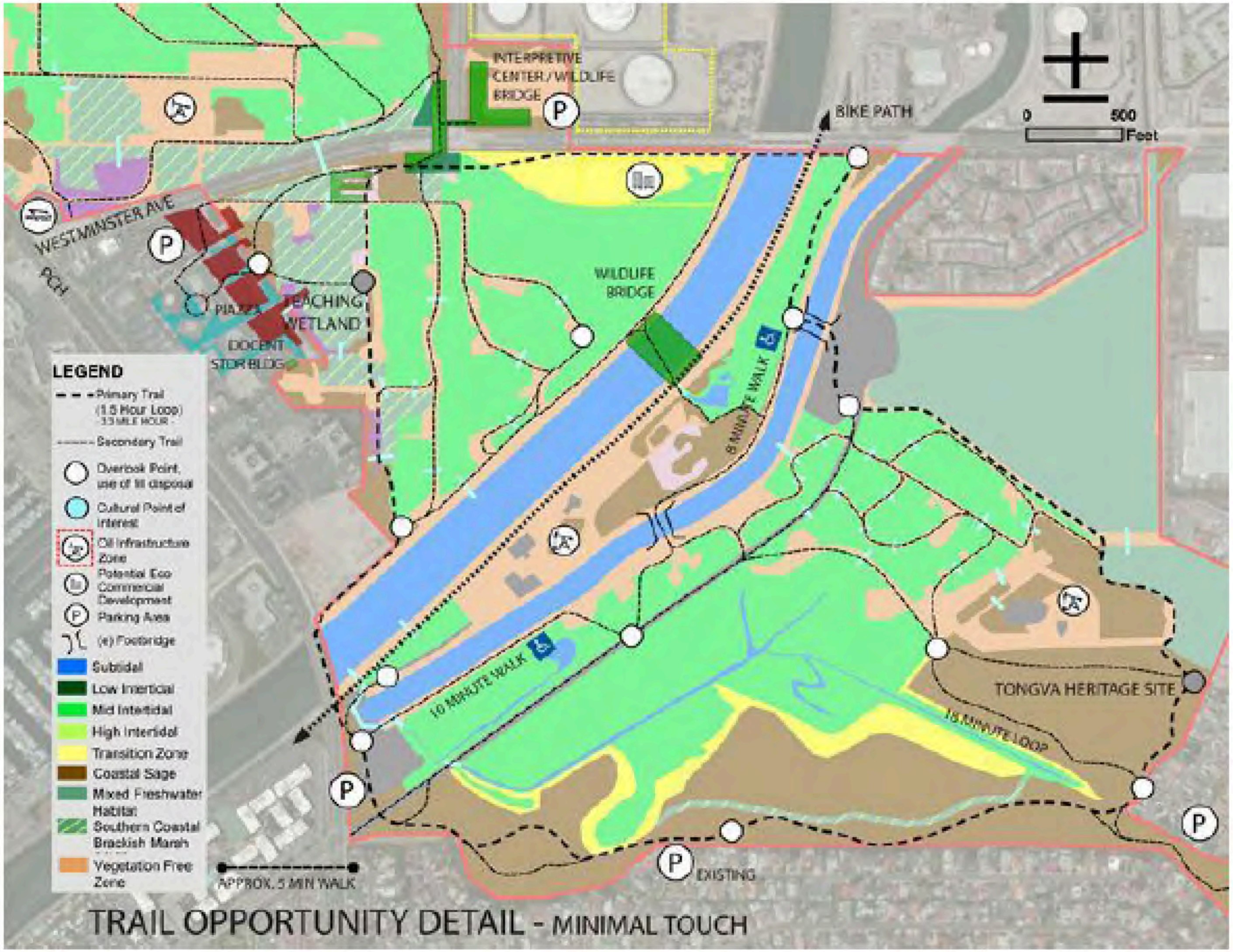
Maximum Touch Alternative From the CRP

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-3

Coastal Restoration Consultants

Map Source: Moffatt & Nichol, CRC



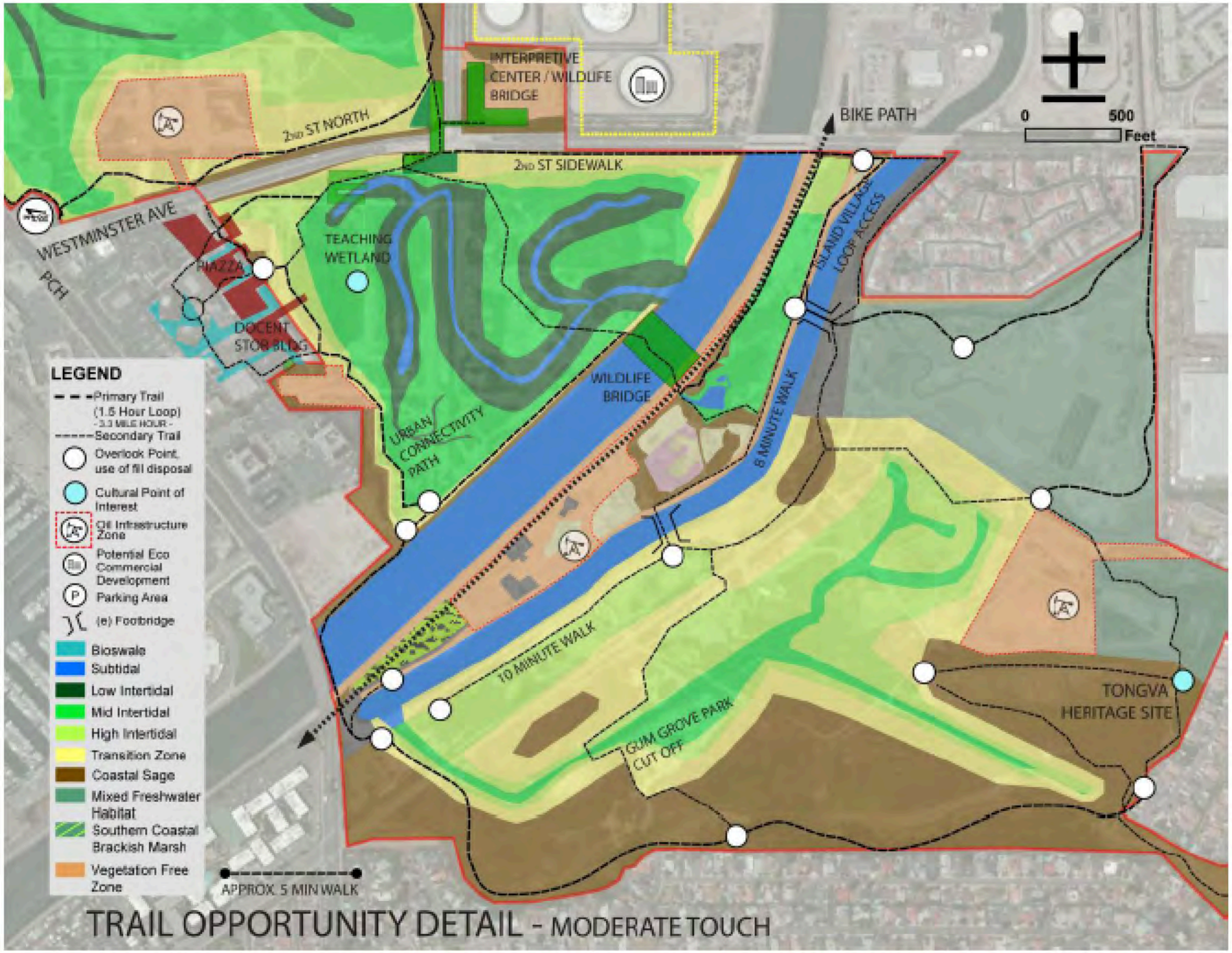
Public Access Minimum Touch From the CRP

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-4

Coastal Restoration Consultants

Map Source: New West Lands



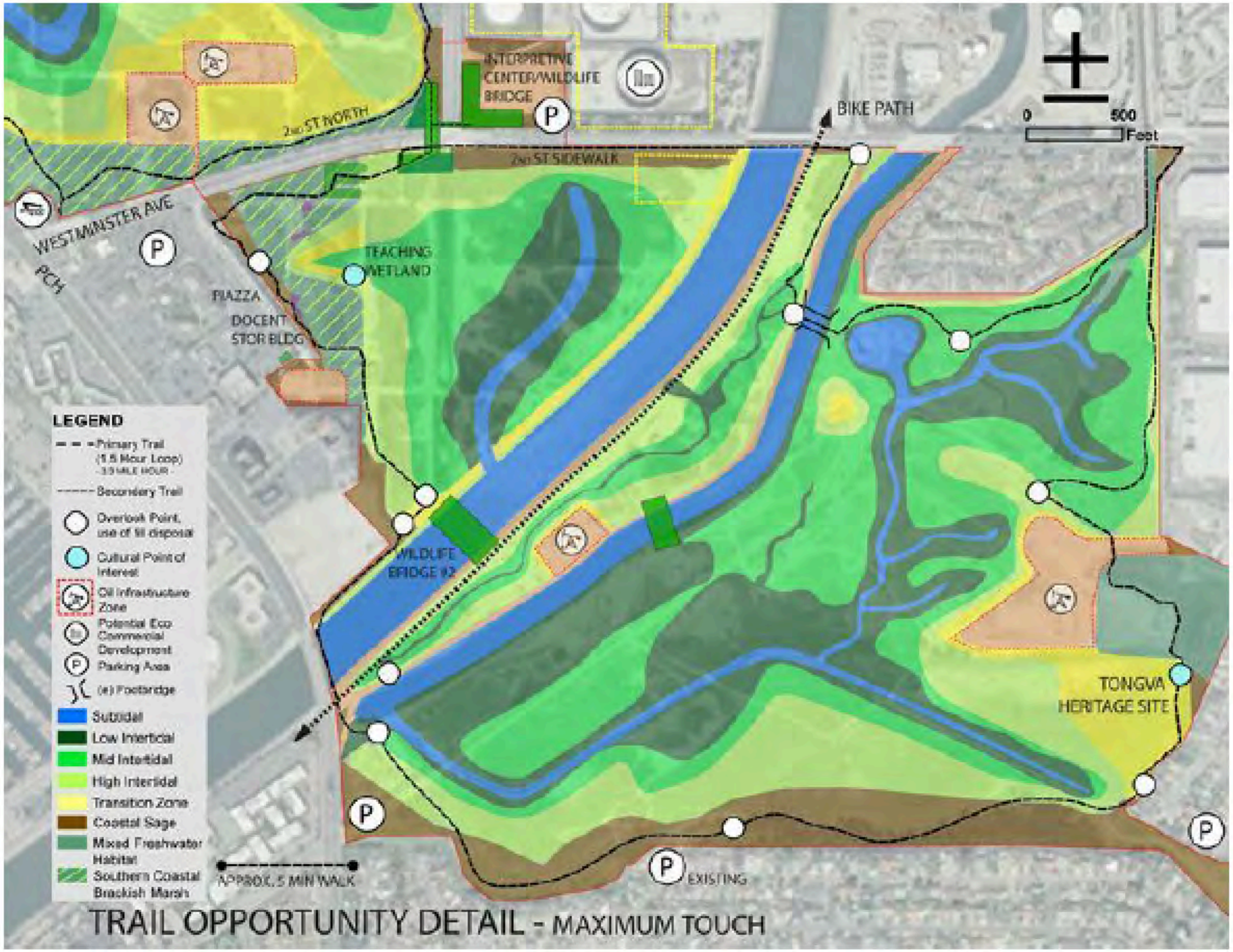
Public Access Moderate Touch From the CRP

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-5

Coastal Restoration Consultants

Map Source: New West Lands



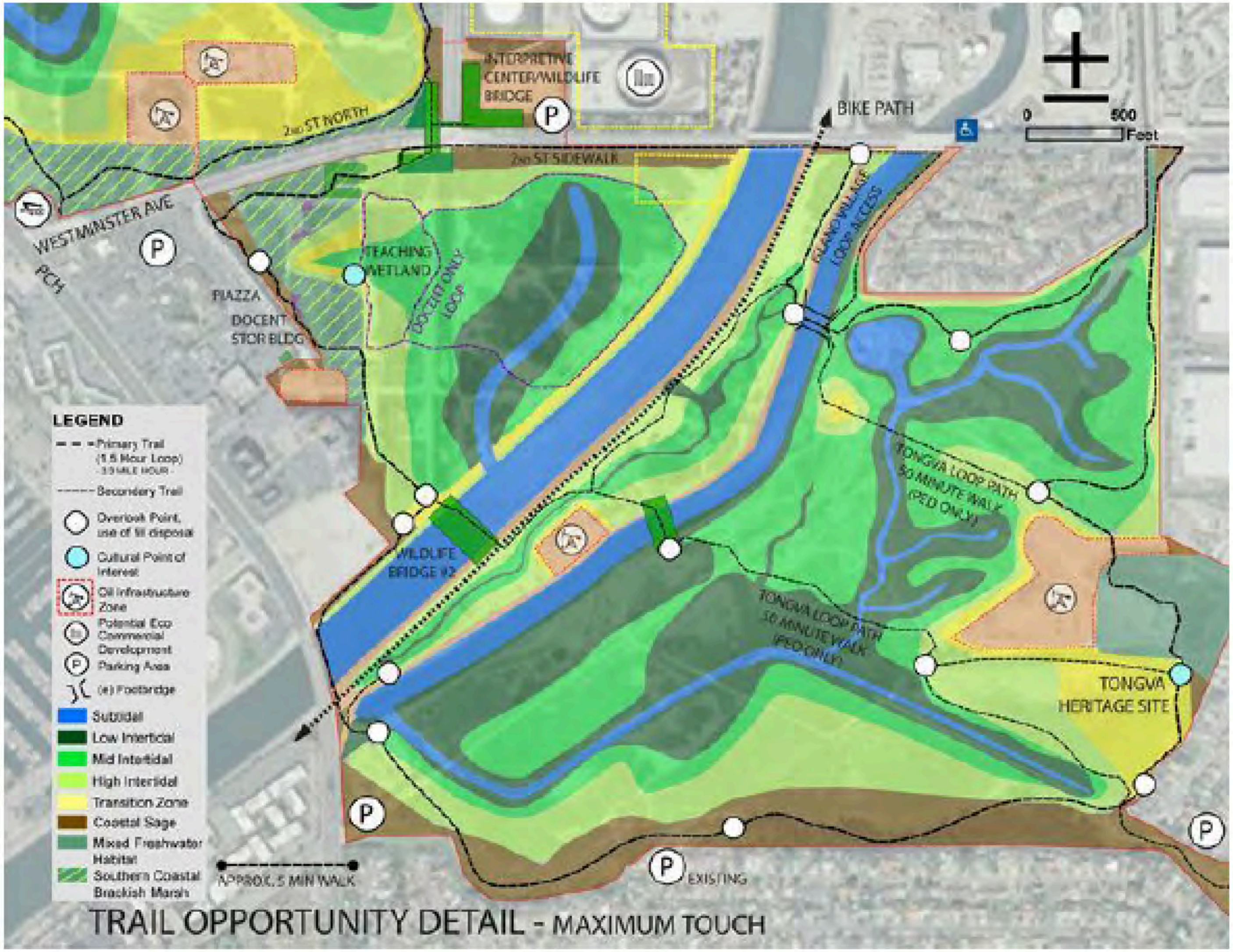
Public Access Maximum Touch Perimeter Concept From CRP

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-6

Coastal Restoration Consultants

Map Source: New West Lands



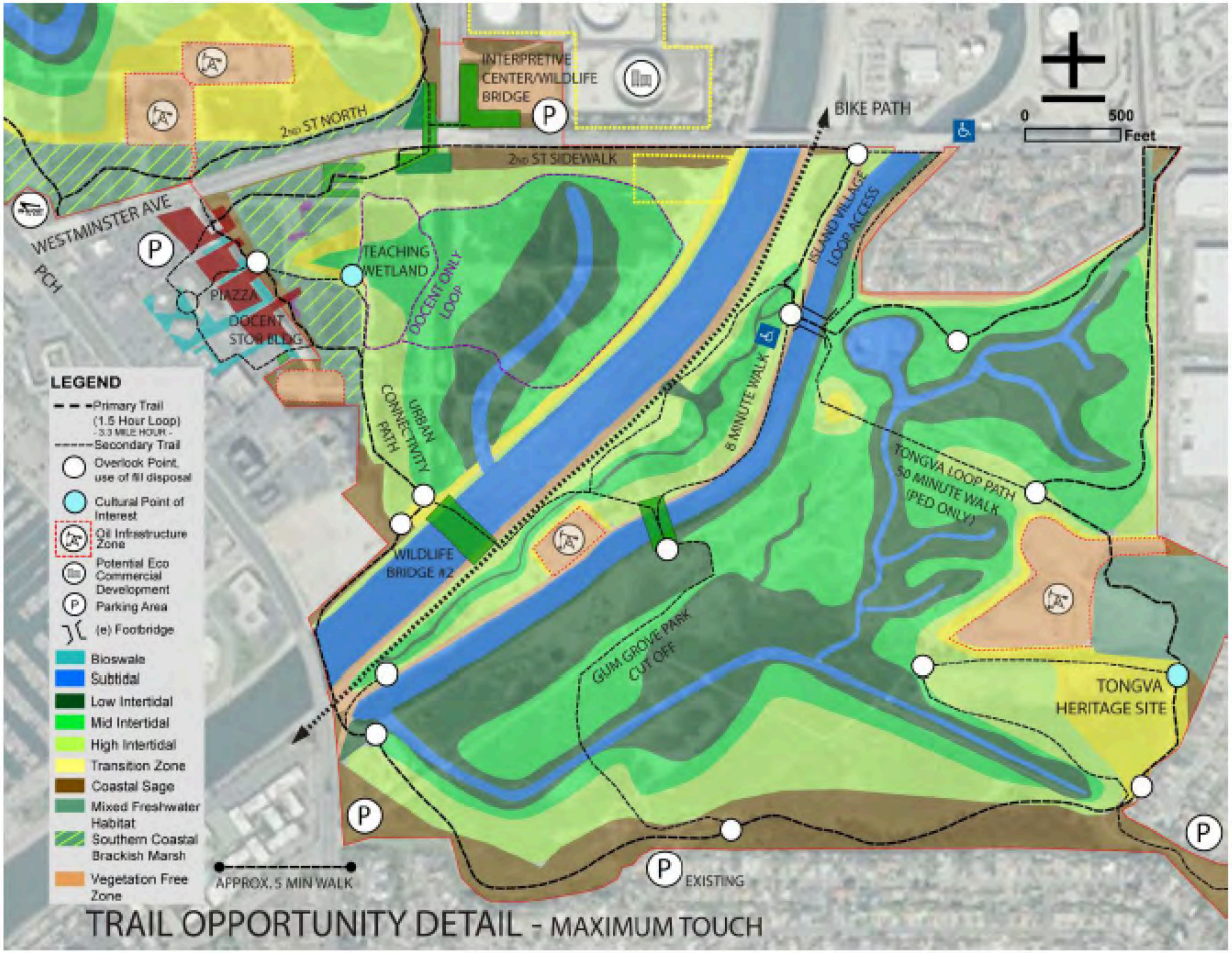
Public Access Maximum Touch Loop Concept From CRP

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-7

Coastal Restoration Consultants

Map Source: New West Lands



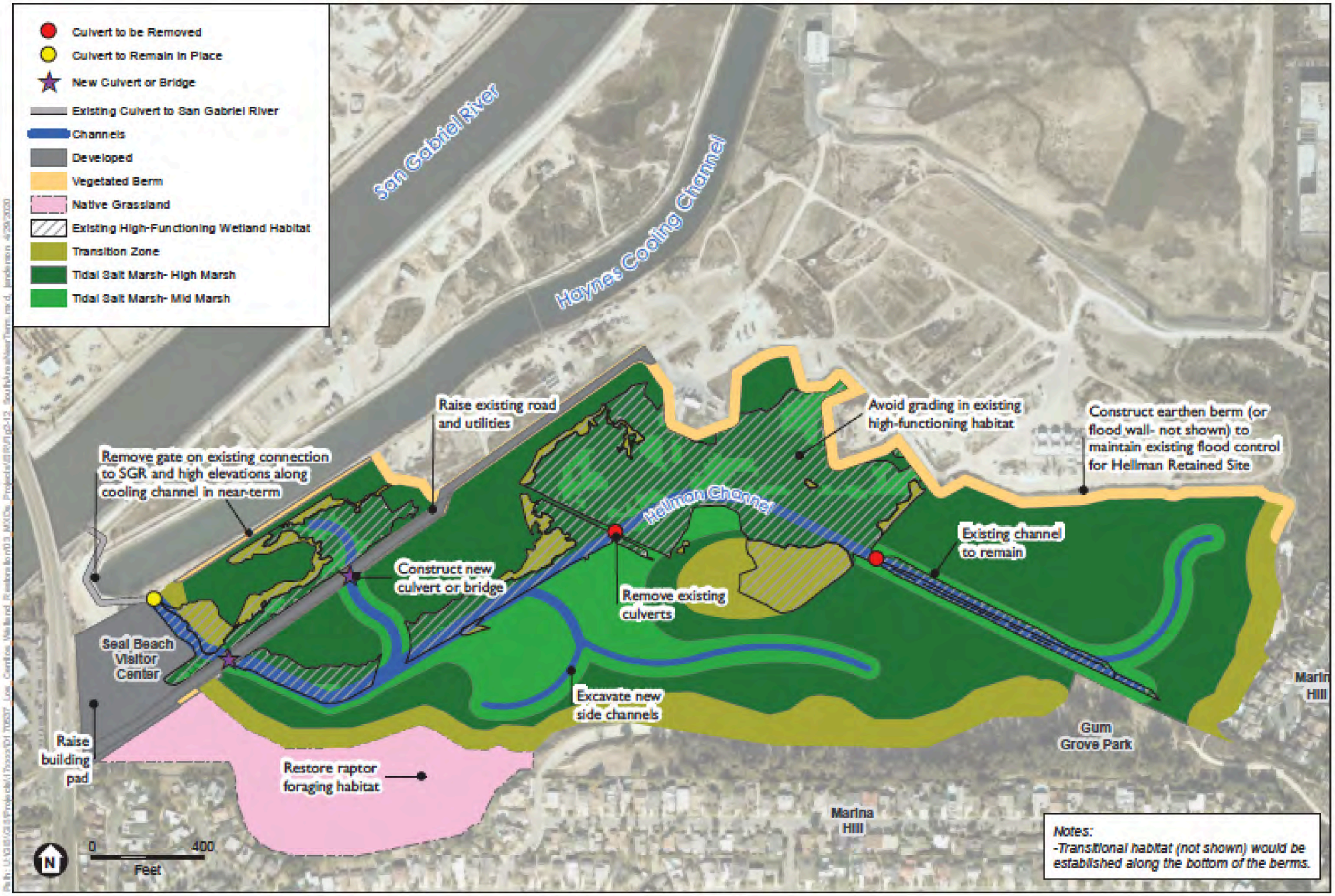
Public Access Maximum Touch Connectivity Concept From CRP

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-8

Coastal Restoration Consultants

Map Source: New West Lands



SOURCE: ESRI,LCWA

Los Cerritos Wetlands Restoration Plan Draft Program EIR

Near-term LCWA South Site Design From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-9

Coastal Restoration Consultants

Map Source: ESA

SOURCE: ESRI,LCWA

Los Cerritos Wetlands Restoration Plan Draft Program EIR

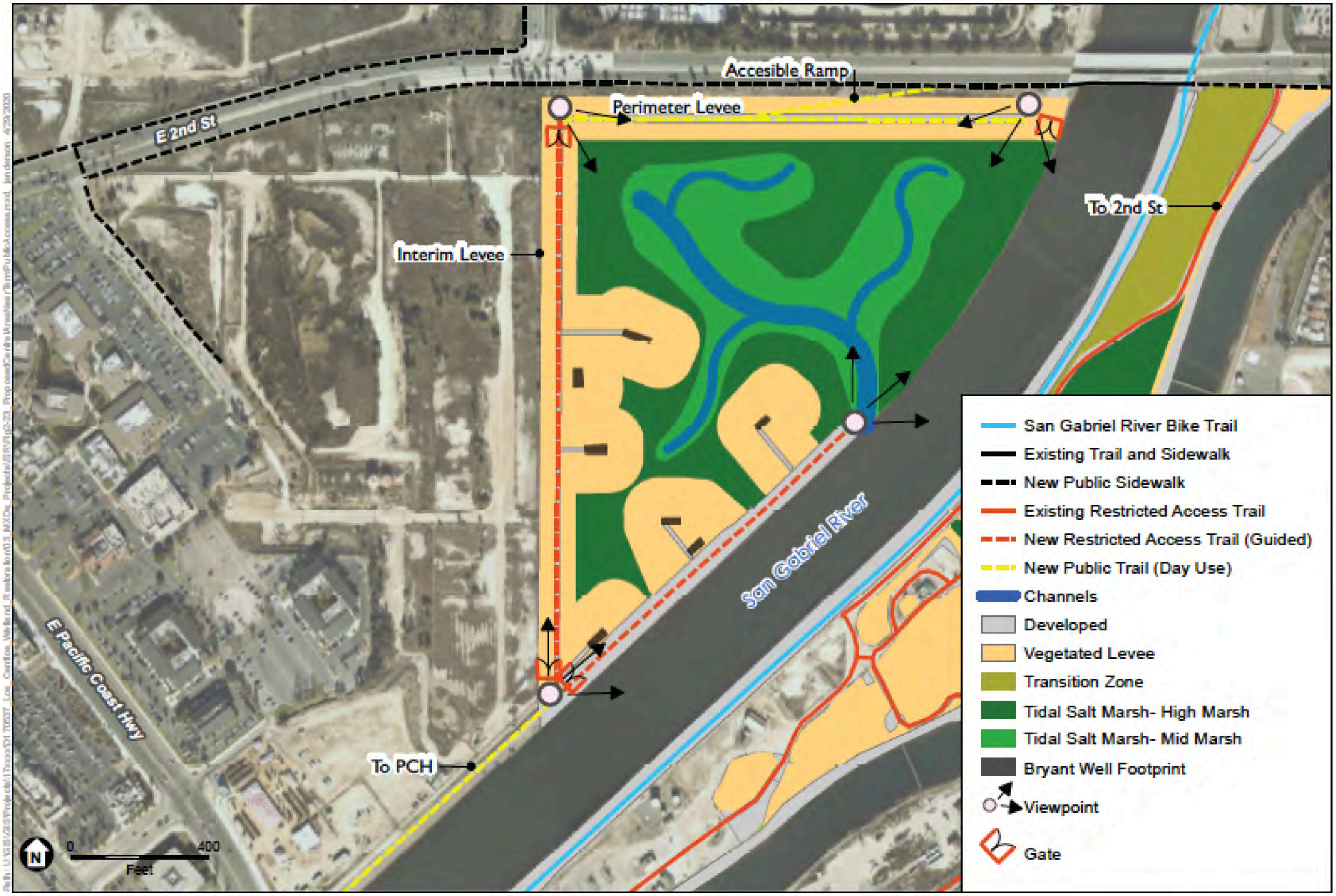
Mid-term LCWA South Site Design From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-10

Coastal Restoration Consultants

Map Source: ESA



SOURCE: NOAA, ESA, LCWA

Los Cerritos Wetlands Restoration Plan Draft Program EIR

Mid-term LCWA Central Site Design From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-11

Coastal Restoration Consultants

Map Source: ESA

SOURCE: NOAA, ESA, LCWA

Los Cerritos Wetlands Restoration Plan Draft Program EIR

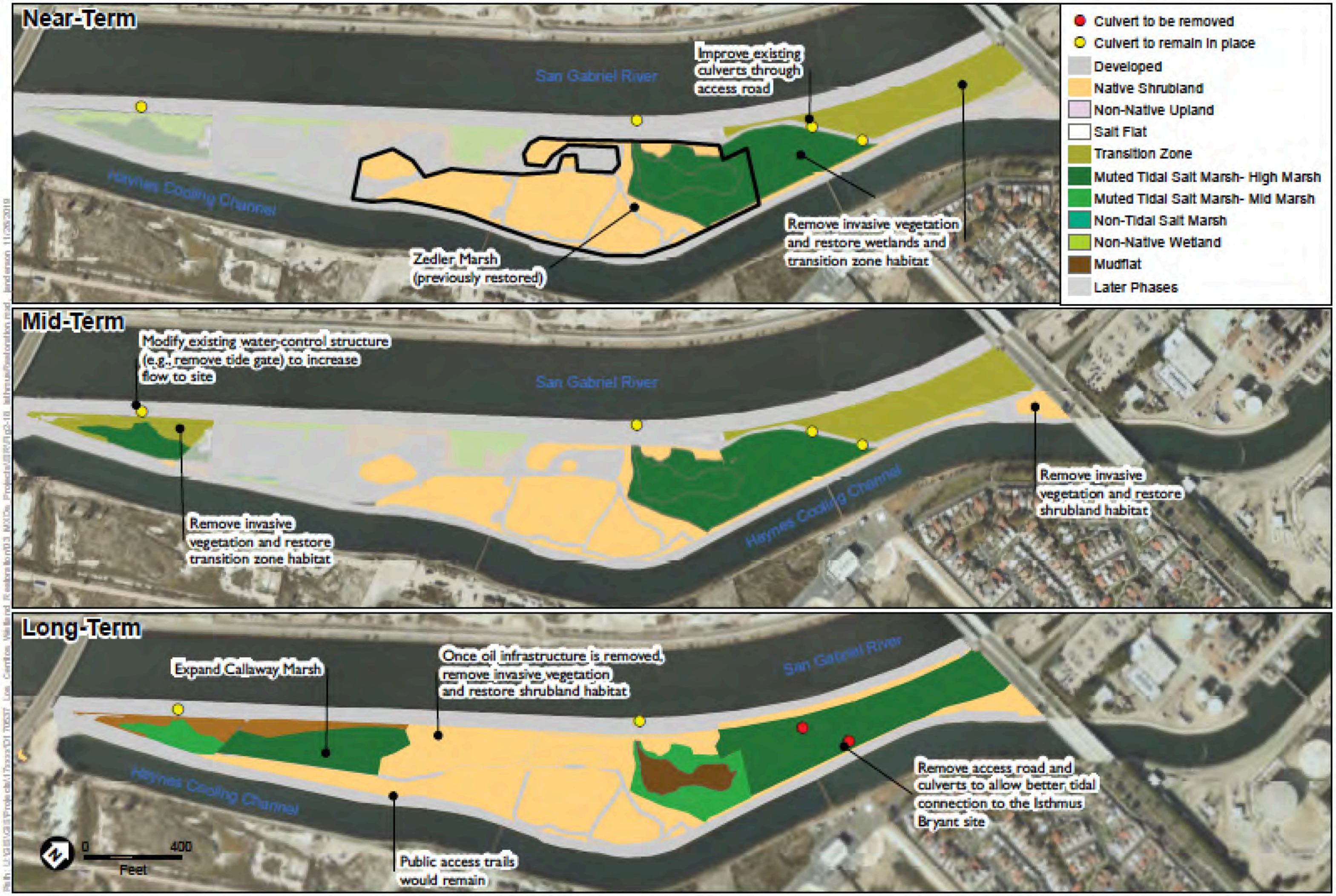
Long-term LCWA Central Site Design From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-12

Coastal Restoration Consultants

Map Source: ESA



SOURCE: Mapbox, LCWA, NOAA, ESA

Los Cerritos Wetlands Restoration Plan Draft Program EIR

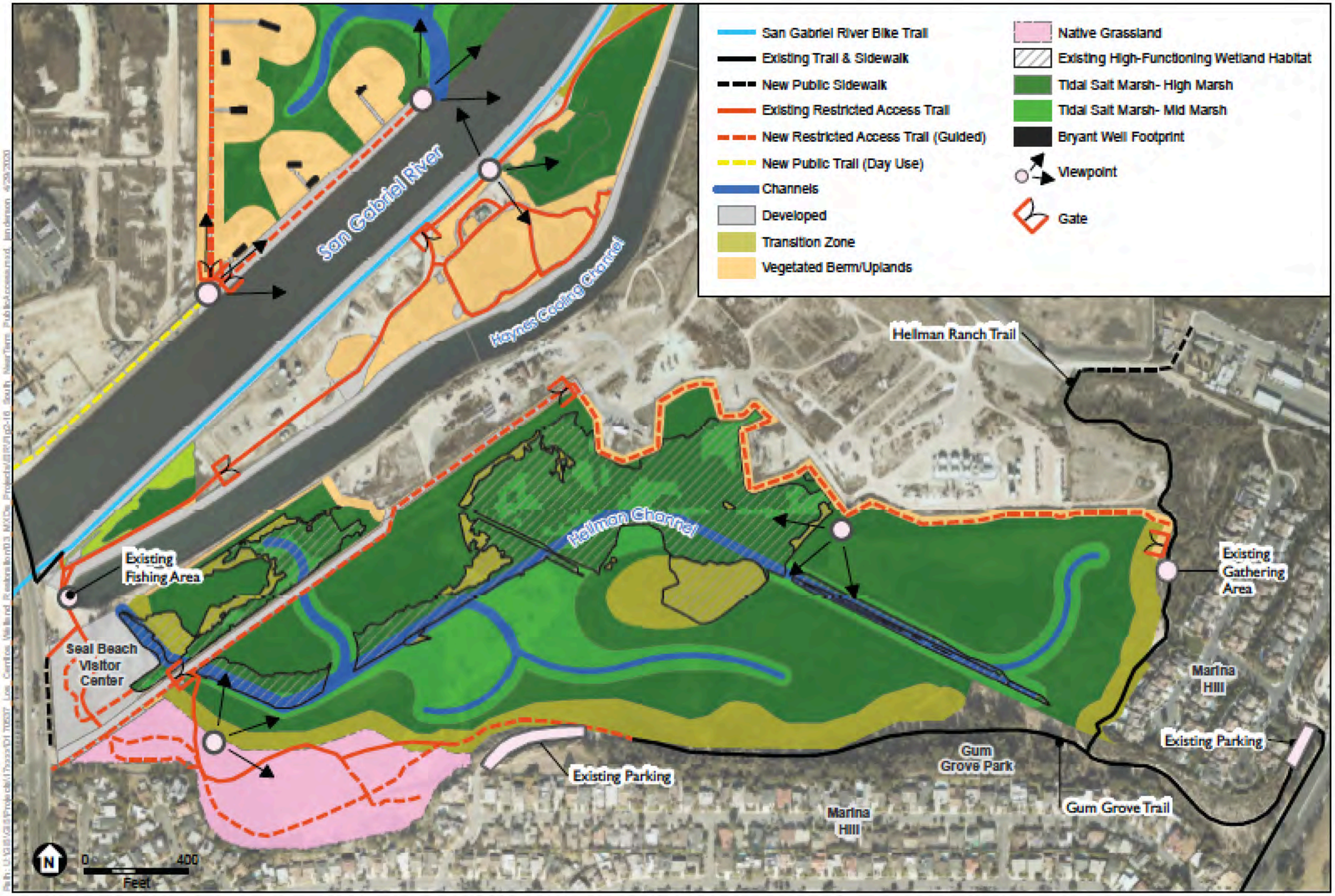
LCWA Isthmus Site Designs From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-13

Coastal Restoration Consultants

Map Source: ESA



SOURCE: ESRI,LCWA, ESA

Los Cerritos Wetlands Restoration Plan Draft Program EIR

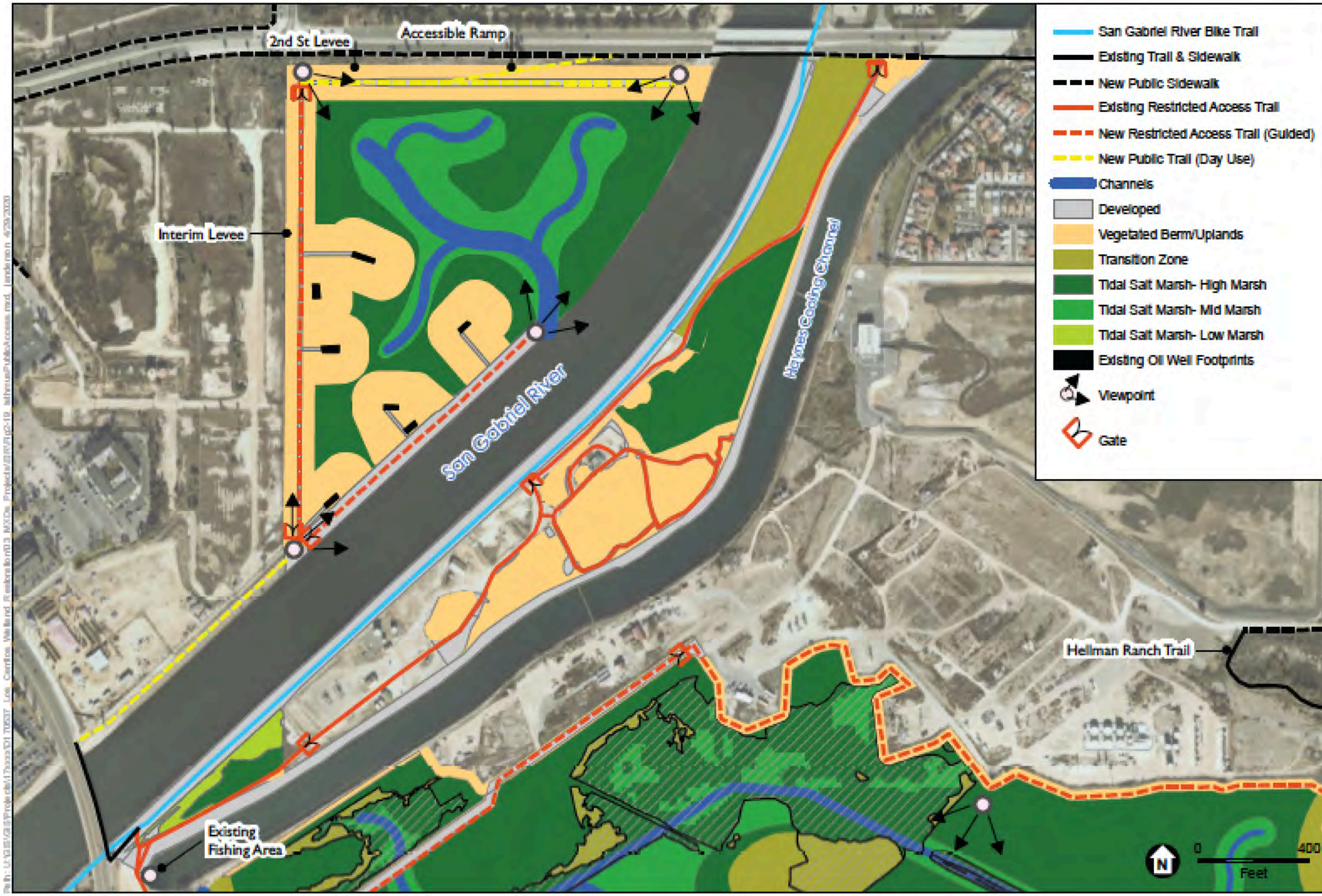
LCWA South Site Access Plan From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-14

Coastal Restoration Consultants

Map Source: ESA



SOURCE: NOAA, ESA, LCWA

Los Cerritos Wetlands Restoration Plan Draft Program EIR

LCWA Isthmus Site Access Plan From the PEIR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 5-15

Coastal Restoration Consultants

Map Source: ESA

6 BASIS OF DESIGN FOR RESTORATION IN THE LCW

Given the large size of the Central Area and the South LCWA Site, there is a wide range of possible approaches for restoring native habitats. The previous four chapters of this plan provide a general basis for design. The project's overall Goals and Objectives and the site-specific Opportunities and Constraints help set limits to the potential actions. Principles of Ecological Restoration, site-specific studies, and current conditions further focus potential designs. As the CRP and PEIR showed, there is still a wide range of approaches to tidal restoration within this framework. This section of the plan outlines the basis of design that supported the development of the Refined Restoration Plan for the South LCWA Site. This principles laid out in this basis of design should also be used for other restoration projects within the LCW as planning for them progresses. The basis of design provides a model for achieving restoration success for different habitats in different areas.

The basis of design identifies how to restore the important ecosystem processes that are essential for establishing self-sustaining habitats. To do this, the target habitats must first be defined. In the case of salt marsh habitats, this is done primarily by plant species composition. Successfully establishing and maintaining the different habitats requires restoration of important ecosystem processes. The most important processes of the basis of design are those related to hydrology, landform, and SLR resilience.

Using this approach for restoration planning provides a clear rationale for success. It is important to acknowledge that at this stage of the planning process, there are still important data gaps. As these gaps in the basis for design are filled in the next stages of planning, the Refined Restoration Plan for the South LCWA Site should be refined.

6.1 Habitats to be Restored

Coastal salt marshes in southern California and northern Baja California have several distinct habitat types (or zones) that generally correspond to the frequency by which they are inundated by tides. Different plant communities and assemblages of animals characterize the different habitats. Vegetation is typically used to define these habitats, as different species are adapted to different ecophysiological conditions at the different elevations. Intertidal areas inundated more than about 50% of the time typically do not support vascular plants; these low intertidal unvegetated areas typically occur as broad flats (mud flats) or on slopes along tidal creeks. Pacific cordgrass (*Spartina foliosa*) is a rhizomatous grass that is capable of growing lower in the intertidal zone than other vascular plants and it can form monotypic stands; these areas are known as cordgrass marsh[4]. Above the cordgrass marsh are mid and high marsh zones that share many species, and distinct boundaries between the two habitats can be hard to distinguish. Parish's Glasswort (*Arthrocnemum subterminale*) is a reliable indicator of high marsh and is generally absent from mid marsh elevations. Shallow depressions in the mid marsh that pond tidal water after moderate high tides are known as mud pannes and depressions in the high marsh that pond after spring high tides are known as salt pannes. The transition zone is the highest area of the marsh and is flooded by tides only very rarely. This zone exhibits a dynamic mix of wetland and upland growing conditions. California Boxthorn (*Lycium californicum*) is a good indicator of transition zone habitat. Uplands are essentially never flooded by tides. Ecotones between these habitats are generally easier to identify on steeper slopes; on very flat slopes, plant species characteristic of different zones can co-occur over broad transitions. Table 6-1 lays out a more complete conceptual model for how the different habitats are defined for this plan for the South LCWA Site assuming fully tidal conditions (*i.e.*, a deep water connection to the HCC).

There are also opportunities to restore upland habitats within the LCW complex (Table 6-1). These could include native grassland or "Los Angeles Coastal Prairie"[5] habitats. While the site did not historically support these habitats, they are regionally very rare as are opportunities for their restoration. Native grasslands are difficult to restore successfully, primarily due to non-native annual grasses that out-compete native perennial grasses. Los Angeles Coastal Prairie is a poorly understood habitat (*e.g.,* soil requirements, hydrology, etc.) and examples of restoration are very limited. There are old herbarium specimens of *Camissoniopsis lewisii* collected from areas that supported this habitat historically[6], suggesting parts of the South LCWA Site that support this species now could support this habitat type. More study is needed, however. The bluffs around the site likely supported coastal sage scrub habitat historically so this habitat is an obvious choice for restoration on slopes or better-drained soils.

There is currently a 9.2-acre polygon in the South LCWA Site that is designated by the California Coastal Commission (CCC) as raptor foraging habitat. It is currently a mix of primarily non-native grasses, mustards, and iceplants. Restoring salt marsh, transition zone,

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[4] The term "low marsh" is often used for these elevations, but Zedler (2000) argues that "cordgrass marsh" is more appropriate because *S. foliosa* does grow with other mid marsh species at higher elevations and there is no clear distinction in plant assemblages other than where *S. foliosa* grows as a monoculture.

[5] This habitat type has been proposed as historically occurring behind coastal dunes from El Segundo to Palos Verdes and may have included vernal pools. Remnants of coastal prairie habitat may still occur near El Segundo. *See* https://www.urbanwildlands.org/prairie.html

[6] *See* Cal Flora: https://www.calflora.org/entry/observ.html?track=m#srch=t&cols=0,3,61,35,37,13,54,32,41&lpcli=t&taxon=Camissoniopsis+lewisii&chk=t&cch=t&inat=r&cc=LAX

and upland habitats in this area would provide high-quality raptor foraging habitat in this area.

Table 6-1. Characteristics of habitats with potential for restoration at the LCW[7]

Habitat	Annual Inundation Frequency	Elevation Range* (NAVD)	Landform	Soil Salinity	Example Plant Species	Example Animal Species
Sub-tidal	>99.99%	< -1.8 ft	Channels and embayments	Equal to sea water	- *Zostera marina* - Algae	•Fish •Green sea turtle •Invertebrates
Low Intertidal Unvegetated	50% - 99.99%	-1.8 to 2.9 ft	Along channels and on flats	Equal to sea water	- Algae	•Shorebirds •Fish •Invertebrates
Cordgrass Marsh	20% - 50%	2.9 to 4.3 ft	Along deep tidal channels and edges of embayments; on flats with tidal channels	Equal to sea water	- *Spartina foliosa*	•Light-footed Ridgway's rail Invertebrates •Fish
Mud Panne		4.8 to 5.4 ft	Shallow depressions on the marsh plain that pond tide water	Equal to sea water	- *Salicornia bigelovii* - *Batis maritima* - Algae	•Shorebirds •Fish •Invertebrates
Mid Marsh	4% - 20%	4.3 to 5.7 ft	Generally flat plains with tidal channels and abundant micro-topography	Equal to sea water to hypersaline	- *Salicornia pacifica* - *Jaumea carnosa* - *Spartina foliosa* - *Frankenia salina* - *Distichlis spicata* - *Batis maritima* - *Triglochin concinna* - *Limonium californicum*	•Belding's savannah sparrow •Shorebirds •Fish
High Marsh	0.05% - 4%	5.7 to 7.1 ft	Gradual to steep slopes; no tidal channels	Hypersaline with low-salinity gaps in the winter	- *Arthrocnemum subterminale* - *Distichlis littoralis* - *Salicornia pacifica* - *Frankenia salina* - *Suaeda esteroa* - *Chloropyron maritimum*	•Terrestrial mammals •Raptor foraging

[7] Alkali meadow habitat was historically widespread in the region (Stein et al. 2007). Some of the disturbed saline (*i.e.,* ocean-derived salts) habitats that pond rainwater at the LCW were mapped as alkali meadow in the CRP. Those areas are very different than the historic alkali meadows, which occurred where groundwater was close to the surface and evaporation led to the concentration of calcium salts (*i.e*., not ocean-derived salts) in the rooting zone, creating growing conditions that supported a unique suite of plants. Some of the salt-tolerant species characteristic of alkali meadows are found currently in the LCW (*e.g., Distichlis spicata*), but these areas have very different hydrologic drivers and different sources of salts than true alkali meadows. Current groundwater conditions in the LCW complex probably do not support restoration of true alkali meadow habitats.

Habitat	Annual Inundation Frequency	Elevation Range* (NAVD)	Landform	Soil Salinity	Example Plant Species	Example Animal Species
					ssp. *maritimum* - *Lasthenia glabrata* ssp. *coulteri*	
Salt Panne	0.05% - 2%	6.5 to 7.1 ft	Flats, very gently slopes, shallow depressions	Hypersaline with low-salinity gaps in winter	- *Lasthenia glabrata* ssp. *coulteri* - *Batis maritima*	•Invertebrates •Shorebirds
Transition Zone	0.05% - 0%**	7.1 to 8.0 ft	Gradual to steep slopes; no tidal channels	Low, rarely saline to hypersaline	- *Lycium californicum* - *Arthrocnemum californicum* - *Distichlis littoralis* - *Isocoma menziesii* - *Atriplex lentiformis* - *Suaeda calceoliformis* - *Suaeda taxifolia*	•Terrestrial mammals •Raptor foraging •Songbirds
Upland – Coastal Sage Scrub	0%	> 8.0 ft	Flat to steep slopes	Very low	- *Eriogonum* spp. - *Isocoma menziesii* - *Atriplex* spp.	•Terrestrial mammals •Raptor foraging •Songbirds
Upland - Grassland	0%	> 8.0 ft	Flat to gradual slopes	Very low	- *Stipa pulchra*	•Terrestrial mammals •Raptor foraging •Songbirds
Upland – Coastal Prairie and Vernal Pool	0%	> 8.0 ft	Flat with shallow depressions	Very low	- *Lupinus bicolor* - *Camissoniopsis lewisii* - *Cryptantha* spp. - *Festuca megalura* - *Phalaris lemmonii* - *Psilocarphus brevissimus*	•Terrestrial mammals •Raptor foraging •Songbirds

*= Assuming full tidal conditions (no muting).
** = Transition zone includes elevations that might be flooded up to once a decade plus about one foot, which can be affected by the capillary fringe during the highest tides.

6.2 Hydrology and Hydraulics

Tidal hydrology is the primary driver of salt marsh functioning. Important aspects to consider include the tide range, tidal muting, and inlet/mouth dynamics. These factors all determine what the inundation frequency will be at different elevations and different locations within a marsh. The CRP and PEIR include modeling of post-restoration hydrologic conditions for a range of restoration designs. This modeling shows that while all of the sources of tide waters for restoration in the South, Isthmus, and Central Areas are fully tidal (i.e., essentially equal to the nearshore ocean), the type, size, and elevation of tidal connections to these sources effect how tides are expressed within the restored marshes. Further, the particular design of channels, the relative amounts of lower versus higher marsh, and other design considerations can affect tidal flows in a restored marsh. Therefore, the analyses done in the previous studies do not perfectly inform the design of the Refined Restoration Plan for the South LCWA Site. The modeling done in the PEIR provides an initial basis for how to restore tidal marshes that optimize wetland functioning while analyzing other factors such as flood control, permitting, construction and maintenance costs, and different effects of SLR. In the next phase of planning, the modeling will need to be updated to assure the project functions as designed.

Existing tidal connections at LCW are extremely restricted. The South LCWA Site is connected to the SGR by a single 48-inch diameter culvert with a leaky flap gate that allows about four feet of tidal range in the tidal channel and less further back in the existing marsh (ESA 2020b). The Isthmus has culverts connecting to the SGR at Zedler and Callaway Marshes. The Zedler Marsh culvert allows about 4 feet of tide range, matching high tide in the SGR, but with restricted drainage due to the culvert invert. The Callaway Marsh culvert has a leaky tide gate that restricts the tide range to about 2 feet (ESA 2020b). The Central LCWA Site has a 24-inch culvert to the SGR with an invert elevation of 5.2 feet NAVD that currently allows only the highest tides into a very small area. Improving these tidal connections is key to restoration. This section uses the modeling results from the CRP and PEIR to determine a preferred approach to improving tidal exchange in each area. In general, the restored marshes can be “fully tidal” if they are connected to the SGR or HCC[8] with deep channels or large culverts, or they can be “muted tidal” if the connections are made with smaller or perched channels or culverts. In addition to tidal hydrology, freshwater inputs (e.g., fluvial sources or point sources) have important implications for habitats and flooding risks and need to be considered as well. Finally, the effect of SLR on tidal dynamics should be considered to help understand how habitats might change in the future.

6.2.1 Full Tidal Marsh

Fully tidal marshes have tides with more or less the same amplitude as those of the ocean. In southern California, that can be over nine feet during spring tides. Restoring fully tidal conditions in the South LCWA Site will require a large, deep connection to the HCC. There is currently no firm agreement in place with the owner of the channel, the Los Angeles Department of Water and Power (LADWP), to connect the South LCWA Site to this source of tidewaters. The CRP, PEIR, and this plan all assume that a tidal connection to the HCC will be feasible, but not until once-through cooling of the power plants ends by or before 2029.

[8] Modeling in the PEIR shows very minor tidal muting in the HCC with SLR as the increased water levels increase the tidal prism moving through the culvert connection to Alamitos Bay. Current plans by LADWP to fill part of the HCC would decrease the tidal prism. Different restoration designs than those analyzed in the PEIR would likely have different tidal prisms (they could be more or less). Modeling of tide ranges in the HCC with SLR will need to be updated in the future to incorporate these other factors.

There may be some potential for connecting to the HCC sooner, but there are concerns about restoring a marsh where entrainment of plankton, propagules, fish, etc. by the power plant intakes is ongoing. This could be a substantial detriment to restoration success, at least in the near-term.

Alternative 3 in the CRP (Figure 6-1) modeled a channel connection to the HCC with a thalweg elevation of about -3.6 feet NAVD and a width of over 150 feet. The PEIR modeled a channel connection to the HCC in the mid-term with a thalweg elevation of about 0 feet NAVD and a width of 30 feet. Both analyses showed a more-or-less full tide range. With appropriately sized channels to convey tidewaters, the far eastern part of the South LCWA Site would have only minor muting (as is common in natural marshes in areas far from tidal connections). In the nearer-term, a tidal connection via the existing culvert to the SGR could provide muted tides to the South LCWA Site (see below).

Ongoing industrial operations in the Isthmus Area limit the tidal connections to existing culverts to the SGR. These culverts are not capable of delivering full tide drainage, limiting the low tide ranges in the marshes. However, the tide gate on the Callaway Marsh culver could be removed, in coordination with construction of a berm around the marsh to allow for higher water levels in the site without flooding the nearby industrial operations. In the future, once the industrial operations cease or in coordination with the construction of additional flood control, it may be plausible to connect marshes in the Isthmus Area to the HCC, which could provide fully tidal conditions.

The Central LCWA Site could be fully tidal with a connection to the SGR via either a deep channel or a set of large culverts (e.g., nine 6-foot culverts). This connection would need to be made through the existing USACOE certified levee, which provides 100-year flood protection for the industrial areas, roads, and businesses to the west. A fully tidal connection would require the establishment of new levees that offer the same level of flood protection for non-restoration areas. Analyses were done on large culverts and a levee breach, but most used a high invert elevation (generally 2.0 feet NAVD) so modeled tides never dropped below about 3.5 feet NAVD (Figure 6-2). A connection (channel or large culvert) with a deep invert would allow fully tidal conditions. The CRP looked at levee breach options and showed full tidal conditions with Alternatives 2 and 3. The PEIR modeling shows that a breach or set of large culverts could allow high tides in the site to match high tides in the SGR. Low tide drainage will depend on the channel invert and dimensions, which will be sized based on hydraulic geometry relationships in the next phase of the design.

Flooding elevations in the Central LCWA Site under different scenarios were also modeled (ESA 2020b). The modeling showed that connecting the river with a channel or set of large culverts resulted in a 100-year flood level of 14.4 feet NAVD within the site. Levees would be needed to protect neighbors and would be designed to meet USACOE requirements for flood control. The levees would be tall and have a large footprint, resulting in a potential net loss of wetland area with restoration (ESA 2020a). Future analyses could fine-tune levee heights and footprints to reduce the impact of necessary flood protection under a full tidal restoration approach for the Central LCWA Site.

6.2.2 Muted Tidal Marsh

Tidal muting occurs where the amplitude of high and/or low tides are different than in the open ocean. There are generally three types of tidal muting in southern California's salt marshes. Some systems do not have a sub-tidal connection to the ocean, and therefore do not drain all the way on the lowest tides (Figure 6-3). These systems typically exhibit high tides similar in height to the ocean. Systems with this type of low tide muting typically have high functioning mid and high marsh habitats but may have limited or no cordgrass marsh because areas that would support cordgrass low marsh habitat do not drain adequately to support cordgrass (and the areas that would provide adequate drainage and the appropriate inundation frequency are limited to very narrow elevation range).

A second type of muting can also occur naturally in areas far from the source of tidewater due to natural tidal hydrodynamic processes. In this case, the essential cause of the muting is that water is taking longer to reach the muted portions of a marsh due to friction of the channel or marshplain acting on the flow of water. Systems with this type of muting can support all of the general habitat types of tidal marshes. However, the elevations where those habitats occur are often different than those predicted for fully tidal systems.

The third type of muting is manmade and occurs where culverts or undersized channels restrict the flow of tidewater, usually leading to lower-than-predicted high tides, and higher than predicted low tides (Figure 6-4). These systems lack some of the natural processes of the other two systems but can still support a range of habitats.

Severely muted systems (with total tide range less than about three feet) tend to become monocultures of pickleweed (e.g., parts of Mugu Lagoon, Callaway Marsh). Moderately muted systems (e.g., those with a tide range of three to five feet) can function similarly in many ways to fully tidal systems (e.g., Carpinteria Salt Marsh, Zedler Marsh). Systems with minimal or no muting tend to be the highest functioning systems (e.g., Tijuana Estuary, parts of Mugu Lagoon, Steam Shovel Slough).

In the near-term, the South LCWA Site is expected to have muted tides due to the undersized and perched culvert that would be the source of tides until the HCC connection is established. The amount and type of muting will be sensitive to the final grading plan, as the most extensive amount of grading would result in the largest tidal prism and the most tidal muting compared to a plan with less grading, and a smaller tidal prism. Modeling will need to be done in the next round of planning for the Refined Restoration Plan for the South LCWA Site in order to understand how the restored marsh will function in the near-term. The PEIR modeling of the near-term conditions provides an upper range of the amount of tidal muting that could be expected with extensive grading.

The Isthmus Area has two muted tidal marshes, known as Zedler Marsh and Callaway Marsh, which are each connected to the SGR by a 3-foot diameter culvert. Zedler Marsh is about 3 acres and is the site of much of the LCWA Stewardship Program's activities. The site gets un-muted high tides and fairly strongly muted low tides due to the culvert having an invert elevation of 2.3 feet NAVD (ESA 2020b). This tide range of 4 feet is adequate to support mid and high marsh and transition zone habitats. There are no current plans to alter the tidal connection at Zedler Marsh. Improving the tidal connection to Callaway Marsh by removing the tide gate is identified as a mid-term conservation goal in the PEIR.

Given the flood control challenges in the Central LCWA Site, having a restricted tidal connection that limits maximum flooding heights, but mutes tides, may be a reasonable approach. Modeling suggests that a single 4-foot culvert with an invert at 0 feet NAVD would provide a tide range of about 5 feet (Figure 6-4, Table 6-2) while reducing the 100-year flood height from 14.4 feet NAVD (breached levee) to 7.7 feet NAVD (ESA 2020b). Based on modeled inundation frequencies for different elevations (Figure 6-5), the resulting marsh could likely support cordgrass, mid, and high marsh in somewhat narrower elevation bands than under fully tidal conditions; however, low tide drainage may not be adequate to support robust cordgrass meadows. Restoring sub-tidal and unvegetated low intertidal habitats would also be feasible depending on grading designs. In the balance, the reduced impacts from flood control infrastructure in terms of footprint area, construction cost, and visual impacts makes the tradeoffs worthwhile. The next phase of planning for the Central LCWA Site should include modeling of different culvert sizes and elevations in order to optimize the tide range while minimizing maximum flood elevations. This will allow the LCWA to make a better-informed decision on the best approach for restoring tides to the Central LCWA Site.

6.2.3 Freshwater

Seasonal freshwater flows can enhance salt marsh functioning so connecting to tide sources like the SGR, that provide seasonal freshwater flows, might be desirable. The PEIR and CRP both assumed that expanding the existing culvert connecting the South LCWA Site to the SGR is not feasible. The SGR is currently the preferred source of tides for the Central LCWA Site and Isthmus (although the CRP did explore the idea of connecting the Central Area to Steamshovel Slough (*see also* Chapter 5 of the PEIR) and the Isthmus to the HCC). Challenges in enhancing tidal connections to the SGR include the need for flood protection and the presence of large quantities of trash in the river. Ideally, enhanced tidal connections to the SGR would provide beneficial occasional freshwater inputs while limiting flooding risks to neighbors and the ingress of trash to restored habitats.

The other sources of freshwater to the site are point sources. One storm drain coming from the Marketplace shopping center drains to the Central LCWA Site at Marketplace Marsh. A second one apparently drains an adjacent business park and enters the Central LCWA Site about a tenth of a mile south of Marketplace Marsh. Both of these appear to have year-round flows and support brackish marsh species (including nearly four acres of tule and cattail at Marketplace Marsh). Such point source inputs will need to be excluded from areas where salt marsh is the target habitat as they will lower soil salinity and favor brackish marsh species instead. This is probably most easily done by diverting the flows into bioswales on the backside of the flood control levees, which can become valuable habitat while removing nutrients and other contaminants from the runoff.

The South LCWA Site does not seem to have any year-round point source inputs. There is a small flashy watershed at the extreme southeast end of the site that drains on to the LCWA property. In its current state, the flows only seem to be related to rainfall. Erosion in the drainage is currently a concern. This source of freshwater needs further study, but it would probably not be beneficial to restored marsh habitats as it is likely a direct drainage from roads and likely has some contaminants (in addition to sediment). The runoff could potentially be used to support freshwater habitats in a bioswale designed to treat contamination and trap sediment.

6.3 SLR Resilience

Current guidance by the State of California suggests that there is a 66% probability that SLR will be between 1.3 to 3.3 feet of SLR by 2100 if high emissions continue (Table 4-1; Ocean Protection Council 2018). Habitats that are sensitive to tidal water levels, like salt marshes, will be altered by even relatively small amounts of SLR. With several feet of SLR, many of southern California's tidal marshes will convert to mud flats and embayments unless sedimentation (natural or human placed) keeps up with SLR. The HCC and SGR have very little sediment so substantial natural accretion is unlikely at the LCW. Subsidence will accelerate the effective rate of SLR in the project area. The Refined Restoration Plan for the South LCWA Site was designed so that the full range of high-functioning marsh habitats will be sustained with up to about 2.5 feet of SLR (expected between 2060 and 2085 based on OPC's medium-high and low risk aversion scenarios). When SLR exceeds this, vegetated marsh habitats will start to be lost unless other actions are taken.

There is no regional consensus on how to build resilience to SLR into restored marshes. Many have recognized the need to include more transition zone and low-lying upland habitat in plans so that marsh habitats have space to migrate upwards. Steep transitions would lead to narrow bands of marsh habitat in the future. Broad flat transitions would allow for wider bands, but take up more space. An obvious tradeoff to this approach is that more high areas means less intertidal areas and less overall salt marsh functioning in the near-term. The other challenge related to this approach is that mid and cordgrass marsh habitats generally occur on nearly flat marsh plains, not on slopes. The future marsh habitats moving up even fairly gradual slopes would function very differently than natural marshes. For example, sloped marshes would not support extensive tidal channels, salt pannes, or mud pannes. Having sloping transition zones and uplands adjacent to the marsh is important to the functioning of the tidal habitats in the near-term so they should be included in restoration designs. Migration of tidal habitats into these areas will occur with SLR, but this is not the primary strategy being used for building in resilience in the Refined Restoration Plan for the South LCWA Site.

Two strategies are recommended for optimizing the functioning of the restored marsh over time as sea level rises. Both of these strategies apply to areas being graded as part of the restoration. First, the elevation of the mid marsh plain should be set towards the high end of the expected elevation range for this habitat. Under fully tidal conditions, this probably means mid marsh areas should be graded to about 5.7 feet NAVD. This will allow these areas to sustain mid marsh habitats as long as possible before converting to cordgrass marsh with 1.4 – 2.0 feet of SLR. The site elevations will need to be fine-tuned with refined modeling and data from reference sites.

Second, fairly extensive areas will be graded to high marsh near the top of the elevation range for this habitat (about 7.0 feet NAVD). These high marsh areas should be on very gradual slopes so they drain after high tides. There would be abrupt transitions between mid and high marsh plains. As sea level rises, these high marsh areas would eventually “type convert” to mid marsh habitat at about the same time as the mid marsh plain is converting to cordgrass marsh (see Figure 6-6). The relatively flat surface would be expected to develop tidal channels, and salt pannes would become mud pannes. This conversion might happen with about 1.5 feet of SLR. The original high marsh areas would remain mid marsh until they type convert to cordgrass marsh with about 3.0 feet of SLR. Transition zone elevations will be sloped and support naturally sloped high marsh areas as sea level rises. With more SLR, transition zone, high marsh, and mid marsh will eventually disappear from the system.

Using these strategies, the site could support extensive areas of all of the different types of intertidal habitat, more or less continually, as SLR rises by about 2.5 – 3.0 feet. Restoring a system that is resilient over the next several decades using the above strategies will give the restoration and regulatory communities time to work out the best strategies for sustaining tidal wetlands with more extreme SLR. These strategies will likely differ between sites, but might include beneficial sedimentation, water control structures, or in the case of restoration sites, re-grading entire sites to appropriate elevations for future sea levels.

This approach will be more difficult to employ in areas connected to tides with culverts, especially where those culverts are undersized and mute tides. This is primarily due to the fact that unlike fully tidal systems, the inundation frequencies and tide ranges would not move upward in a 1:1 relationship with SLR (see M&N 2015 and ESA 2002b). Modeling for the PEIR suggests that the HCC culverts will cause a very slight increase in tidal muting in the South LCWA Site with SLR. In the Central LCWA Site, the modeling shows that a 4-foot culvert under 1.7 feet of SLR would result in a 2-foot tide range and a 1-foot tide range under 3.3 feet of SLR compared to almost five feet at current sea level. Future analyses should investigate strategies for building resilience in the Central LCWA Site with different types of culvert connections to the SGR. These might include a combination of control structures on culverts, multiple culverts of different sizes and/or elevations that are opened or closed as sea level rises, and/or beneficial sedimentation.

6.4 Landform

The Refined Restoration Plan for the South LCWA Site includes attempts to replicate natural landforms, preserve existing landforms, and restore somewhat artificial landforms to help build in resilience to SLR (see Section 6.3 above) or avoid grading in certain areas. Grading in existing tidal salt marsh areas will be avoided as much as possible.. Landforms in these areas are generally appropriate for the habitats they are expected to support when full tidal conditions are restored. These include generally flat mid marsh plains with depressions that support mud pannes, high marsh and transition habitats on very gentle slopes, high marsh in shallow depressions that will support salt panne, and mid marsh on steeper slopes adjacent to the existing tidal channel.

In areas excavated to restore large areas of mid and cordgrass marsh, the marsh plain will be generally flat, but with abundant microtopography (shallow depressions and low mounds) and sinuous tidal channels. In other areas, mid marsh may be restored on slopes, especially where the slopes are transitions between lower habitats and uplands around infrastructure and the edges of the project area. High marsh will be restored on nearly flat plains in some areas as a SLR resilience strategy. These areas should have microtopography but not tidal channels. In other areas, high marsh will be restored on slopes, especially where they are transitions between lower habitats and uplands around infrastructure and the edges of the project area. Transition zones will range from steep to fairly low gradient. Upland will be restored on existing slopes and flats and on newly placed fill.

Max Touch Alternative, South Area From CRP

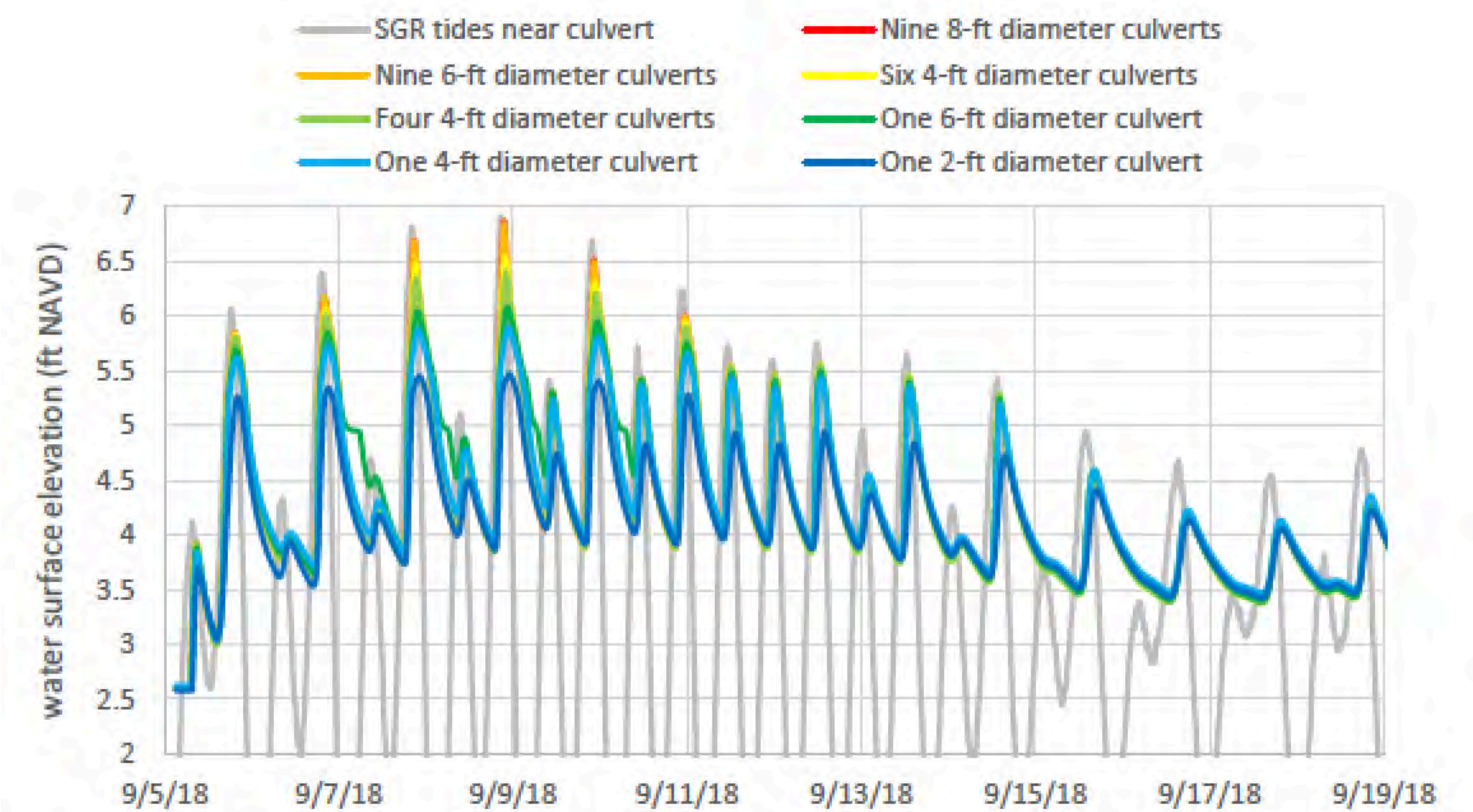
Los Cerritos Wetlands Habitat Restoration Plan

Figure 6-1

Coastal Restoration Consultants

Map Source: Moffatt & Nichol

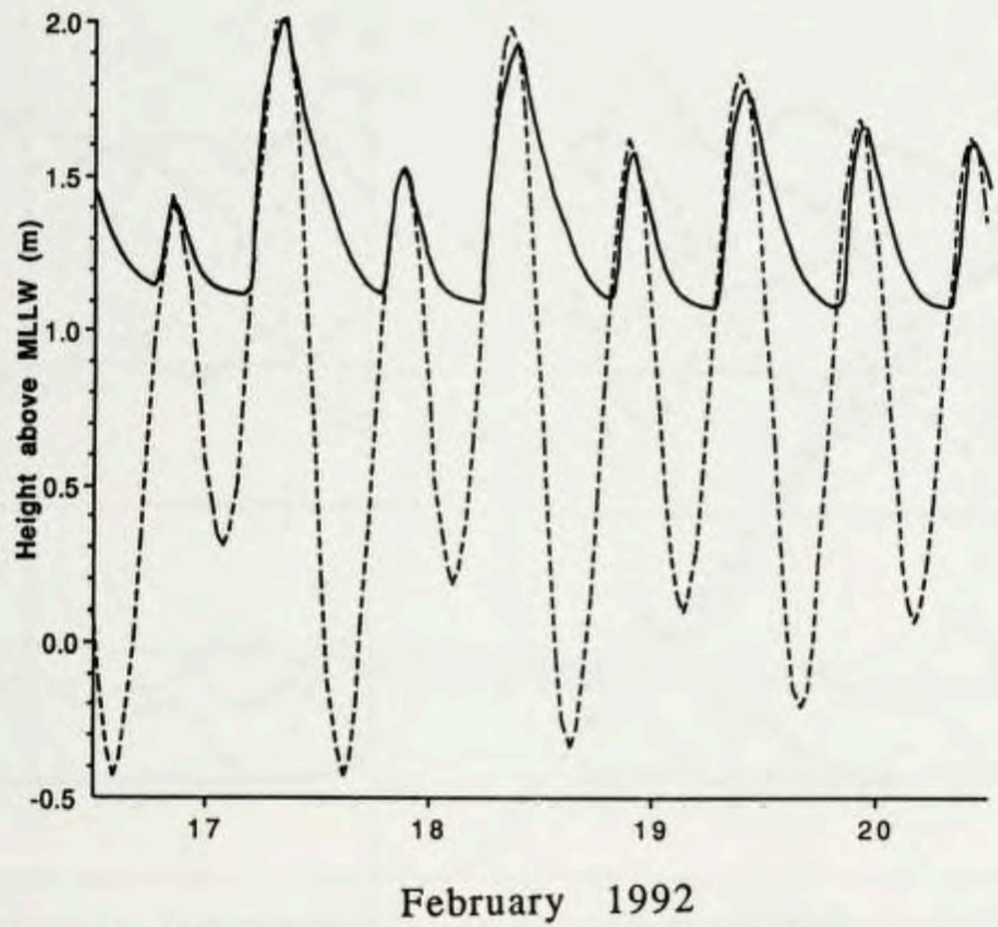
Figure 6-2. LCWA Central site modeled tides with different culvert designs. All designs have 2 foot NAVD invert elevation.



SOURCE: ESA 2019

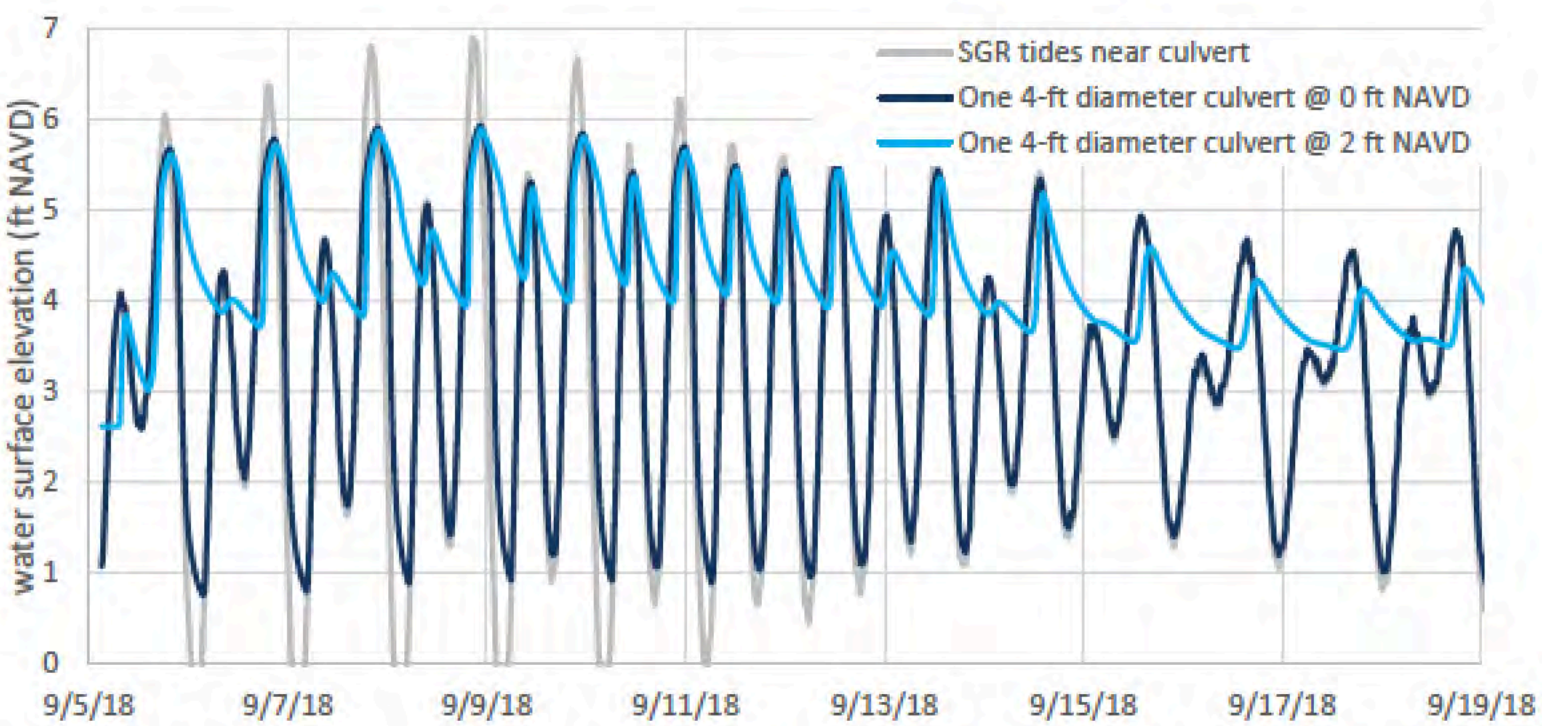
Los Cerritos Wetlands Restoration Plan Program EIR Hydrodynamic Technical Report

Figure 6-3. Example of muted low tides in a natural marsh. Carpinteria Salt Marsh. From Hubbard 1996.



Carpinteria Salt Marsh tides (solid line) and predicted tides (dotted line), 16–20 Feb 1992.

Figure 6-4. LCWA Central site modeled tides with different invert elevations.



SOURCE: ESA 2019 Los Cerritos Wetlands Restoration Plan Program EIR Hydrodynamic Technical Report

Figure 6-5. LCWA Central site modeled inundation frequency versus ground elevation for 4-foot culvert with 0-foot NAVD invert elevation.

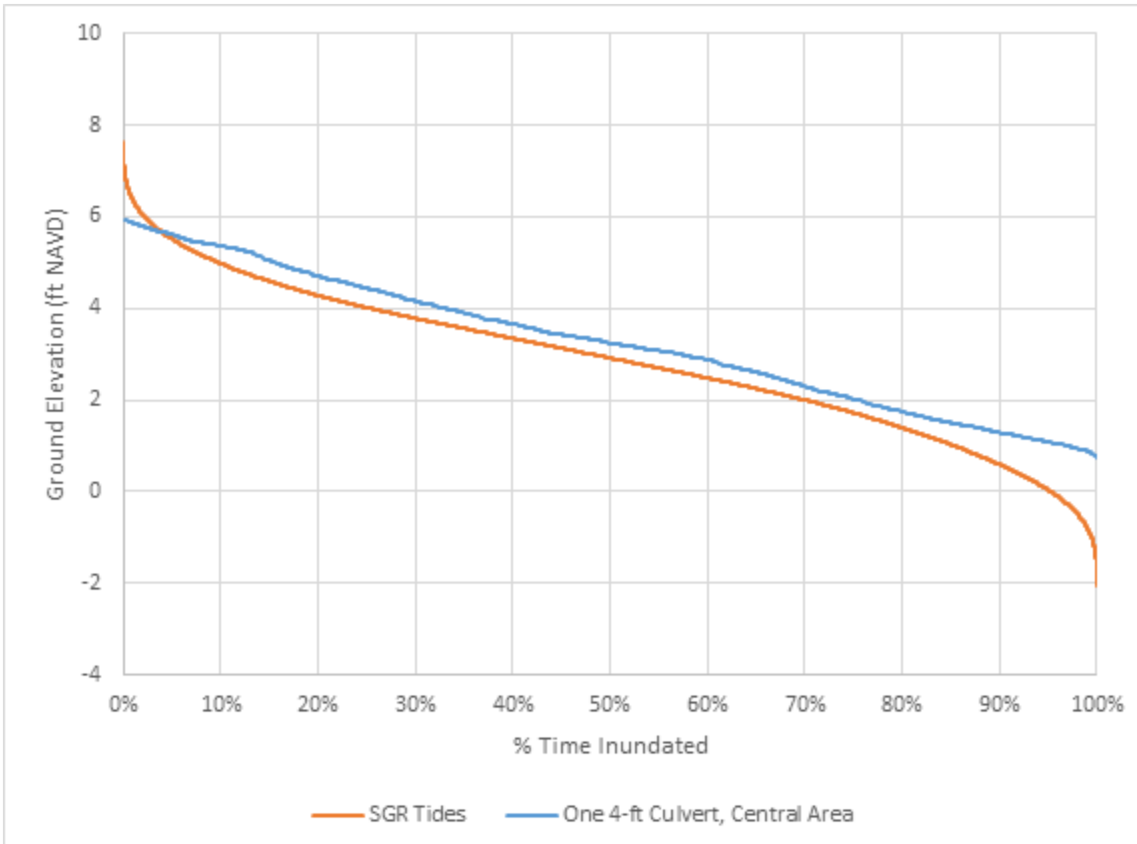


Figure 6-6. Conceptual design for SLR resilience in restored marshes using tiered wetland terraces.

Current Sea Level

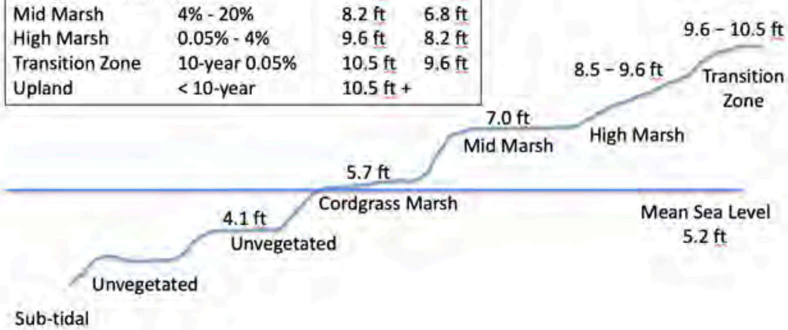
Habitat	Inundation Freq.	From	To
Sub-tidal	99.99% - 100%	-1.8 ft	
Unvegetated	50% - 99.99%	2.9 ft	-1.8 ft
Cordgrass Marsh	20% - 50%	4.3 ft	2.9 ft
Mid Marsh	4% - 20%	5.7 ft	4.3 ft
High Marsh	0.05% - 4%	7.1 ft	5.7 ft
Transition Zone	10-year 0.05%	8.0 ft	7.1 ft
Upland	< 10-year	8.0 ft +	

+1.3 Feet of SLR

Habitat	Inundation Freq.	From	To
Sub-tidal	99.99% - 100%	-0.5 ft	
Unvegetated	50% - 99.99%	4.2 ft	-0.5 ft
Cordgrass Marsh	20% - 50%	5.6 ft	4.2 ft
Mid Marsh	4% - 20%	7.0 ft	5.6 ft
High Marsh	0.05% - 4%	8.4 ft	7.0 ft
Transition Zone	10-year 0.05%	9.3 ft	8.4 ft
Upland	< 10-year	9.3 ft +	

+2.5 Feet of SLR

Habitat	Inundation Freq.	From	To
Sub-tidal	99.99% - 100%	0.7 ft	
Unvegetated	50% - 99.99%	5.4 ft	0.7 ft
Cordgrass Marsh	20% - 50%	6.8 ft	5.4 ft
Mid Marsh	4% - 20%	8.2 ft	6.8 ft
High Marsh	0.05% - 4%	9.6 ft	8.2 ft
Transition Zone	10-year 0.05%	10.5 ft	9.6 ft
Upland	< 10-year	10.5 ft +	



+3.0 Feet of SLR

Habitat	Inundation Freq.	From	To
Sub-tidal	99.99% - 100%	1.2 ft	
Unvegetated	50% - 99.99%	5.9 ft	1.2 ft
Cordgrass Marsh	20% - 50%	7.3 ft	5.9 ft
Mid Marsh	4% - 20%	8.7 ft	7.3 ft
High Marsh	0.05% - 4%	10.1 ft	8.7 ft
Transition Zone	10-year 0.05%	11.0 ft	10.1 ft
Upland	< 10-year	11.0 ft +	

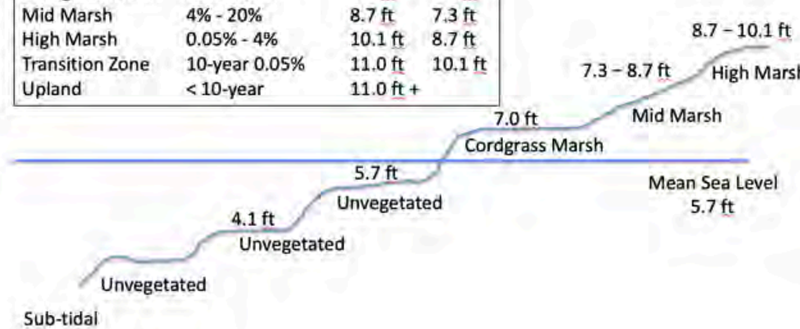


Table 6-2. 100-year flood levels with different culvert connections to the LCWA Central site. *From* ESA 2020b

FREEBOARD TO 2ND STREET DURING THE 100-YEAR STORM EVENT

	Maximum 100-year stormwater level (feet NAVD)	**Freeboard to 2nd Street (feet)**
Full Breach (for reference)	***14.4***	***9***
One 4-foot culvert[1]	7.7	16
Six 4-foot culverts	11.0	12
Nine 6-foot culverts	13.6	10
Nine 8-foot culverts	14.3	9

1 For both culvert with invert of 2 feet and 0 feet NAVD

7 SITE-SPECIFIC DESIGN CONSIDERATIONS

The basis of design outlined in Chapter 6 sets general parameters on potential restoration designs for the project area. This chapter describes project-specific and site-specific design considerations that were used to inform the development of the Refined Restoration Plan for the South LCWA Site. These considerations will be important in the next rounds of planning, as the Refined Restoration Plan for the South LCWA Site is refined. Restoration on other parcels within the LCW will need to develop similar site-specific design considerations as planning proceeds.

Restoration designs for tidal salt marshes need to specify where the different habitats will be restored within the system. There are multiple approaches to making these decisions. Table 7-1 summarizes a few of the approaches that could be used as design strategies for the South and Central LCWA sites. All of these approaches must keep the overall Goals and Objectives and the site-specific Opportunities and Constraints in mind. For this plan, a combination of these approaches was used to develop the Refined Restoration Plan for the South LCWA Site. The important aspects of this “integrated approach” are discussed in the following sections.

7.1 Setting Targets for Different Habitats

As the designs in the CRP and PEIR show, there is a wide range of possibilities for restoring different habitats in different proportions in the South LCWA Site. The CRP analyzed approaches that left extensive areas at-grade and approaches that included extensive grading throughout the site. For the Refined Restoration Plan for the South LCWA Site, grading will be minimized in about 20 acres of lower lying areas that support salt marsh species and are already at intertidal elevations (Figure 7-1). The existing grades will determine the post-restoration habitats in these areas. The improved tides will provide a great deal of functional lift in these areas without grading and without directly impacting existing resources. Some grading in these areas may be warranted where contaminated soils need to be cleaned up, where flood protection measures need to be installed, or to create smooth transitions to adjacent graded areas.

Extensive areas of upland and some low-lying existing wetlands will be graded to restore salt marsh habitats. The amount of excavation will determine post-restoration habitats in these areas. The following design considerations were used in developing a conceptual grading plan for the Refined Restoration Plan for the South LCWA Site:

- Provide sub-tidal habitat using deep channels or low-invert culverts connected to sources of tides
- Restore cordgrass marsh in areas with the best tidal flushing
-

Table 7-1. Design approaches for tidal salt marsh restoration.

Approach	**Design Considerations**	**Pros**	**Cons**
Use natural reference marshes	• Dominated by mid marsh • *Cordgrass* marsh on bay edges • Relatively narrow high marsh zone • Extensive sinuous tidal creek network	• Most closely mimics historic conditions • Intuitive approach for stakeholders and the public • Promotes near-term biodiversity	• Without a source of sediment, loss of vegetated marsh with moderate SLR • Requires good tidal flushing • Challenging to construct
Optimize for SLR resilience	• More emphasis on high marsh, transition zone, and upland habitats	• Maintains marsh functioning with SLR • Focus on habitats often ignored in marsh restoration • May help counter regional habitat losses in the future	• Does not mimic historic conditions • Less wetland functioning in near-term • Less marsh area at any point in time
Provide mitigation credits	• Will depend on mitigation needs	• Built-in funding • More likely to include robust monitoring and performance criteria	• Might not mimic historic conditions • Can lead to designs that are not a good fit for sites or that have a narrow focus (one or a few dominant habitats) • May not protect existing functioning marsh
Maximize habitat diversity	• Include all salt marsh habitats • Include appropriate non-salt marsh habitats (e.g., uplands, brackish marsh, etc.)	• Supports more species • May support more special status species	• Does not mimic historic conditions • On small sites, patches can become too small to function optimally • Challenging to construct
Integrated approach	• Emphasize mid marsh like natural systems • Include more high marsh than natural marshes • Site cordgrass marsh in areas with the best tidal flushing • Accommodate potential mitigation funding, but it doesn't drive the design • Include meaningful areas of all marsh zones and adjacent uplands	• Balancing of the above approaches leads to optimized design • Accommodates a range of SLR adaptation strategies • Opportunities for various sources of funding • Diverse habitats support high species diversity	• Might not mimic historic conditions • Might not be intuitive to stakeholders and the public • Space can be limited

- Prioritize large areas of mid marsh on flat marsh plains with abundant tidal channels and microtopography
- Restore substantial areas of high marsh on nearly flat plains as outlined in Chapter 5 and on slopes
- Include some gradual salt marsh to upland transition zones to allow for significant areas of upslope migration of high marsh habitats with SLR
- Include some steep salt marsh to upland transition zones in order to increase the overall area of salt marsh
- Avoid grading in most existing tidal marsh areas
- Avoid grading in some upland areas that are potential ESHA or contaminated
- Spoil excavated material on site to the extent feasible
- Restore upland habitats on spoil areas
- Use excavated material to raise 1st Street and protect it from flooding
- Use excavated material to protect the Hellman Retained site from flooding

7.2 Restoration Actions With Multiple Benefits

Development of the Refined Restoration Plan for the South LCWA Site included attempts to prioritize restoration actions that achieved multiple benefits. Examples include:

- Use excavated fill to protect the Hellman Retained site and 1st Street from flooding
- Excavate weedy uplands to intertidal elevations to maximize functional lift
- Preserve higher functioning wetland areas so they can provide propagules (e.g., seeds, planktonic larvae, etc.) to adjacent restored areas
- Consider changing the elevations of existing low-lying wetland areas that would need to be excavated anyway due to contamination
- Identify opportunities where minor grading of high areas would allow tides into adjacent low-lying areas to minimize grading and maximize hydrologic connection
- Identify opportunities where selective grading and placement of soil on site can provide mitigation areas for impacts to non-salt marsh special status species (e.g., southern tarplant and Lewis' evening primrose)

7.3 Phasing Within and Between Areas

It may be desirable to phase the implementation of restoration in the South LCWA Site. This is primarily due to at least five aspects of uncertainty around connecting the South LCWA Site to tides. First, there is not currently a firm agreement with LADWP to use the HCC as a tidal connection. Second, connection to the HCC, if it happens, won't occur until the Los Alamitos and Haynes Generating Stations stop using water drawn through the HCC for cooling; this is expected by 2029 but could happen sooner. Third, there is considerable uncertainty of how tides could be delivered to the site if the HCC is not available as a source or tides. Fourth, while the PEIR assumed a near-term project using the existing culvert to the SGR and a mid-term project connecting to the HCC, the timing of implementation is uncertain and will hinge on a range of factors including availability of funding, permitting complexity (e.g., will a 408 permit be needed for altering the existing culvert?), and probably other unforeseen opportunities or challenges. And fifth, the different near and mid-term tidal connections would likely result in different inundation frequencies at different elevations, complicating restoration planning and implementation (*i.e*., mid marsh elevations in the near-term might become low marsh or high marsh once fully tidal conditions are restored)[9].

The Refined Restoration Plan for the South LCWA Site was developed as two phases as a way to deal with this uncertainty. Phase 1 is designed to function in the near-term with only the existing culvert to the SGR with the following assumptions:

- The design should assume a future connection to the HCC within about five years of construction
- The smaller footprint of Phase 1 would have less tidal prism through the existing culvert in the near-term and therefore less tidal muting (and in the longer-term if the HCC never becomes available as a source of tides)
- The smaller footprint of Phase 1 would lead to a smaller change in inundation frequencies between phases
- Cordgrass marsh, high marsh, and transition zone areas might function differently in the near-term with muted tides but should be designed with full tides in mind; modeling in the next phase of planning will make better predictions and fine-tune grading

Phase 2 was designed to have a full tidal connection to HCC. Phase 2 has the following assumptions:

- Implementation would follow a firm agreement with LADWP to use the HCC as a source of tides
- Connection to the HCC would allow a larger tide range and greater tidal prism
- The design elements would complement and be compatible with Phase 1
- If the HCC did not become available, a redesign would be needed that is compatible with a tidal connection using the existing culvert
- Modeling in the next phases of planning will need to address hydrologic and hydraulic conditions and fine-tune grading elevations and channel sizes

[9] Modeling for the PEIR designs suggests this would not be a major issue for mid marsh elevations but there would be substantial changes in high marsh and transition zone elevation ranges. This will need to be confirmed with modeling of the new restoration design in the next phase of planning.

Ideally, much of the uncertainty surrounding the tidal connections in the South LCWA Site will be resolved in the next round of planning. This could result in either a re-design of Phase 2 if the HCC does not become available or implementing both phases simultaneously if there is more clarity on the timing of implementation and/or availability of the HCC.

7.4 Known Soil Contamination

The Refined Restoration Plan for the South LCWA Site was developed with known areas of contaminated soil (Figure 4-15) taken into consideration. It is generally desirable to clean up contaminated soils on the site, especially where levels are high enough to be potentially harmful to humans and/or wildlife. The following general guidance was developed for the Refined Restoration Plan for the South LCWA Site:

- If grading occurs in or near old oil sumps, the soils should be remediated, stabilized and contained in place, or hauled off site as appropriate
- Old oil sumps in existing wetlands and un-graded uplands should be cleaned up if future studies suggest harmful effects for humans or wildlife or the potential for contaminants to migrate with reintroduction of hydrology
- Grading in non-sump contaminated areas (e.g., Area 18) should be avoided, if possible, pending future testing and modeling of potential contaminant migration with reintroduction of hydrology

Further examination of contamination in the next round of planning may lead to changes in grading footprints. Dealing with contaminated soils will add cost to the project. Avoiding areas that do not require cleanup will help control implementation costs.

7.5 Regulatory and Permitting Considerations

While the habitats at LCW are generally highly degraded and in need of restoration, they do support a range of special status species, sensitive habitats, and jurisdictional waters and wetlands (ESA 2020a, CRC 2019, Tidal Influence 2012). The restoration of tidal wetlands will necessarily have near and long-term impacts on some sensitive resources as habitats change due to grading and reintroducing tides. The regulatory agencies have shown great support for the restoration project but will nonetheless need to assure sensitive resources are protected and impacts are mitigated. As such, the Refined Restoration Plan for the South LCWA Site was developed with the following sensitivities in mind:

- Minimize impacts to special status species, ESHA, and wetlands
- Assure designs are self-mitigating
- Designs should result in a net increase in jurisdictional wetlands and ESHA
- Impacts to sensitive resources related to salt marsh habitats should be self-mitigating
- Impacts to sensitive resources related to non-salt-marsh habitats (e.g., southern tarplant and Lewis' evening primrose) should be mitigated on site where feasible

7.6 Water Quality

Given the limited options for tidal connections, the Refined Restoration Plan for the South LCWA Site was not designed around specific water quality considerations. For the South LCWA Site, the culvert to the SGR will bring trash into the site. Trash accumulations in the current tidal areas, even with a partially closed culvert, are considerable. Removal of the flap gate on this culvert will likely allow more trash into the site. The HCC should have very small amounts of trash, though it may be a source of other marina-related pollutants. The Central LCWA Site will connect to the SGR via one or more culverts so trash will likely be an issue. Culvert designs that limit the ingress of trash and/or the use of a trash collection boom should be explored in future planning. Trash is already an issue in the Isthmus Area. Future connection of the Isthmus to the HCC instead of the SGR would alleviate the trash problem to a great extent.

On-site contamination of soils may degrade water quality on any of the three sites. Future soil testing will determine the need to clean up contaminants to assure suitable water quality once tides are restored.

The Central and Isthmus Areas both have active oil operations. There is therefore a risk of an oil spill affecting restored habitats and degrading water quality. Oil infrastructure will need to be surrounded by required containment structures (e.g., berms) to eliminate the risk.

7.7 Public Access

The public access design for each area will need to be refined in future planning. The trail system presented as part of the Refined Restoration Plan for the South LCWA Site is based on designs from the CRP and PEIR. The current design, and future refinements, should be based on the following:

- Improved public access is a priority in the South LCWA Site
- Maintain or improve access from Seal Beach Blvd. to Gum Grove Park
- Establish access from Gum Grove Park to 1st St. and the proposed Seal Beach visitor center area (*see* Figure 8-3)
- Access along 1st street with vehicles yielding to pedestrians
- Access along flood protection berms as practical
- Focus access in uplands
- Establish trails with different levels of access (*e.g.,* open dusk to dawn, open to docent-led tours, access only for managers, etc.)
- Consider access for public safety (e.g., police and fire) as needed
- Final designs should build on ideas in the CRP and PEIR

Interpretive and educational installations will be part of the public access plan. These elements will be included along trails and will be developed in coordination with educational elements in and around the visitor center. Potential themes could include, but are not limited to:

- The plants, wildlife, and ecology of tidal salt marshes
- The historical ecology of the area
- SLR and its effects on salt marshes
- The SGR and its watershed
- The mineral extraction history of the area
- The prehistoric to recent cultural history of the area
- The ongoing importance of the area to indigenous cultures

Legend

Wetlands to be Enhanced (~20 Acres)

Minimal to No Grading Wetland Areas - South

Los Cerritos Wetlands Habitat Restoration Plan

Figure 7-1

750 feet

N

Coastal Restoration Consultants

Photo Source: Google Earth May 2019

8 REFINED RESTORATION DESIGNS

Restoration designs for the four project areas have been developed to different levels of detail. Section 8.1 below presents the Refined Restoration Plan for the South LCWA Site and a series of analyses of the design and a conceptual public access plan for the South LCWA Site. Restoration in the Central LCWA Site is expected to occur after implementation of restoration in the South LCWA Site. A design for the Central LCWA Site is included in Section 8.2 below but that design is more conceptual for now due to many uncertainties related to land ownership, permitting complexity, and the nature of the tidal connection. The Isthmus Area already has a restoration plan for 4.87 acres of restored wetlands and uplands and there is ongoing restoration at the Zedler Marsh site. That design is briefly discussed in Section 8.3 below. Finally, planning for restoration in the North Area is currently underway and is discussed briefly in Section 8.4 below.

8.1 Refined Restoration Plan for the South LCWA Site

The South Area is composed of the Haynes Cooling Channel, Los Alamitos Pump Station Site, Los Alamitos Retarding Basin Site, Hellman Retained Site, State Lands Parcel Site, and the South LCWA Site. The proposed restoration designs presented in Chapter 2 of the PEIR should be referenced for the Haynes Cooling Channel, Los Alamitos Pump Station Site, Los Alamitos Retarding Basin Site, Hellman Retained Site, and State Lands Parcel Site as these are all mid- or long-term phases and therefore will be refined in the future. The South LCWA Site is expected to be a Near- and Mid-term phase and therefore its restoration design is the focus of this section.

The Refined Restoration Plan for the South LCWA Site (Figure 8-1) was developed with the guidance set forth in Chapters 2 through 7 of this plan. It includes a mix of elements from Maximum, Moderate, and Minimum Touch alternatives from the CRP (*see* Figures 5-1, 5-2 and 5-3) and is similar in many ways to the design in the PEIR. The Refined Restoration Plan for the South LCWA Site avoids grading in the upland areas to the east and southwest and existing tidal areas like the Minimum and Moderate Touch designs but includes a deep channel with more low and mid intertidal habitats and more grading in the south-central area like the Maximum Touch design and the PEIR design. Figures 8-2 and 8-3 show some of the actions and design features for two potential phases of construction (see Section 8.1.1 for a description of the phasing).

New design elements include excavating a deep tidal channel instead of enlarging the existing channel. This was done primarily to minimize impacts to invertebrate populations (*e.g*. shore crabs and mollusks) in parts of the existing channel, which if preserved, might speed colonization of the restored habitats. The existing tidal channel would still function to supply tides to the northern areas.

Part of the eastern section of the existing tidal channel and the adjacent existing road would be converted to intertidal experimental plots (Figure 8-3). These plots could be used for manipulative experiments or observational studies related to SLR, restoration techniques, etc. Final designs for these should be coordinated with researchers with specific hypotheses to address.

Unlike the CRP alternatives, the Refined Restoration Plan for the South LCWA Site retains 1st Street through the project area (Figure 8-3). As discussed in the PEIR, this is due to the need to preserve existing utilities under the road and an access easement for the Hellman retained property. The road will need to be raised to 10-feet NAVD to keep it from flooding (ESA 2020b). The northernmost sections of the road would be moved west to allow for more transition zone habitat adjacent to the existing marsh. There will need to be a bridge over the new tidal channel. Existing power lines would ideally be relocated underground. Flood protection for the Hellman Retained property will require a berm or floodwall to an elevation of 10-feet NAVD (Figure 8-4).

Restoration actions in an approximately one-acre area in the far southeastern section of the project (Figure 8-3) will need to be determined in the next phase of planning. Strongly muted tides in the area are supporting wetlands on the neighboring property (owned by the City of Seal Beach). Introducing a larger tide range might expand this wetland area and potentially cause flooding to an existing footpath. Cutting off tides might have negative impacts to jurisdictional areas. Flood modeling in the PEIR and CRP did not assess this area so future studies and consultation with the City of Seal Beach will be needed before making decisions about restoration actions on LCWA property in the adjacent area.

The northeastern area that includes known contamination in Area 18 (*see* Figure 4-15) and currently supports a population of a rare plant (Lewis' evening primrose) (see Figure 4-14) will not be excavated (Figure 8-3). This will avoid impacts to the plant, provide an area to mitigate impacts to the same species elsewhere on the site, and potentially avoid the extra cost of dealing with high levels of contamination. Further information and analysis is needed on the contamination to understand the impacts of bringing tides into the site and the potential for contaminant migration, which may require capping the contaminants in place or removing them offsite.

Another new design feature is the inclusion of a bioswale that would support riparian trees and shrubs around the northeastern perimeter of the site (Figure 8-3). This feature will provide multiple benefits. First, it will intercept overland stormwater runoff that would otherwise have potentially negative impacts on restored tidal areas (e.g., pollutants, sediment, etc.). Second, the trees will act as a visual screen of industrial areas to the north for visitors and potentially for homeowners to the east. Third, it will effectively increase the area of existing riparian habitat that was restored on the adjacent property that is supporting nesting of endangered least Bell's vireo. Finally, it might support cottonwood trees adjacent to the Tongva/Gabrieleno Cultural Site; cottonwood is a species of special significance to the Tongva/Gabrieleno culture. Compared to the PEIR design for the South LCWA Site, the bioswale feature would likely not increase flooding potential for neighbors. This, along with the hydrology required to support this habitat feature, will need to be analyzed in the next phase of the design and any potential impacts under CEQA would need to be analyzed at the project level.

The Refined Restoration Plan for the South LCWA Site also avoids any excavating in the Former Landfill Area (*see* Figure 4-15). This is due to uncertainty surrounding the nature of the landfill material (which unlike oil-contaminated areas is not posing a risk to ecological or human health). Given the fact that this area supported the last of the historic tidal marsh in this area (into the late 1960's), it might be expected to have somewhat intact salt marsh soils under the fill and therefore quickly support high-functioning marsh. Further, the area is close to tidal connections and would likely have very good tidal flushing and limited muting of tides if restored. The next phase of planning should strongly consider restoring tidal marsh in this area once more is known about the landfill.

Four hypothetical cross sections through the site (Figure 8-5) are shown in Figures 8-6 and 8-7. These cross sections include areas without grading based on the sites existing topography and graded areas with sloping transitions and high and mid marsh plains (*see* Section 6.3). Subtle mounds in the mid marsh plain provide mid to high marsh transition areas that typically hold high plant diversity. Shallow depressions in the mid marsh plain support mud panne habitat that can provide excellent foraging for shorebirds at low tide. The depths shown for the smaller and larger tidal creeks are estimates. Actual cross sections for these features will need to be designed with hydrogeomorphic modeling in the next phases of planning.

8.1.1 Phasing

Phasing of the restoration project is recommended given the current level of uncertainty regarding the nature and timing of tidal connections and the timing of implementation (*see* Section 7.3). The Refined Restoration Plan for the South LCWA Site is presented as two phases. Ideally these phases will be built at the same time with either a firm agreement in place with LADWP to connect to the HCC at the time of construction or within a few years of construction. Without such assurance in place, it is recommended to move forward with Phase 1 and then build Phase 2 as presented when the HCC becomes available, or re-design Phase 2 to be compatible with muted tides through the existing culvert (*i.e.*, more limited grading focused closer to the tidal connection).

Phase 1 is about 40 acres and uses the existing culvert with the flap gate removed for tidal circulation (Figure 8-2). Some actions in Phase 1 assume a Phase 2 (*e.g.*, excavation of a sub-tidal channel not yet connected to the HCC) but in general, could function well given the limited tidal connection in the long-term if connection to the HCC does not happen. The cordgrass marsh area might function as a mudflat in the near-term due to presumably muted tides through the existing culvert. With full tides, cordgrass marsh would be restored in this area. While this area currently supports wetlands, it is expected that the oil contamination at the site will require excavation and alteration of the existing habitat. Additionally, since the area is closest to the HCC, it will have the best tidal flushing and is the area most likely to support tall cordgrass capable of supporting nesting light-footed Ridgway's rail. Excavated material from this area and new mid and high marsh areas west of 1st Street would be used to raise 1st Street and build flood protection berms (Figure 8-2). Any extra fill would be spoiled in the fill areas identified in Phase 2. Contaminated soils will need to be dealt with in excavated areas. Further studies are needed to assess the need to clean up contamination in un-graded areas.

Phase 2 would be built when the HCC becomes available as a source of tides and is about 60 acres (Figure 8-3). It includes restoration of significant areas of tidal marsh by removing fill and spoiling it elsewhere on site. Existing salt flat habitat would be re-introduced to tides to form more productive salt panne habitat. Some transitions from marsh to upland, especially around the perimeter of the site, are necessarily steep in order to optimize the amount of tidal marsh on the site. Transitions within the site are generally more gently sloped (Figure 8-3). Eelgrass habitat could be restored in the new sub-tidal channel and potentially in the HCC.

8.1.2 Habitats and SLR

The Refined Restoration Plan for the South LCWA Site includes a full range of intertidal habitats and opportunities to restore a variety of upland and other wetland habitat types. The relative amounts of the different intertidal habitats in the Refined Restoration Plan for the South LCWA Site were carefully considered. Mid marsh habitat is emphasized along with a relatively high proportion of high marsh and transition zone habitats (Figure 8-8) in order to help maintain habitat diversity with SLR. Limited areas of cordgrass marsh were included as this habitat is likely to expand at the site with SLR.

The following analysis of habitat conversions with SLR is semi-quantitative since there is not an actual grading plan for the site. To estimate the changes, current topography was used for un-graded areas and assumptions of marsh plain grading elevations were used in most graded areas. Rough estimates for habitat conversion were used on slopes around the perimeter of the project. This analysis assumes that water levels will rise within the site at slightly less than a 1:1 ratio with water levels in the ocean. This is based on SLR modeling for the PEIR (ESA 2020b).

By setting the mid marsh and high marsh plains high within the elevation range for each habitat in the graded areas, the site will see only minor changes to habitats with about 1.5 feet of SLR (Figure 8-9). In the un-graded areas and around the project's perimeter, habitats will be moving up-slope and much of the transition zone habitat will be lost. The cordgrass marsh will convert to unvegetated low intertidal habitat (in this case, a mudflat) that will provide excellent shorebird habitat.

Beyond 1.5 feet of SLR, the site will see rather dramatic changes in habitat distributions. As SLR passes about 1.5 feet, the mid marsh areas will start to convert to cordgrass marsh and the high marsh areas will start to convert to mid marsh, which would persist until about 2.8 feet of SLR (Figure 8-10). By this time, mudflat habitat would increase slightly though much of the site would remain vegetated marsh. High marsh habitats however would largely be squeezed out.

Beyond 2.8 feet of SLR, substantial areas would start to turn to mudflat and with 4.4 feet of SLR, most of the mid and high marsh and transition zone would be lost with some areas of cordgrass marsh left on what was originally transition zone and the highest areas of high marsh (Figures 8-11).

The Refined Restoration Plan for the South LCWA Site was developed to be resilient to about 2.5 – 3.0 feet of SLR. This analysis shows this is largely possible with this design – a wide array of habitats in significant proportions remain up to about 2.8 feet of SLR. However, it will likely be best for future managers to employ adaptation strategies such as beneficial sedimentation to improve the resilience of the site. Future restoration on adjacent properties is another potential strategy for improving resilience within the system. This analysis shows that such actions will be crucial for maintaining marsh functioning as SLR exceeds three to four feet.

8.1.3 Hydrology

The Refined Restoration Plan for the South LCWA Site was developed with the assumption that there would be different near-term and mid-term hydrologic regimes. This scenario was investigated and modeled for the PEIR using assumptions about grading that are different than those in the Refined Restoration Plan for the South LCWA Site. The difference in tidal prism between the PEIR near-term design and Phase 1 of the Refined Restoration Plan for the South LCWA Site is not known. If they are meaningfully different, it is expected that tidal muting and inundation frequencies at different elevations will be different than those presented in the PEIR. If they are similar, mid marsh elevations would expect to change little and high marsh and transition zone elevations would change substantially. Updated modeling of the Refined Restoration Plan for the South LCWA Site will help predict how habitats might be expected to establish in Phase 1 and then might change in Phase 2.

The mid-term modeling in the PEIR set the connection to the HCC at an invert elevation of zero feet NAVD with minor muting of high tides at the back of the marsh and muting of the lowest tides in areas nearest the HCC (due to the invert elevation). The Refined Restoration Plan for the South LCWA Site would connect to HCC at a lower elevation and have a tide range of over eight feet. The Refined Restoration Plan for the South LCWA Site was designed with the assumption of very slightly muted high tides at the back of the marsh and habitat elevation ranges equal to fully tidal systems.

The Refined Restoration Plan for the South LCWA Site also differs from the PEIR design by having a deeper and wider channel under 1st Street with a bridge. The width and depth of the channel will need to be designed so that there is minimal additional muting at the east end of the marsh. Modeling for the PEIR showed that the eastern areas of the marsh could be subject to severe muting of lower tides and minor muting of high tides depending on how culverts and channels are designed (ESA 2020b).

Analyses in the PEIR showed limited influence of fluvial flooding in the SGR on water levels in the South LCWA Site. Once connected to the HCC, coastal flooding would control maximum water levels in the site. This is expected to be true in both the near- and mid-term. The modeling predicted that flood protection for infrastructure and neighbors set at 10 feet NAVD would be sufficient for a 100-year fluvial or coastal flooding event (ESA 2020b). Example flood protection structures were developed for the PEIR (Figure 8-12).

The hydrology of the bioswale/riparian area has not been studied. Areas on the neighboring property between about 0 and 9 feet NAVD are supporting healthy willow trees. That site was designed to recieve runoff during storm events, but it is likely that trees are tapped in to more or less fresh groundwater. Understanding the groundwater elevation and salinity will be crucial to understanding how this habitat type might be expected to be self-sustaining with some, but likely significantly less, stormwater inflows compared to the neighboring site.

8.1.4 Soils

The soil studies analyzed for the CRP did not include any analyses of soil texture in the South LCWA Site. This will be an important data gap to fill in the next round of planning. Most of the filled areas appear to have fairly to very sandy soil, which would not be desirable for tidal wetland restoration. There are silty soils at the surface in some areas as well that would likely support salt marsh habitats, but their extent is now well understood. It is presumed that old salt marsh soils, with very low sand content, are present at some depth below the surface, but it is not known if they are still at appropriate elevations for tidal restoration due to compaction and/or subsidence. The analysis of historical aerial photos (Section 4.1) suggests fill material at the surface came from excavated marsh (during construction of the HCC) and from the channelized SGR. The former should have lower sand content than the latter. Existing wetland areas in the South LCWA Site are likely on fill that appears to have low sand content.

8.1.5 Special Status Species

The Refined Restoration Plan for the South LCWA Site includes a range of habitats that are expected to support several rare species. Some of these species already occur on site and their populations will be preserved or expanded. Others may colonize the site on their own or could be re-introduced as part of the restoration project. The following analysis is based on current understanding of special status species on-site and target restored habitats. There will be opportunities to expand these lists when focused searches for a wider range of special status species are conducted as part of future CEQA review and permitting.

8.1.5.1 *Rare Species Already On Site*

Several special status species occur in the South LCWA Site and/or HCC presently. They are all expected to benefit from the restoration passively or with restorative actions (Table 8-1).

Table 8-1. On-site special status species and their restoration potential

Special Status Species	Status	Restoration Potential in South LCWA Site
FLORA		
California Boxthorn *(Lycium californicum)*	CNPS list 3 Fed: None State: None	High: Increase current population (three plants) in all transition zone and upland areas by planting from container stock
Coulter's Goldfields *(Lasthenia glabrata ssp. coulteri)*	CNPS list 1B.1 Fed: None State: None	High: Expand current small population in high marsh and salt panne habitats by collecting and distributing seed from current population
Lewis' Evening Primrose *(Camissonia lewisii)*	CNPS list 3 Fed: None State: None	Moderate: Impacts to a smaller population will be mitigated on site at the appropriate ratio via direct seeding from on-site collections; existing larger population will be preserved
Southern Tarplant *(Centromadia parryi ssp. australis)*	CNPS list 1B.1 Fed: None State: None	High: Upland fill areas and transition zones will support this species, which should be seeded from on-site collections
FAUNA		
Belding's Savannah Sparrow *(Passerculus sandwichensis beldingii)*	Fed: None State: Endangered	High: Existing Population is expected to expand in mid and high marsh areas
California Least Tern *(Sterna antillarum browni)*	Fed: Endangered State: Endangered	Moderate: Expanded foraging habitat in tidal channels and potential nesting habitat in salt panne
Pacific Green Sea Turtle *(Chelonia mydas)*	Fed: Threatened State: None IUCN: Endangered	Low: Rarely present in the HCC, expanded foraging in sub-tidal and low intertidal areas
Salt Marsh Wandering Skipper (*Panoquina errans*)	Fed: None State: SSC	High: Expanded areas of salt grass (*Distichlis spicata*) in mid and high marsh will support a larger population

8.1.5.2 *Special Status Species That Could Colonize or be Introduced*

The restored habitats in the South LCWA Site could support several special status species that are not currently on site. These species might colonize naturally or be introduced during the restoration effort. Table 8-2 includes some of the obvious species that the site might support post-restoration.

Table 8-2. Special Status species not currently know in the South LCWA Site that restored habitats could support.

Special Status Species	Status	Restoration Potential in South LCWA Site
FLORA		
Salt Marsh Birds Beak *(Chloropyron maritimum ssp. maritimum)*	CNPS list 1B.2 Fed: Endangered State: Endangered	High: Introduce from seed in mid marsh-high marsh transitions and mid-marsh mounds; determine appropriate seed collection site in consultation with USFWS and CDFW
Ventura Marsh Milk-vetch *(Astragalus pycnostachyus var. lanosissimus)*	CNPS list 1B.1 Fed: Endangered State: Endangered	Moderate: Experimental introductions recommended in consultation with USFWS in transition zones and uplands
Estuary Sea-Blite *(Suaeda esteroa)*	CNPS list 1B.2 Fed: None State: None	High: Introduce from seed or nursery stock in mid marsh habitats; collect seed from Steam Shovel Slough and/or Zedler Marsh
Woolly seablite (Suaeda taxifolia)	CNPS list 4.2 Fed: None State: None	High. Introduce from nursery stock in high marsh and transition zone areas
Coast woolly heads (Nemacaulus denudate)	CNPS list 1B.2 Fed: None State: None	Moderate: Introduce from seed upland areas with sandy soil (Lewis' evening primrose areas)
FAUNA		
Least Bell's Vireo *(Vireo belii pusillus)*	Fed: Endangered State: Endangered	High: Nesting pairs currently present in willow woodland on adjacent property; bioswale areas could support one or more additional nesting territories
Light-footed Ridgway's Rail *(Rallus longirostris levipes)*	Fed: Endangered State: Endangered	Low: Once cordgrass marsh is established, this species could colonize or be introduced in consultation with USFWS
Tidewater Goby *(Eucyclogobius newberryi)*	Fed: Endangered State: Endangered	Low: Lack of brackish waters/freshwater interface and full tides make colonization by this species unlikely

8.1.6 Jurisdictional Waters and ESHA

Implementation of both phases of the Refined Restoration Plan for the South LCWA Site will result in approximately 60 to 70 acres of jurisdictional waters and wetlands and ESHA (not including the HCC). This is a significant increase from the 38 acres of jurisdictional areas and 45 acres of potential ESHA currently estimated to be on site (CRC 2019).

8.1.7 Public Access – South LCWA Site

An important aspect of the restoration project is to encourage public access to the site. This plan presents a conceptual view of where trails could be developed (Figure 8-12) based on trail designs from the CRP and PEIR. It may be desirable to limit access on some of these trails (e.g., docent-led tours) while others should be open to general access. Future planning for the site will need to refine the trail design and develop interpretive elements that help the public engage with the restored habitats. Trail locations, lighting, and other aspects of the design should be sensitive to wildlife that use the site.

8.2 Central Area

The Central Area is composed of the San Gabriel River, Central Bryant Site, Central LCWA Site, Long Beach City Property Site, and Pumpkin Patch Site. The proposed restoration designs presented in Chapter 2 of the PEIR and in the Los Cerritos Wetlands Oil Consolidation and Restoration Project should be referenced for the Long Beach City Property Site, and Pumpkin Patch Site as these are both long-term phases and therefore will be refined in the future. The San Gabriel River, Central Bryant Site, and Central LCWA Site have potential to be restored as Near- or Mid-term phase and therefore a conceptual restoration design considering Alternative 1 of the PEIR is the focus of this section. However, the PEIR should be referenced for the proposed full tidal breach design.

8.3 Refined Culvert Alternative for the Central LCWA Site

Restoration in the Central LCWA Site is expected to follow implementation in the South LCWA Site. Restoration in the Central LCWA Site is more complicated than the South LCWA Site due to ongoing oil extraction and its associated infrastructure and roads, multiple landowners, and significant challenges related to flood control. The site does hold great potential for restoration; most of the site is already at intertidal elevations and the SGR is a good source of tidewaters. The following discussion and design ideas are highly conceptual in nature and combine restoration approaches from the CRP with consideration of the constraints identified in the PEIR. The conceptual design presents an approach to restoration using a culvert connection to the SGR in contrast to the levee removal approach analyzed in the most detail in the PEIR.

8.3.1 Tidal Connections

The Moderate and Maximum Touch alternatives in the CRP and the PEIR design include breaching of the levee along the SGR to connect the area to tides via an open channel. This type of connection was found to be desirable for a range of reasons, including lower maintenance costs, less chance of tidal muting, and better connectivity for fish and wildlife. However, a major shortcoming of the CRP is that these designs did not consider the extra flood protection that would be needed when breaching the SGR levee, which is USACOE certified. The new levees would need to protect neighboring infrastructure and existing oil wells from a 100-year fluvial flood event[10]. The PEIR estimated the levees would need to be built to a height of 24 feet NAVD. Even with steep 3:1 slopes, this makes for a large footprint (Figure 8-13) and a potential net loss of wetlands on the site (ESA 2020a).

The PEIR also modeled a range of potential culvert connections of different size, number, and invert elevations (ESA 2020b). The modeling looked at tide ranges for spring and neap tides and water elevations behind the levee in a 100-year fluvial event. Based on this modeling, it is not clear how large a culvert connection would be needed to be to get full tides as most of the modeling was done with a 2-foot NAVD invert elevation (so low tides would be muted). Modeling does suggest that multiple large culverts would be needed to get full expression of high tides (Figure 6-2). However, a design modeled with a relatively modest 4-foot culvert with a lower 0-foot NAVD elevation shows promise as a compromise solution for the area. First, while the tides are muted, the total tide range of about five feet (Figure 6-4) would support high functioning mid marsh, unvegetated low intertidal, and sub-tidal habitats, none of which currently exist in this area. High marsh and transition zones would be more challenging due to presumed narrow elevation bands within the correct inundation frequencies for these habitats. Restoring robust cordgrass marsh could be challenging due to the muted tides and limited flushing. Second, this approach with the smaller culvert would keep the 100-year flood elevation to 7.7 feet NAVD versus 14.4 feet NAVD for the full breaching of the levee with a tidal channel (ESA 2020b). The result would be significantly lower levees with smaller footprints and a potentially increased area of restored wetland with room for low-lying uplands and SLR resilience.

The conceptual design for the Central LCWA Site assumes that some sort of culvert connection that allows muted tides into the site but keeps 100-year floodwater heights similar to the 7.7 feet NAVD elevation modeled for a 4-foot culvert could be used. Different culvert designs will need to be explored when planning for the Central LCWA Site proceeds to the next phase. In any case, the goal should be to optimize tidal range versus the height of flood protection needed. Designs that should be explored include:

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[10] Agencies will make the final determination of the elevation of new flood protection structures during the permitting process. They will require structures to have some freeboard above the maximum predicted water levels and likely some extra height to accommodate SLR.

- Culverts of different sizes with 0-foot to minus 2-foot NAVD invert elevations with muted tidal regulators that will allow for adjustment of tidal exchange at the site
- Multiple culverts at different invert elevations that would be opened or closed in the future could potentially mitigate the negative effects of SLR on habitats
- Simple control structures (*e.g.*, flap gates) to increase tide range without increasing flooding risk[11]
- Culverts with sub-tidal connections to the river to potentially minimize the ingress of floating trash from the river

8.3.2 Soils

There have been multiple studies of soils on the Phase 1 Bryant Parcel in the Central LCWA Site (see Kinnetic Laboratories Incorporated 2012). There is considerable contamination at the site, mostly associated with old oil sumps. Soil texture analyses at depths were also done in at least five locations in the Central LCWA Site (Figure 8-14). There is high variation in texture between locations and at different depths (Table 8-3). In general, soils with sand content below about 20% are suitable for tidal salt marsh restoration. Soils with sand content below about 5% are probably best. This data, while limited, suggest soils at or near the surface would be suitable for tidal marsh restoration.

8.3.3 Oil Operations

There are seven active oil wells in the Central LCWA Site. It is expected that they will remain in operation for the foreseeable future. The well sites need to be protected from flooding. In addition to the active wells, there are pipeline and other associated infrastructure on the property. An agreement exists between the LCWA and the operator that would allow for the pipelines, roads and electric lines to be reconfigured to accommodate wetlands restoration. Currently, oil operation regulations dictate a vegetation clearance of at least 50 feet in diameter around well sites, a 20-foot perimeter around pipelines, and a 6-foot diameter around power poles (Moffatt & Nichol 2015).

8.3.4 Conceptual Design – Central LCWA Site

The restoration design for the Central LCWA Site (Figure 8-15) was developed with a similar approach as that taken for the Refined Restoration Plan for the South LCWA Site. First, existing wetlands in areas that will become intertidal are largely preserved (Figure 8-16). Second, tidal channels are excavated mostly through existing high ground to avoid some of the existing wetlands. Third, low-lying uplands and transition zones habitats are included to

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[11] Marshes fed by culverts generally fill faster than they drain due to hydraulic head forcing more water into the site on rising tides. On low tides, friction and lack of head slows drainage and mutes low tides. One or more additional culverts with a flap valve that aids in draining the marsh but doesn't allow more floodwater to enter might increase tide range without increasing floodwater heights.

allow habitat transgression with SLR. Fourth, salt panne will be restored where existing topography will support the proper hydrology. Fifth, microtopography (mud pannes, mid marsh mounds, and tidal channels) is created on the mid marsh plain to increase habitat diversity and species diversity within the site. And finally, point source stormwater runoff will be contained in a bioswale.

Muted tides due to the culvert connection will limit the range of habitats that the Central LCWA Site is expected to support. Cordgrass would likely be able to establish along tidal creeks and in lower areas of the mid marsh plain but limited tidal flushing probably precludes tall monocultures of cordgrass. High marsh habitats other than salt panne will likely be difficult to restore due to the expected muting of the highest tides (*see* Figure 6-5). High marsh would be expected in a narrow band around the edges of the mid marsh, but they are not shown in Figure 8-15. The transition zone will also occur within a very narrow elevation band. This is due to the design purposefully limiting water levels during flood events and extreme high tides. Low lying areas adjacent to the marsh might support transition zone species where the capillary fringe of tide waters effect growing conditions, but this would be a very narrow elevation zone.

It is estimated that flood control structures significantly lower than those proposed in the PEIR will be needed to protect neighbors and oil wells from flooding. Most of the oil wells on site are at about 8-9 feet NAVD. Protecting the wells from flooding would likely therefore require berms instead of high levees. This approach to restoration would decrease disruptions for those with existing rights of use and access easements. The conceptual design is shown with 25-30 foot wide buffers around oil wells that would be vegetation free and include flood protection berms that would also act to help contain any oil spills. This space meets oil operation regulations (Moffatt & Nichol 2015) and allows vehicle access and turnaround space. The final footprint of these buffers will need to be refined in future stages of planning. The new levee around the perimeter of the site (along 2nd Street and the City of Long Beach site) and the existing SGR levee would provide opportunities for public access trails and vehicular access to the oil wells.

8.4 Isthmus Area

The Isthmus Area is composed of the DWP Site, Isthmus Bryant Site, Zedler Marsh Site, Isthmus LCWA Site, and Callaway Marsh Site. The proposed restoration designs presented in Chapter 2 of the PEIR should be referenced for the Isthmus LCWA Site, and Callaway Marsh Site as these are both mid- or long-term phases and therefore will be refined in the future. Enhancement of the Zedler Marsh Site has been on-going since 2009 and no large-scale restoration projects are proposed for this sub-area. However, Restoration of tidal wetlands and uplands is already planned for the DWP Site and Isthmus Bryant Site part of the Isthmus AreaIsthmusin the Near-term should access to the properties be acquired. That plan would on a parcel of land being purchased by the LCWA expand Zedler Marsh on the Isthmus Bryant and DWP sSite (Tidal Influence 2017). The proposed restoration project is located north of Zedler Marsh and covers 4.87 acres (Figure 8-17). The area is currently a mix of weedy uplands, non-tidal salt flats, and disturbed wetlands that lie at elevations between 8 and 10 feet NAVD. In the near-term, target habitats include coastal salt marsh, alkali meadow, transition zone, and coastal sage scrub. With SLR, this area will transform to high marsh (1-2 feet of SLR) and eventually mid marsh (2-3+ feet of SLR) (Figure 8-18). By allowing SLR to convert higher intertidal habitats to mid marsh habitats, the site is expected to change dramatically over the next decades (Figure 8-19). The restoration project will be implemented through the LCWA Stewardship Program, which has been closely involved with past and current on-the-ground restoration at the Zedler Marsh site. The project is currently seeking funding and will need to be permitted once the land purchase is completed. The PEIR includes restoration designs for the Callaway Marsh site (Figure 5-13).

8.5 North Area

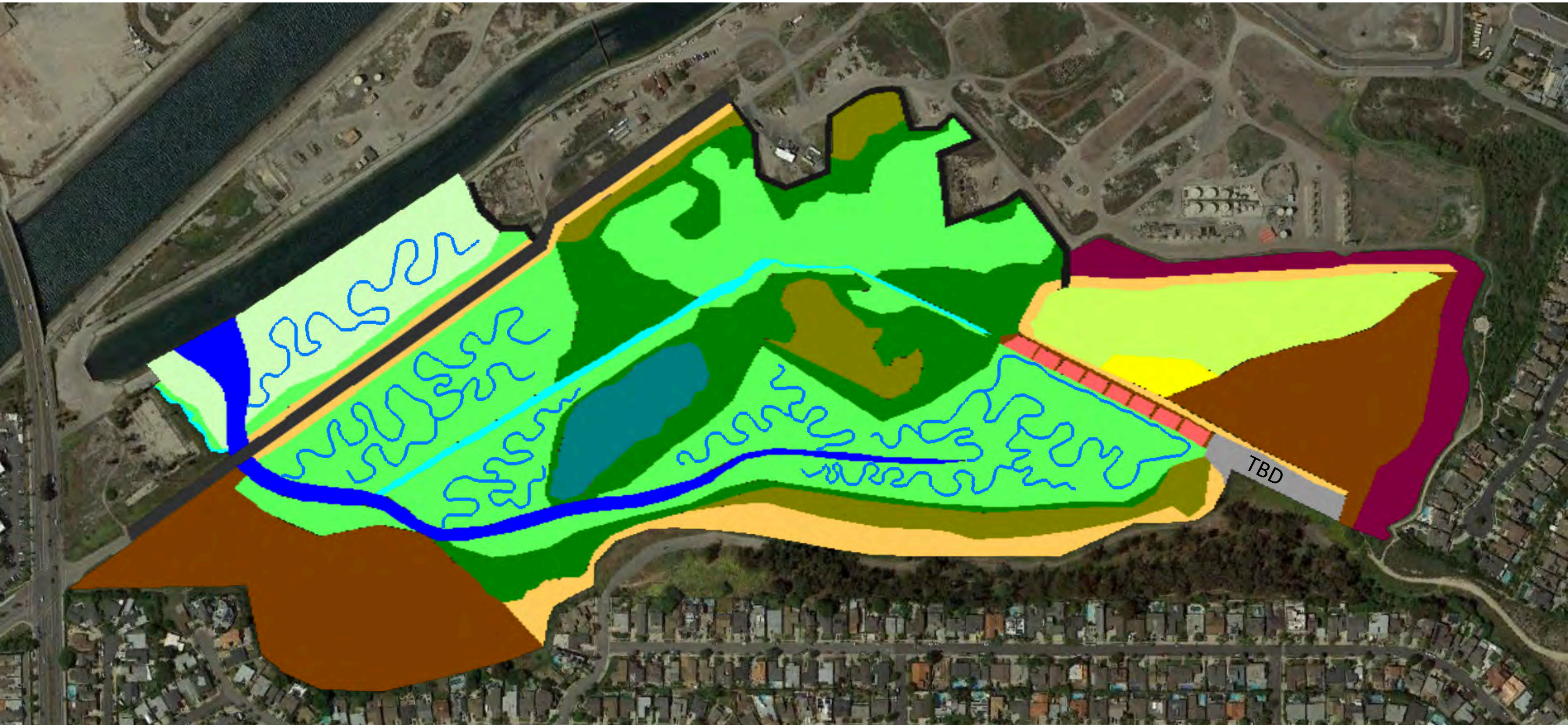
The North Area is composed of the Northern Synergy Oil Site, Southern Synergy Oil Site, and Alamitos Bay Partners Site. A project-level EIR was prepared for the City of Long Beach in 2018 that covers the Northern Synergy Site and aspects of the Southern Synergy Site. This document evaluates the environmental effects associated with the Los Cerritos Wetlands Oil Consolidation and Restoration Project (State Clearinghouse No. 2016041083). The project applicant, Beach Oil Minerals Partners, proposes to consolidate existing oil operations and implement a wetlands habitat restoration project in portions of the North and Central Areas.

The first phase of the project would be focused on the 76.52-acre Northern Synergy Oil Field site, and provide the conditions necessary for the reestablishment of coastal salt marsh habitat and associated hydrologic, biogeochemical, and habitat functions, including:

- Remediating any contaminated areas identified through sampling, and as required by permit, and restoring a natural wetland area that would be operated as a wetlands mitigation bank
- Constructing a new barrier consisting of sheet piles and earthen berms along the southern limits of the Northern Synergy Oil Field site
- Establishing tidal channels, by means of grading, to convey tidal water from the Los Cerritos Channel/Steamshovel Slough to areas that currently lack tidal flows
- Removing segments of the existing berm and roads that currently separate Steamshovel Slough from non-tidal portions of the Northern Synergy Oil Field site

The first phase of the project would also include work on the Southern Synergy Oil Field site, including relocating the existing office building on site to house the Long Beach Visitor Center, and construction of a parking lot, trail, overlook, sidewalk enhancements, and bikeway improvements. The first phase of the project is expected to be implemented within 4 years of obtaining construction permits which makes it a near-term project. Eventually, all remaining oil operations would be removed and the 73.07-acre Southern Synergy Oil Field site may be restored to tidal salt marsh by breaching or lowering the earthen berm and removing the sheet pile wall.

The proposed restoration designs presented in Chapter 2 of the PEIR should be referenced for the Southern Synergy Oil Site and Alamitos Bay Partners Site as these are both long-term phases and therefore will be refined in the future.



Legend

- Sub-tidal
- Tidal Channel
- Cordgrass Marsh
- Mid Marsh
- High Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- C. lewisii Preservation
- C. lewisii Mitigation
- Upland on Fill
- Bioswale/Riparian
- Experimental Plot

Refined Restoration Plan for the LCWA South Site

Los Cerritos Wetlands Habitat Restoration Plan

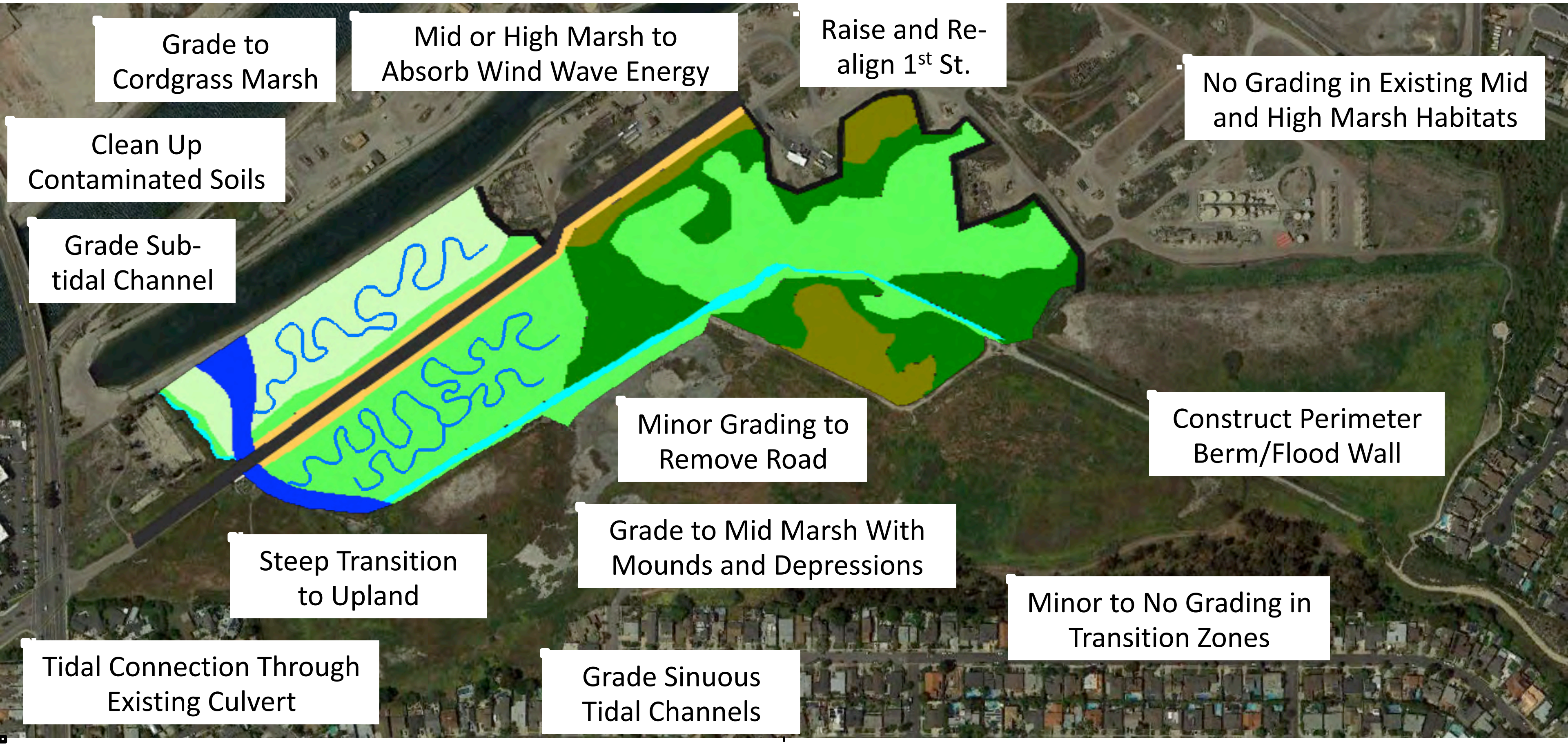
750 feet

N

Figure 8-1

Coastal Restoration Consultants

Photo Source: Google Earth May 2019



Legend

- Sub-tidal
- Tidal Channel
- Cordgrass Marsh
- Mid Marsh
- High Marsh
- Transition Zone
- Upland
- Infrastructure

Phase 1 Short-Term LCWA South Site

Los Cerritos Wetlands Habitat Restoration Plan

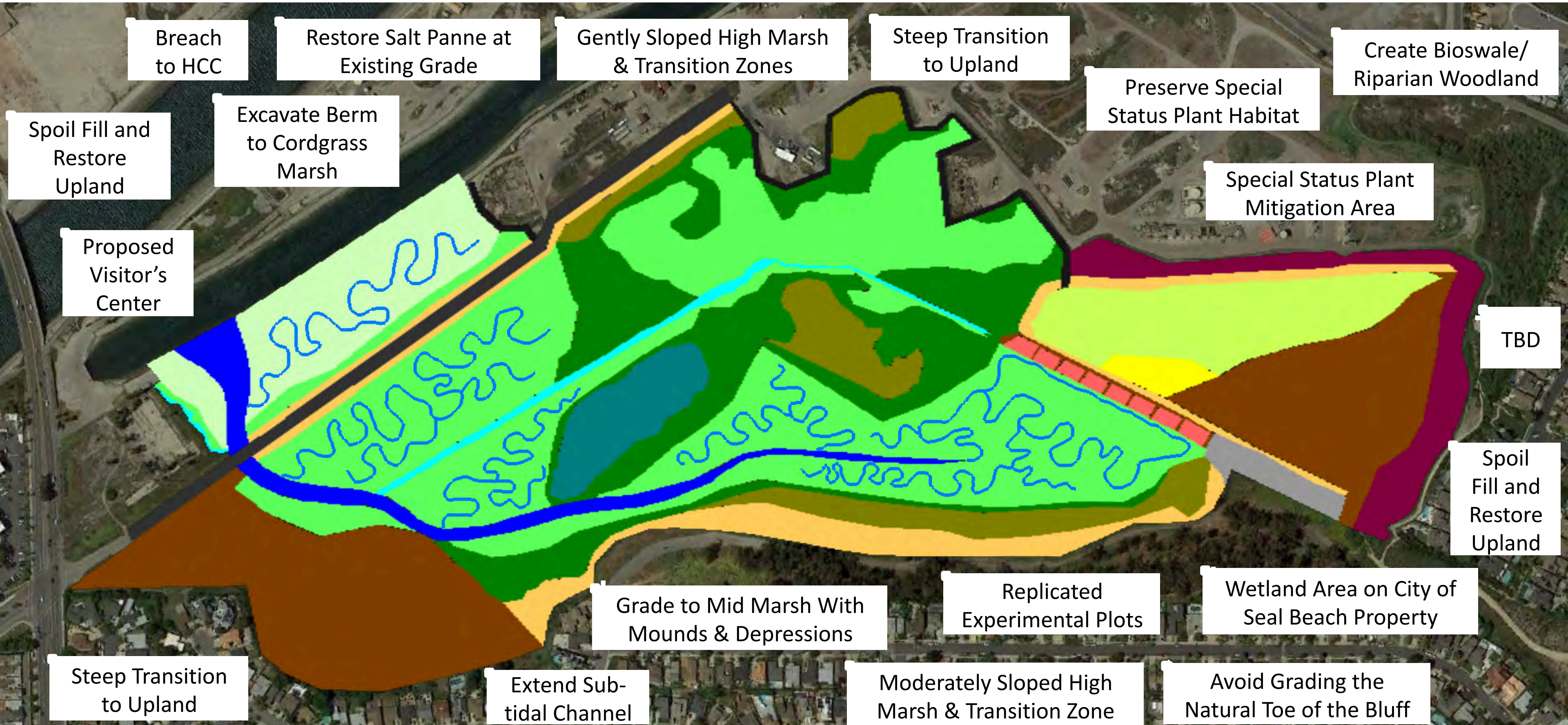
Figure 8-2

750 feet

N

Coastal Restoration Consultants

Photo Source: Google Earth May 2019



Legend

- Sub-tidal
- Tidal Channel
- Cordgrass Marsh
- Mid Marsh
- High Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- C. lewisii Preservation
- C. lewisii Mitigation
- Upland on Fill
- Bioswale/Riparian
- Experimental Plot

Phase 1&2 Mid-Term LCWA South Site

Los Cerritos Wetlands Habitat Restoration Plan

Figure 8-3

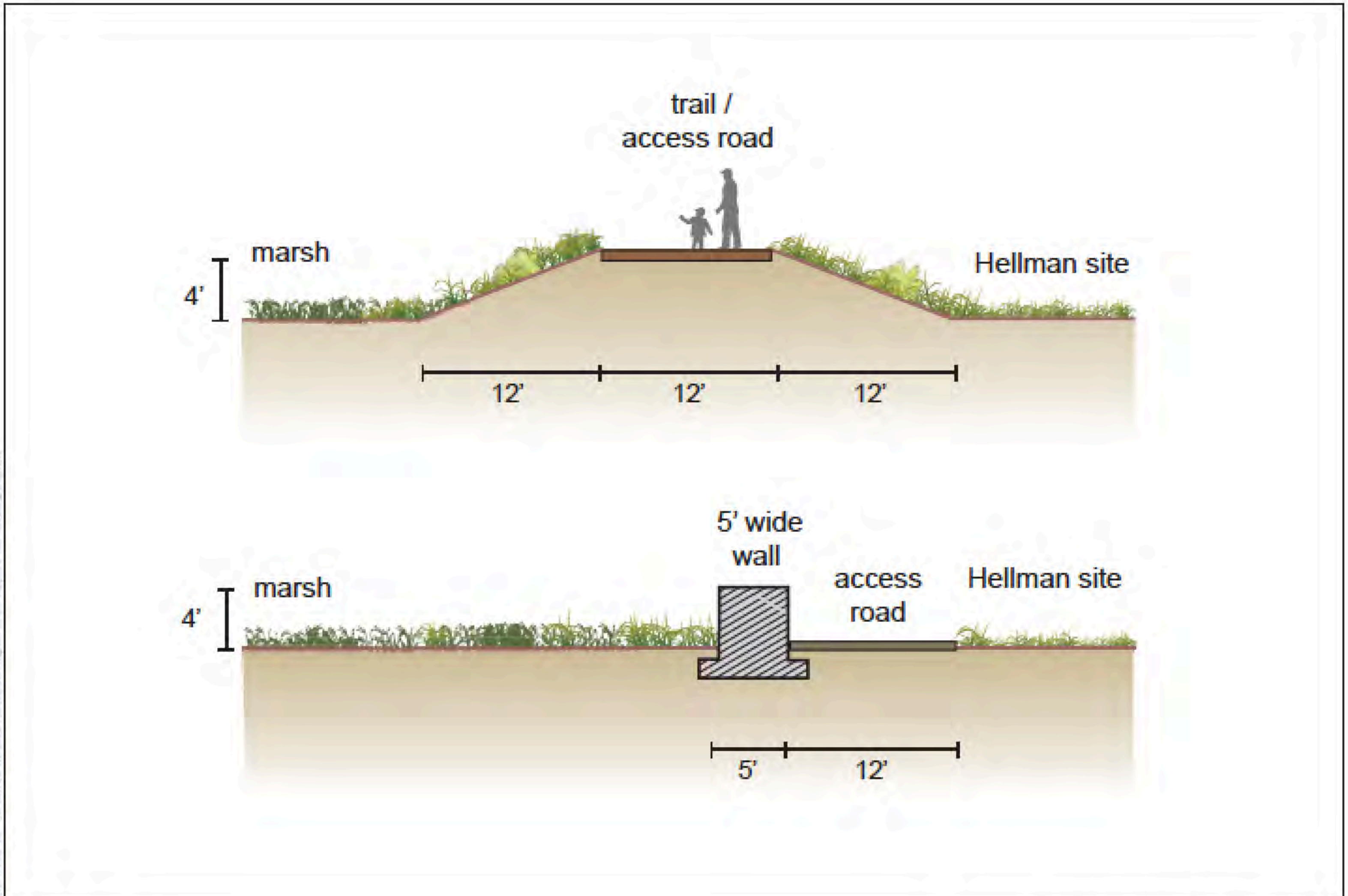
750 feet

N

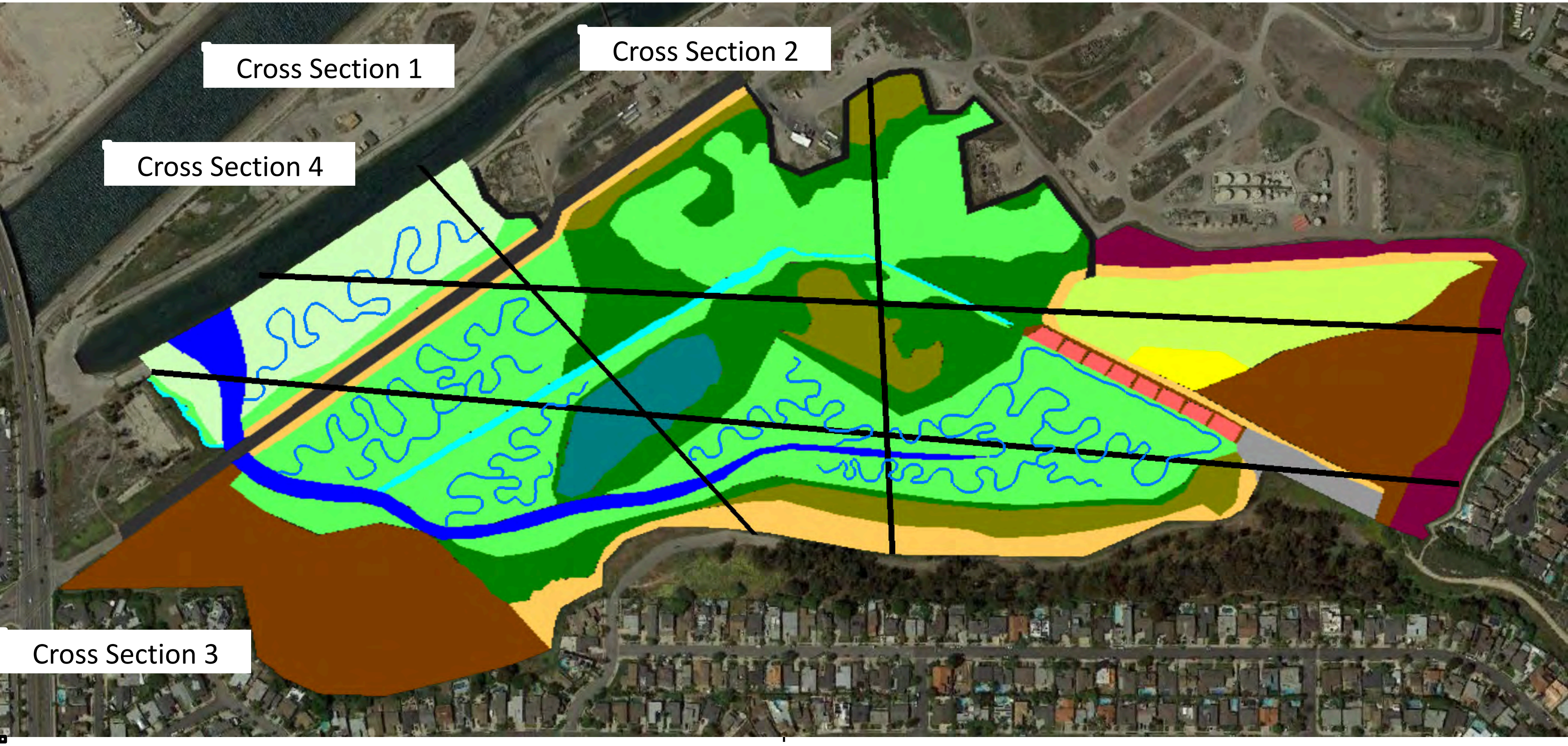
Photo Source: Google Earth May 2019

Coastal Restoration Consultants

Figure 8-4. Conceptual designs for new LCWA South site flood protection with full breach to HCC.



SOURCE: ESA, 2019



Legend

- Sub-tidal
- Tidal Channel
- Cordgrass Marsh
- Mid Marsh
- High Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- C. lewisii Preservation
- C. lewisii Mitigation
- Upland on Fill
- Bioswale/Riparian
- Experimental Plot

Example Cross Sections

Los Cerritos Wetlands Habitat Restoration Plan

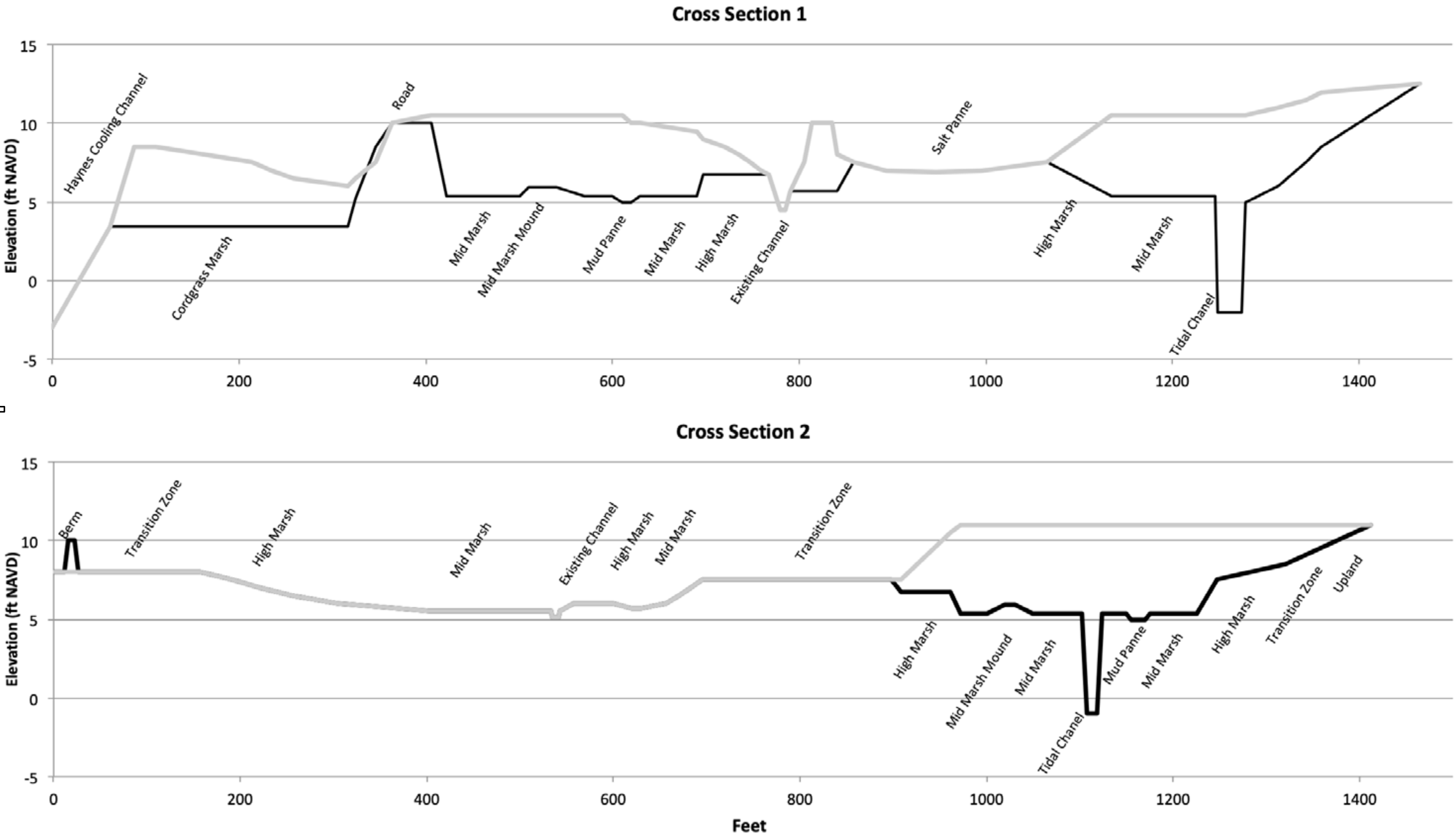
Figure 8-5

750 feet

N

Coastal Restoration Consultants

Photo Source: Google Earth May 2019



Legend

Approximate Existing Topography

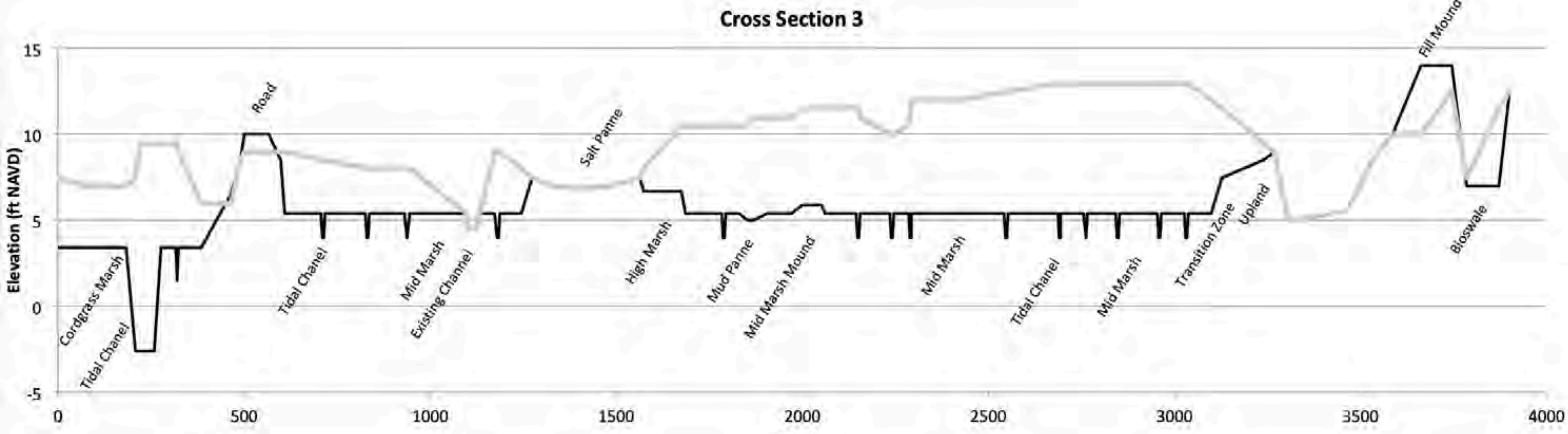
Post-Restoration Topography

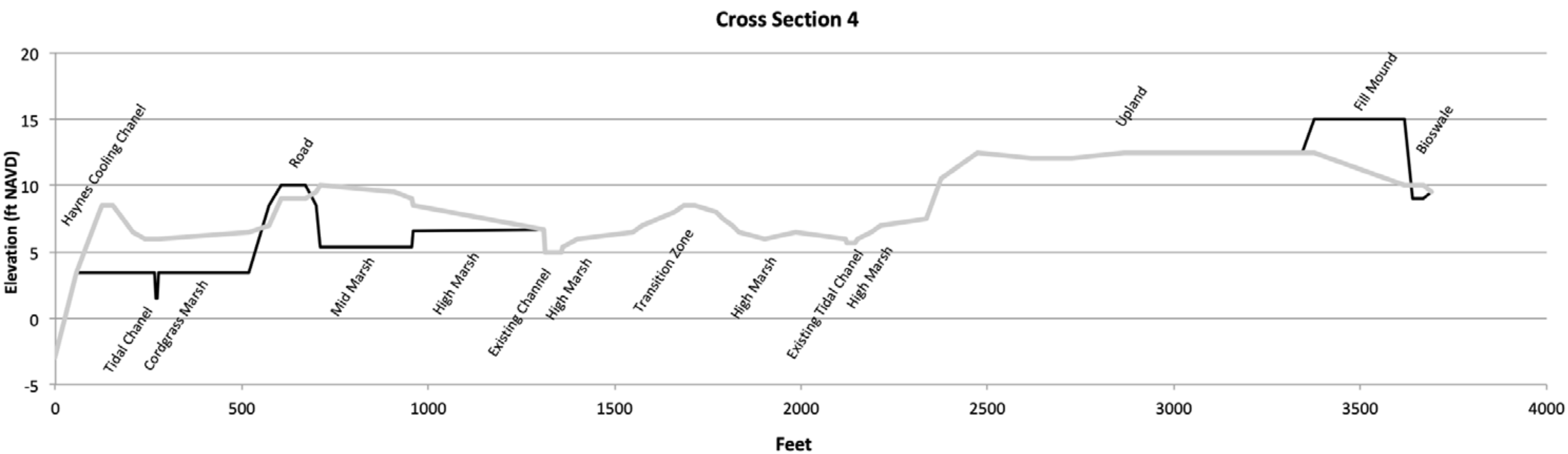
Approximate Surface Elevations Pre- and Post Restoration

Los Cerritos Wetlands Habitat Restoration Plan

Figure 8-6

Coastal Restoration Consultants





Legend

- Approximate Existing Topography
- Post-Restoration Topography

Approximate Surface Elevations Pre- and Post Restoration

Los Cerritos Wetlands Habitat Restoration Plan

Figure 8-7

Coastal Restoration Consultants

Legend

- Sub-tidal
- Tidal Channel
- Cordgrass Marsh
- Mid Marsh
- High Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- C. lewisii Preservation
- C. lewisii Mitigation
- Upland on Fill
- Bioswale/Riparian
- Experimental Plot

Habitats at Current Sea Level

Los Cerritos Wetlands Habitat Restoration Plan

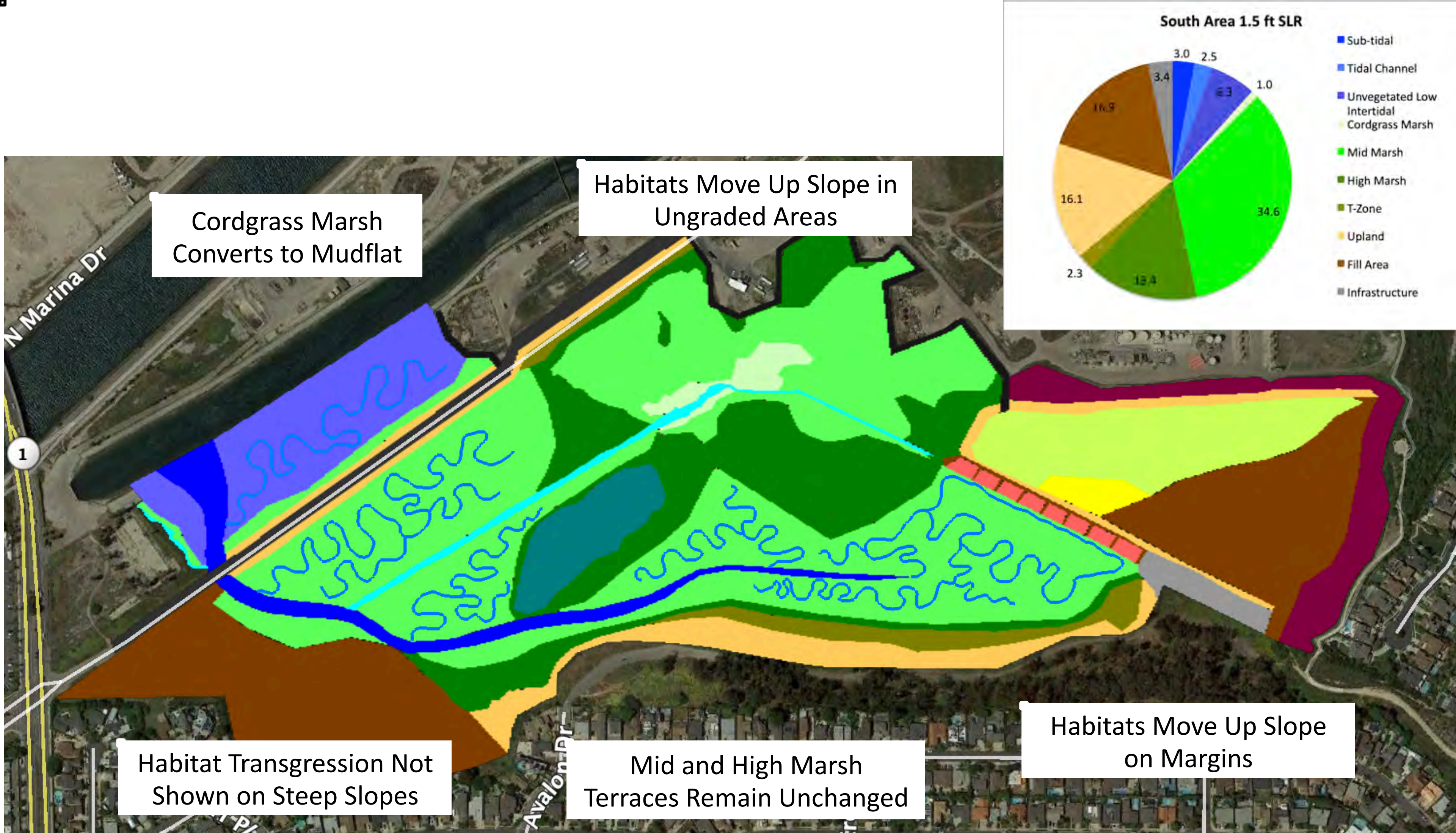
Figure 8-8

750 feet

N

Coastal Restoration Consultants

Photo Source: Google Earth May 2019



Legend

- Sub-tidal
- Unvegetated Low Intertidal
- Cordgrass Marsh
- Mid Marsh
- High Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- C. lewisii Preservation
- C. lewisii Mitigation
- Upland on Fill
- Bioswale/Riparian
- Experimental Plot

Habitats with 1.5 Feet of SLR

Los Cerritos Wetlands Habitat Restoration Plan

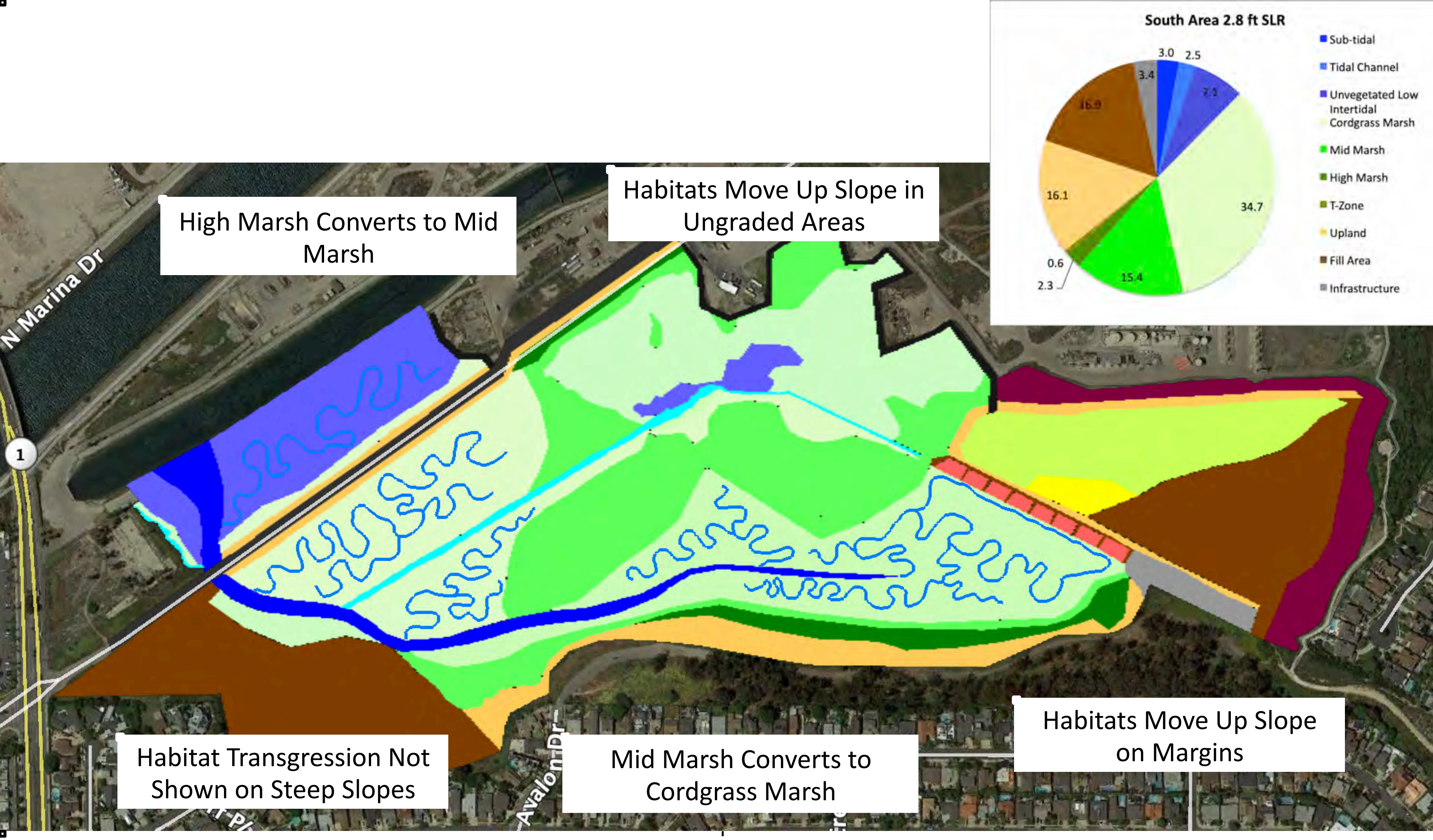
750 feet

N

Figure 8-9

Coastal Restoration Consultants

Photo Source: Google Earth May 2019



Legend

- Sub-tidal
- Unvegetated Low Intertidal
- Cordgrass Marsh
- Mid Marsh
- High Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- C. lewisii Preservation
- C. lewisii Mitigation
- Upland on Fill
- Bioswale/Riparian
- Experimental Plot

Habitats with 2.8 Feet of SLR

Los Cerritos Wetlands Habitat Restoration Plan

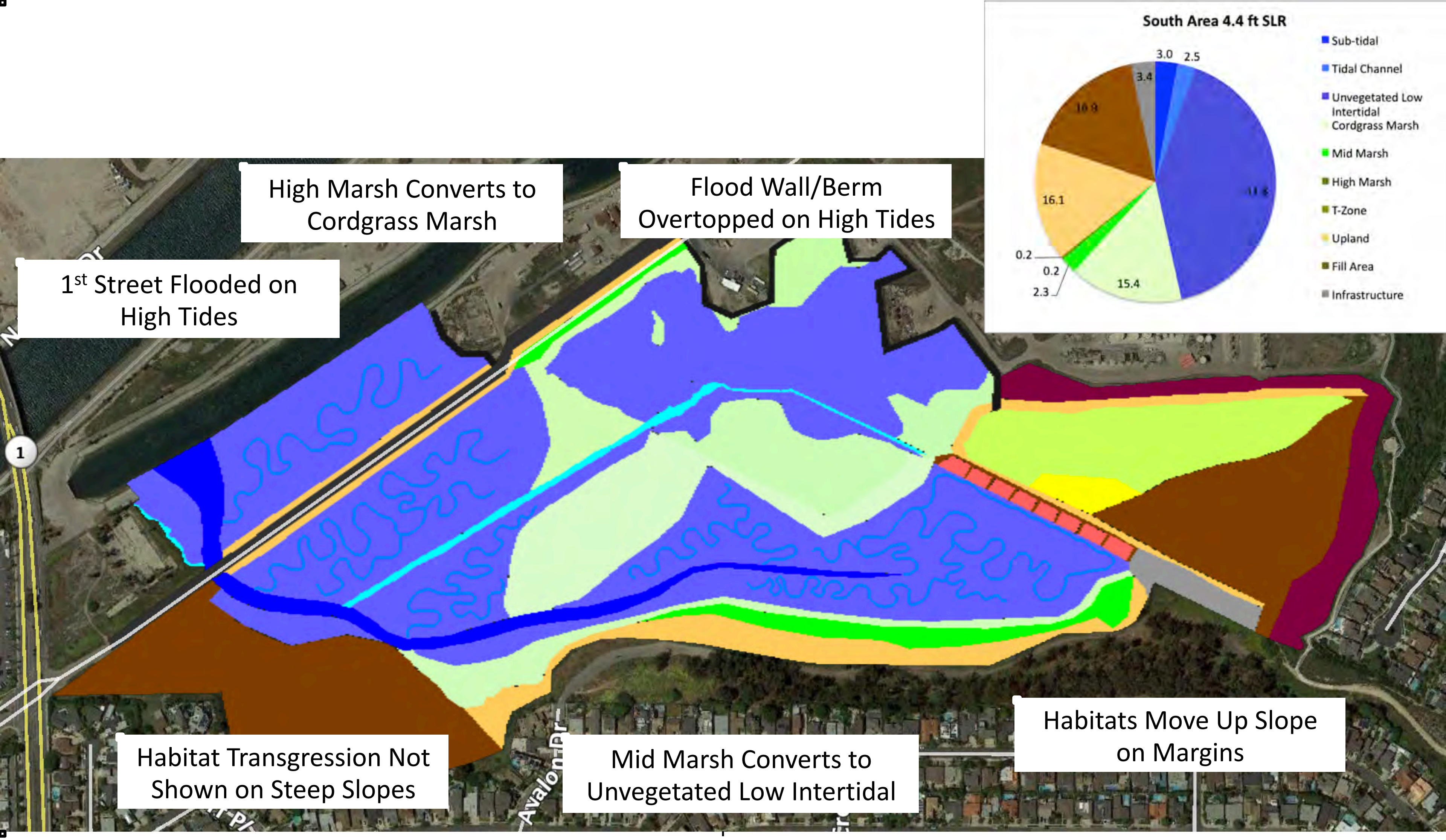
Figure 8-10

750 feet

N

Coastal Restoration Consultants

Photo Source: Google Earth May 2019



Legend

- Sub-tidal
- Unvegetated Low Intertidal
- Cordgrass Marsh
- Mid Marsh
- High Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- C. lewisii Preservation
- C. lewisii Mitigation
- Upland on Fill
- Bioswale/Riparian
- Experimental Plot

Habitats with 4.4 Feet of SLR

Los Cerritos Wetlands Habitat Restoration Plan

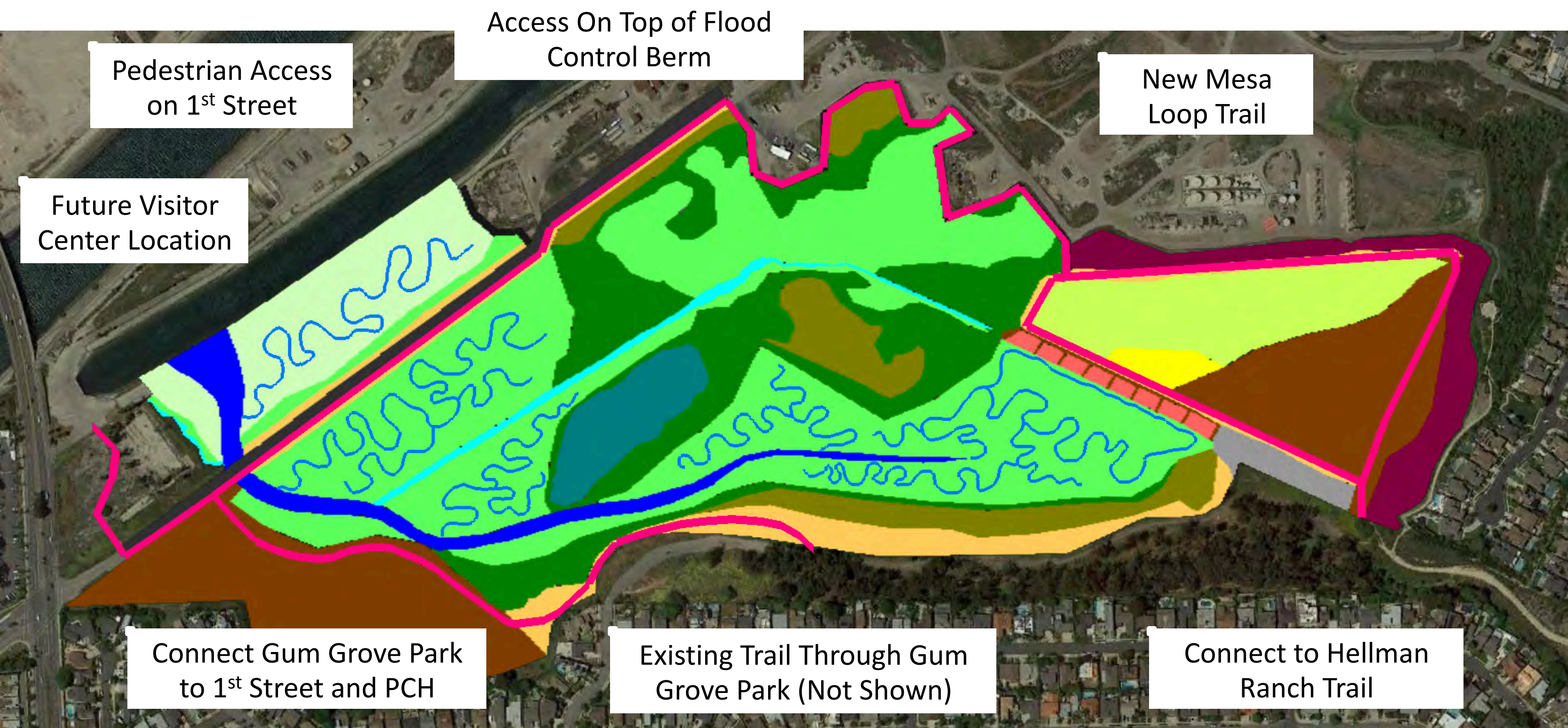
Figure 8-11

750 feet

N

Coastal Restoration Consultants

Photo Source: Google Earth May 2019



Legend

- Sub-tidal
- Unvegetated Low Intertidal
- Cordgrass Marsh
- Mid Marsh
- High Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- C. lewisii Preservation
- C. lewisii Mitigation
- Upland on Fill
- Bioswale/Riparian
- Experimental Plot

Conceptual Public Access Plan – LCWA South Site

Los Cerritos Wetlands Habitat Restoration Plan

Figure 8-12

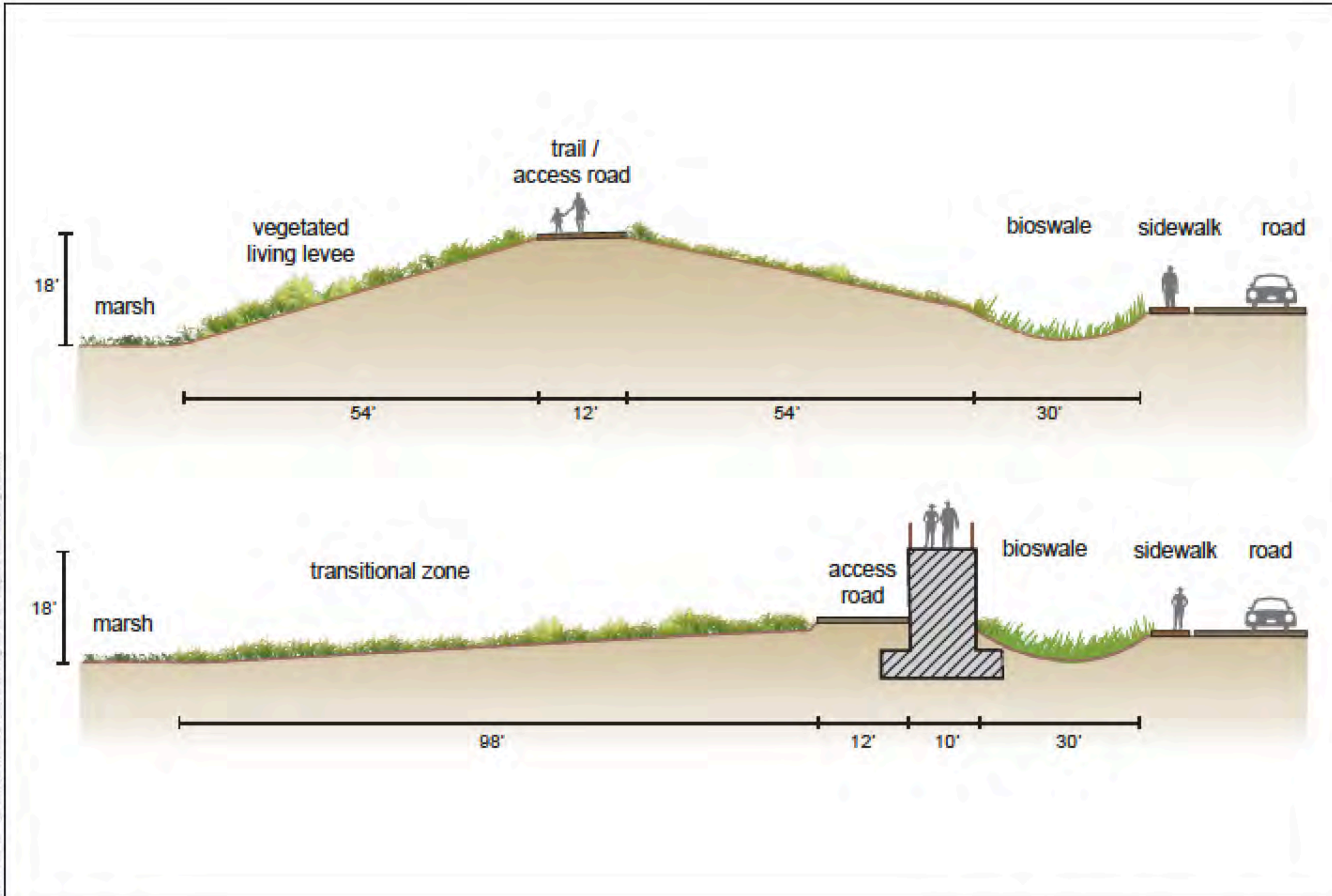
750 feet

N

Coastal Restoration Consultants

Photo Source: Google Earth May 2019

Figure 8-13. Conceptual designs for new LCWA Central site flood protection with full breach to SGR.



SOURCE: ESA, 2019

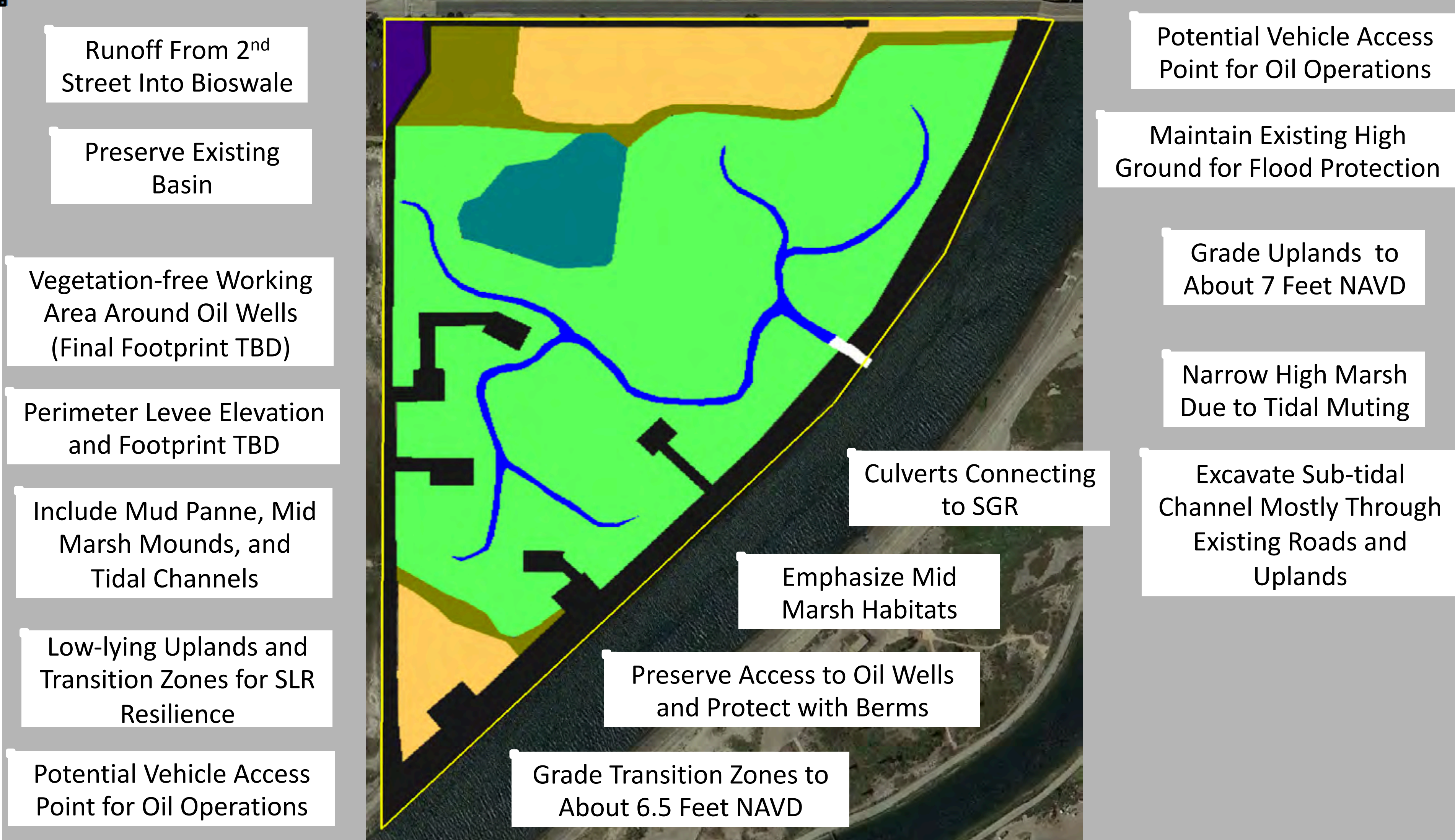
Soil Sampling Locations From the CRP

Los Cerritos Wetlands Habitat Restoration Plan

Figure 8-14

Coastal Restoration Consultants

Map Source: Kinnetic Laboratories, Inc.



Legend

- Sub-tidal
- Mid Marsh
- Transition Zone
- Salt Panne
- Upland
- Infrastructure
- Bioswale/Riparian
- Project Boundary

Culvert Alternative – LCWA Central Site

Los Cerritos Wetlands Habitat Restoration Plan

Figure 8-15

750 feet

N

Coastal Restoration Consultants

Photo Source: Google Earth May 2019

Legend

Wetlands to be Enhanced (~6 Acres)

Minimal to No Grading Wetland Areas - Central

Los Cerritos Wetlands Habitat Restoration Plan

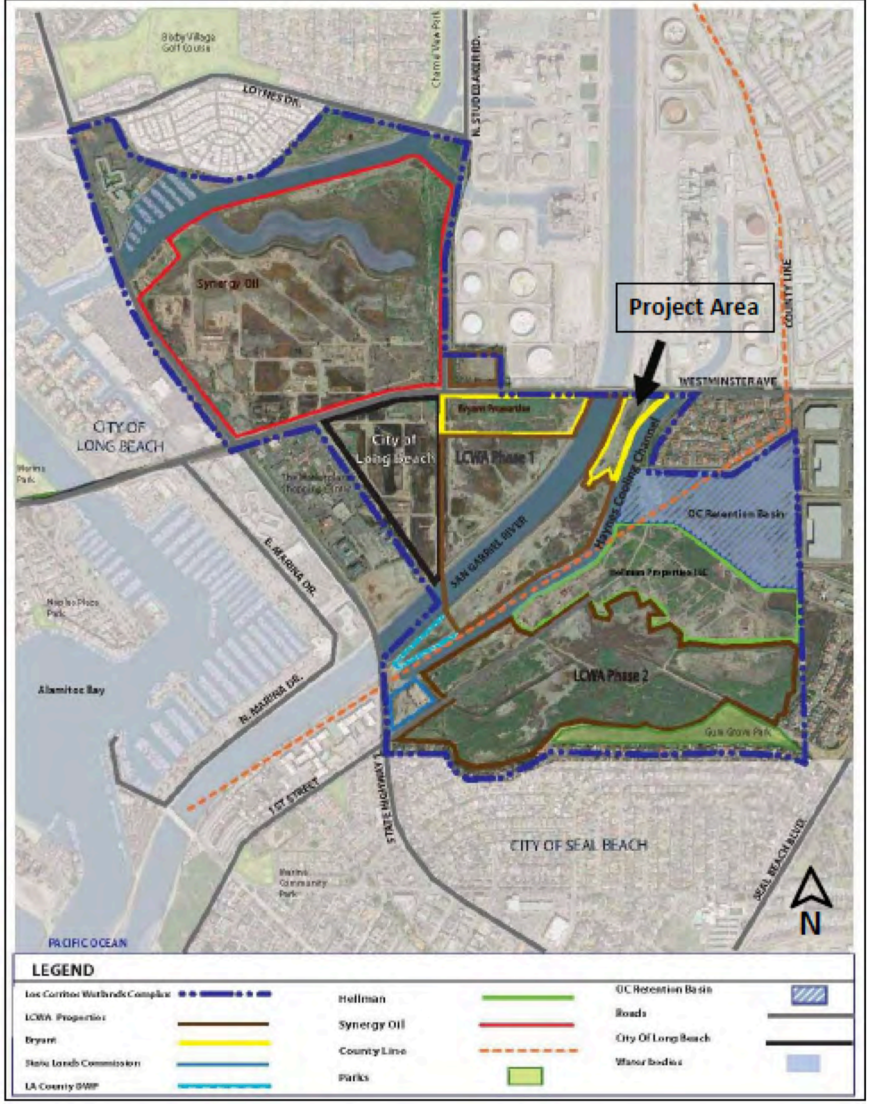
Figure 8-16

750 feet

N

Coastal Restoration Consultants

Photo Source: Google Earth May 2019



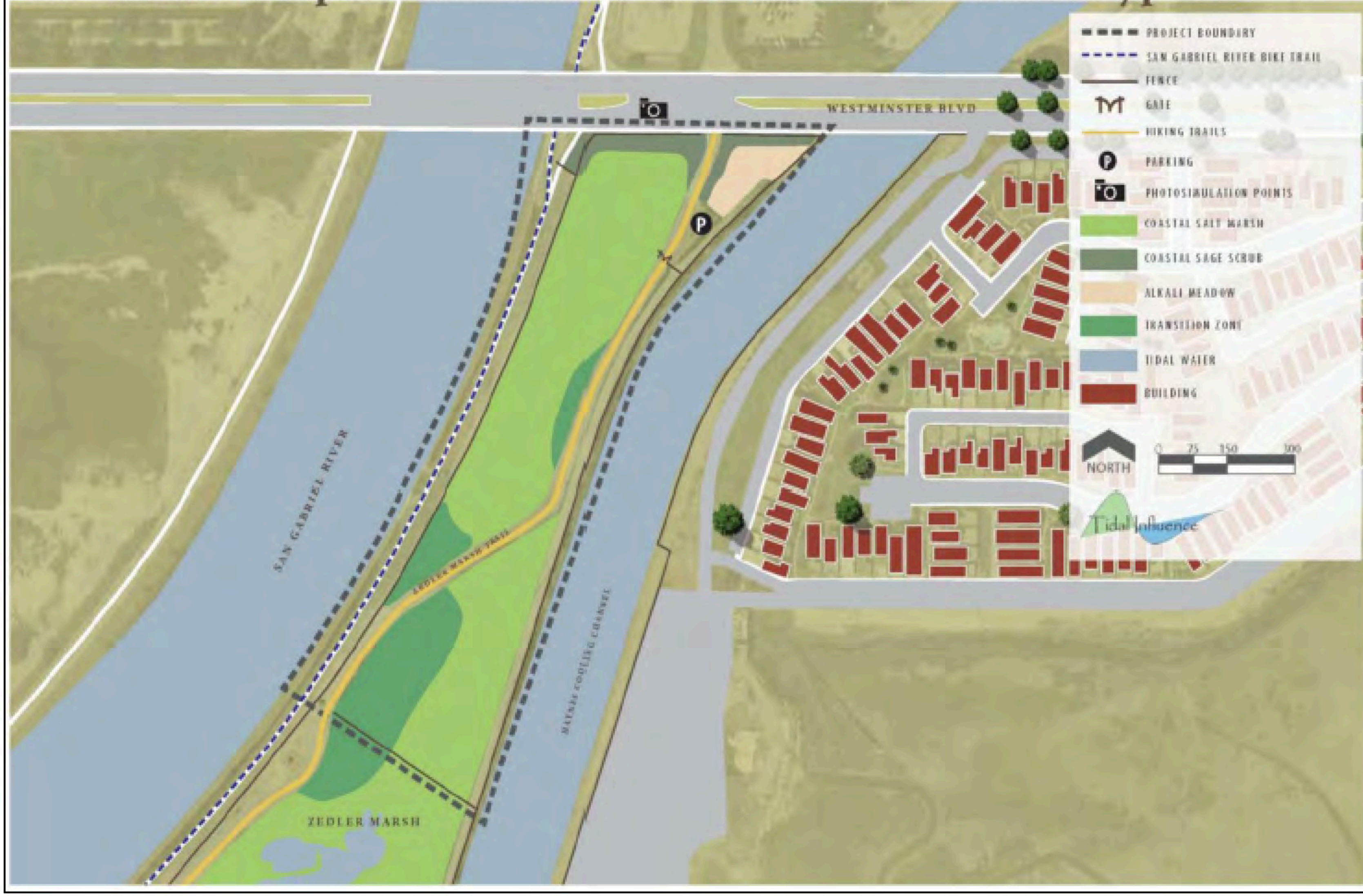
Zedler Marsh Expansion Project Location

Los Cerritos Wetlands Habitat Restoration Plan

Figure 8-17

Coastal Restoration Consultants

Map Source: Tidal Influence



Zedler Marsh Expansion Future Habitats with SLR

Los Cerritos Wetlands Habitat Restoration Plan

Figure 8-18

Coastal Restoration Consultants

Map Source: Tidal Influence

Figure 8-19. Zedler Marsh Extension current conditions (left) and with restoration and SLR in 50 years (right).

Table 8-3. Soil texture analysis from five locations in the LCWA Central site. Sand fractions less than about 20% are most suitable for salt marsh restoration.

Particle Size Distributions and Depth-Ranges Associated with Subsamples of Soil from Each Core.

Site	Depth (ft BGS)	% Gravel	% Sand	% Silt	% Clay
A-1	0-3.5	2	23.1	53.1	21.9
A-2	4.75-7.25	5.6	29.3	48.6	16.6
A-3	7.25-8.25	0	21.7	71.8	6.5
A-4	8.25-9.9	0	2.5	77.3	20.2
A-5	9.9-10.0	0	20	68.5	11.5
B-1	1.0-3.25	0	14	61.4	24.6
B-2	5.75-8.0	0	4.8	81.6	13.6
B-3	8.3-10.4	0	28	67.2	4.8
B-4	10.4-11.5	0	1.3	68.2	30.5
C-1	0-3.4	0.8	23.6	51.6	24.8
C-2	3.4-6.9	0	8	70.2	21.8
C-3	6.9-9.0	0	19.3	69.6	11.1
C-4	9.0-10.0	0	3.4	67.5	29.1
C-5	10.0-11.5	0	47	49.2	3.8
D-1	0-2.5	5.1	43.5	37	14.4
D-2	3.25-4.75	0	61.3	34.4	4.3
D-3	5.0-7.25, 7.6-11.0	0	36.8	53	10.2
D-4	7.25-7.6	0	6.4	67.8	25.8
E-1	0-6.6	0	1.8	63.6	34.6
E-2	6.6-8.4	0	4.4	80.9	14.7
E-3	8.6-10	0	35.4	52	12.6

9 IMPLEMENTATION GUIDANCE

Implementation of large-scale restoration projects like the ones outlined in this plan are expensive and complicated, and success is never guaranteed. While careful planning is crucial in the early and mid stages of project design, the final stages of planning that deal with the actual building of the project can make or break a project. It is crucial that experienced restoration engineers and restoration ecologists work together to develop good guidance for contractors to follow for the construction *(i.e.*, earth moving) and installation (*i.e.*, planting) phases of the project(s). The following discussion provides very general guidance on some of the important aspects of helping to assure the project is built and installed in a way that will maximize the chances of success. The following sections highlight topics that are often overlooked in implementation plans. These topics, along with many others, will need to be developed in more detail in the form of implementation plans for each project.

9.1 Adaptive Management and Adaptive Restoration

Adaptive management is a tool for achieving success where there is uncertainty as to what actions will be needed to accomplish specific goals. Ecological restoration is inherently uncertain. There are simply too many variables to control, especially in a large tidal salt marsh restoration as proposed in this plan. Implementing this project using an adaptive management and adaptive restoration approach will lead to better outcomes and help the project meet its goals.

The hallmark of the adaptive management approach is a reliance on streams of data that are regularly analyzed and used to assess progress towards the achievement of goals. In the implementation phase of restoration there are typically detailed goals and/or performance criteria (e.g., percent cover of native species, population sizes for special status species, specific hydrologic regimes, etc.) and adaptive management has a clear role in assuring the goals are met by assessing progress (i.e., data collection) and fine-tuning techniques and designs as necessary to achieve the goals. Adaptive restoration is a process of “learning while restoring” (Zedler 2016). The goal is to achieve on-the-ground ecological goals, fill data gaps and reduce uncertainty, while also improving strategies for future restoration. Project-specific adaptive management plans should be included as part of implementation plans.

9.2 Soils

There is limited information available on the soil texture below the surface in most of the South LCWA Site. The whole site has either received fill or been severely disturbed in the past. In some places the fill might be more than 10 feet deep. The entire area was likely tidal salt marsh historically and those native marsh soils may still be present, though at what depth, is not currently known. Ideally, marshes could be restored on the historic marsh soils.

While this may be feasible, it is more likely that compaction and subsidence have moved that old marsh surface to a depth too deep to support target habitats. This needs to be examined in the next round of planning.

Casual observations of soil conditions on the surface and analysis of historic aerial photos suggest there were multiple rounds of filling from different sources over many years. For instance, there are areas with very high sand content in two areas. Shells in these materials suggest the soil was dredged from near-coast sub-tidal areas. Soils in large areas of the upland seem to be loamy and may have come from river sediment or grading in adjacent uplands. Other areas, especially the lower elevations, seem to have fairly heavy soils (*i.e*., compacted or with high silt and/or clay content).

There is limited information on the salinity of soils at depth for the South LCWA Site as well. High soil salinity will not be a problem for restoration in tidal areas, but establishing upland and transition zone habitats on salty soils will be problematic. Contaminated soils will need to be reclaimed, remediated, buried, or hauled off site.

Restoration success will depend on having appropriate soil texture for cordgrass, mid, and high marsh habitats. These soils should have low sand and high silt and clay content. Uplands and transition zones can be restored on a variety of soil textures, but they should have very low salinity. Further studies of the existing soil characteristics will be crucial in the next phase of planning and development of a plan for soil remediation, treatment, and amendment.

9.3 Revegetation Strategies

Detailed revegetation plans will be part of the implementation plan(s). Specific guidance on revegetation will need to be developed. Table 9-1 outlines general strategies, based on the experience of the authors and relevant literature (Zedler 2000), for restoring different habitats that should be followed.

Table 9-1. Revegetation strategies for different habitats. Guidance for vegetating levees can be found in the PEIR.

	Considerations for Restoration
Sub-tidal	- Establishing *Zostera marina* from turion transplants - Shown to be successful at other sites
Low Intertidal Unvegetated	- No planting
Cordgrass Marsh	- Plant *Spartina foliosa* from container stock or plugs - Establishing tall robust plants requires fine soils with organic matter and good tidal flushing
Mud Panne	- Plant *Salicornia bigelovii* from seed - Plant *Batis maritima* on margins
Mid Marsh	- Plant high diversity of marsh species from container stock - Irrigation may aid establishment - Do not plant or seed *Salicornia pacifica*

	-Plant *Suaeda esteroa* from seed
Salt Panne	- Seed *Lasthenia glabrata* ssp. *coulteri* around edges
High Marsh	- Plant high diversity of marsh species from container stock and seed - Use irrigation to control soil salinity and aid establishment - Do not plant or seed *Salicornia pacifica*
Transition Zone	- Plant high diversity of species from container stock and seed - Use irrigation to control soil salinity and aid establishment - Plant more wetland species at lower elevations and more upland species higher
Upland	- Use direct seeding and container plants - Plant grassland species on heavy soils - Plant coastal prairie species on sandy soils - Plant coastal sage scrub on slopes and better-drained soils - Use irrigation only in the rainy season to aid establishment - Will require extensive weeding
Riparian/Bioswale	- Plant cuttings/stakes and container stock - Use irrigation until roots reach groundwater - Will require weeding

9.4 Final Grading

Grading plans based on the Refined Restoration Plan for the South LCWA Site will need to be developed in the next phase of planning. These plans will be developed to different levels of detail over time. The earliest grading plans will have the least detail and will support hydrologic and hydraulic modeling, which will be used to refine the grading plan. Eventually, smaller details will need to be included in these grading plans, like microtopography features such as mud pannes and mid marsh mounds in the marsh plain and small sinuous tidal channels.

Prior to construction, bid documents will be developed that will direct details on how the grading contractor should handle soils. It will be important to identify specifications for selective grading such as:

- Burying saline soils at the bottom of fill mounds or flood protection structures so that upland habitats can be restored
- If soil needs to be hauled off-site, selectively haul saline soil and keep soils appropriate for upland restoration on-site in fill areas
- Assure the top two feet of soil in fill areas is appropriate to the target habitat to be restored
- Dealing with contaminated soils will require special attention
- Protecting some existing sensitive habitat features in place

Specifications for soil compaction will need to be developed as well. Soil placed in fill areas will need to be compacted, but final soil surface should be ripped to two feet deep and then disked to assure water infiltration for grassland and coastal sage scrub restoration. Shallower ripping followed by disking may be appropriate for other habitats such as coastal prairie and vernal pool. Soil compaction should be avoided in restored tidal areas. This can be accomplished by using low ground pressure construction equipment (preferred) or by ripping and disking areas after final grading.

All of these guidelines will add cost to the construction aspect of the project. However, this cost is justified by 1) making the revegetation phase less expensive and more successful, and 2) making the marsh and upland areas higher-functioning sooner.

9.5 Ecosystem Monitoring

Demonstrating many of the ecological benefits of restoration requires ecosystem monitoring. A detailed monitoring plan will need to be included as part of the implementation plan(s). This monitoring will be used to demonstrate how the site is functioning post-restoration and will assess progress towards and achievement of quantitative goals related to vegetation, hydrology, wildlife, etc. Additional baseline monitoring should start before the restoration project is built, preferably in the next phase of planning. This monitoring should be designed to provide a "before" picture of how the site is functioning now. This will allow for more effectively demonstrating some of the ecological benefits of the restoration project by showing how the functioning of the site changes post-restoration. An example of this type of comprehensive monitoring was developed for the SONGS mitigation project at San Dieguito Lagoon in San Diego County[12].

9.6 On-site Mitigation

The Refined Restoration Plan for the South LCWA Site includes actions that could lead to impacts to existing wetlands, special status plants, and probable ESHA. The CCC and other agencies will review these actions closely, and any impacts will need to be mitigated, preferably on-site. The Refined Restoration Plan for the South LCWA Site includes turning large areas of upland into jurisdictional waters and wetlands so it is expected to be self-mitigating in that regard. Mitigating impacts to non-wetland species, specifically *Camissoniopsis lewisii* and *Centromadia parryi* ssp. *australis* will likely be required. Continued and more detailed data collection on existing populations prior to permitting and construction will help determine appropriate mitigation goals. Relatively little is known about restoring *C. lewisii* so pilot re-introductions and other studies should begin soon to better understand this species and assure any impacts can be successfully mitigated on site.

[12] https://marinemitigation.msi.ucsb.edu/documents/ccc_reports/SONGS_permit/SONGS_permit_6-81-330-A_(formerly_183-73)_May1997.pdf

10 NEXT STEPS

The next phase of restoration planning will be focused on the South LCWA Site. The LCWA has already started scoping for the next phase of planning. This section of the restoration plan includes an outline of LCWA's plans along with additional data gaps that will ideally be filled prior to implementation.

10.1 The Next Phase of Planning – South LCWA Site

LCWA has secured grants to begin the next phase of restoration planning for the South LCWA Site. That planning effort will further refine the Refined Restoration Plan for the South LCWA Site design, initiate permitting, and progress to the project-level CEQA review. The current plan is for the next phase of planning to include the following tasks:

1. Data collection related to hazardous materials, cultural, and biological resources
2. Geotechnical analyses
3. A wetland delineation
4. Preliminary design including grading plans, hydraulic modeling, and planting plans
5. Project-level CEQA including at least an Initial Study and Mitigated Negative Declaration
6. Agency consultation and permitting
7. 65% designs for restoration
8. Outreach to stakeholders and the public via multiple outreach events/meetings

10.2 Data Gaps – South LCWA Site

The Refined Restoration Plan for the South LCWA Site developed in this plan is a feasible approach for accomplishing the projects' goals and objectives. However, there are still many details to be worked out, due in large part to important data gaps related to soil contamination, permitting requirements, and timing and availability of tidal connections, and to a lesser degree, hydrology and special status species. While it is not expected that all data gaps will be filled prior to building the project, working towards that goal while refining plans will increase the probability of achieving success in the long run. The data gaps fall into two general categories, 1) data and studies needed to support CEQA and permitting and 2) data needed to refine the basis of design.

10.2.1 Data Gaps Related to CEQA and Permitting

Tasks 2.1-2.4 in the list of tasks shown above in Section 10.1 are expected to fill important data gaps needed to complete CEQA and permitting. Other important items that will factor into permitting and CEQA review that will need to be addressed early in the next phase of planning, include:

- Consultation with USACOE about permitting needs (404 only or 404 and 408 permit) regarding the removal of the flap gate on the existing culvert between the SGR and the South LCWA Site
- Consultation with City of Seal Beach about existing wetlands and potential hydrologic changes on their property
- Consultation with LADWP about using the HCC as a source of tides
- Consultation with easement holders including utilities and oil operators

10.2.2 Data Gaps Related to Refining the Basis of Design

The basis of design detailed in Chapter 6 of this plan can be improved upon and refined with more data collection and analysis. This will need to be done as the Refined Restoration Plan for the South LCWA Site is developed into the 65% design in the next round of planning. Specific approaches for filling different data gaps will vary with the nature of the data needed, but all data should be collected with a specific question or hypothesis in mind. The data collection methodology (e.g., frequency of sampling, precision of measurements, number of sampling point, etc.) should be sufficient to answer the question or hypothesis. In many cases, single data streams can be used to help answer multiple questions and hypotheses. As data is collected and analyzed, new questions and hypotheses will likely develop. Thus, the data gaps identified herein may need to expand or at least be refined over time. Data gaps fall into the following categories:

10.2.2.1 *Hydrology and Hydraulics*

Data collection, modeling, and analyses will be needed to develop a grading plan that will lead to successful restoration of the target habitats laid out in the Refined Restoration Plan for the South LCWA Site. The grading plan will be developed based on the expected hydrology with the two phases of tidal connections.

- Modeling existing culvert and Phase 1 with updated grading plan
- Modeling of Phase 2 HCC connection with updated grading plan
- Hydrogeomorphic design and sizing of tidal channels using hydraulic geometry relationships
- Study of flooding extent on City of Seal Beach property in the southeast corner of the site
- Assess strategies to limit ingress of trash through the SGR culvert
- Study of overland stormwater flows at the east end of the site
- Monitor groundwater (depth and salinity) in the bioswale/riparian area
- Refine the hydrodynamic model as needed

10.2.2.2 *Soils*

Based on the Phase 1[13] findings, it is known that soils in the South LCWA Site have been impacted from past oil operations. A Phase 2 investigation is needed to better define the concentration and extent of impacted soils on the site. The remediation approaches will be developed following the investigation, but could include, in-situ treatment/remediation, removal and disposal at a permitted facility, and/or stabilization, containment, and avoidance.

In addition to soil testing to better understand contaminants on the site, systematic soil sampling in areas to be excavated will be needed to assess their suitability for restoration. This should be done with a "geo probe" or similar (Figures 10-1 and 10-2) by a qualified restoration ecologist or soil scientist familiar with restoring wetlands and uplands in southern California. Important parameters to understand will be soil texture (in wetlands and uplands) and soil salinity (in spoil areas). Comprehensive soil suitability testing (e.g., macronutrients, micronutrients, pH, etc.) should be done on a subset of samples. This testing will inform the extent to which selective grading will or will not be needed to assure the near-surface soils are appropriate for supporting target habitats. Along with the contamination analyses, this data should inform potential changes in the grading footprint to potentially avoid some problematic areas and/or take advantage of "good" areas (e.g., where historic marsh soils are found buried).

Other investigations related to soils include:

- Nature and extent of landfill material in the southwest corner
- Assess feasibility of stockpiling appropriate soil on site for future use in beneficial sedimentation of the marsh as sea level rises or for flood protection in the Central Area

10.2.2.3 *Biological*

The next phase of planning will require directed surveys for special status species and a wetland delineation. These, along with biological studies in the CRP and PEIR, are likely adequate to support the next phase of planning and any revisions in the project design. There are important biological data that could start to be collected before implementation to ultimately be able to show the ecological benefits of the restoration project, demonstrate successful implementation, and reduce the uncertainty around certain restoration actions. These can include before/after studies of the restoration site, data collection from reference sites, and small-scale trials.

[13] Environmental assessments of soils are conducted in two phases.

Before/After studies can be fairly simple or include rigorous statistical analyses. The goal is to show how a site is functioning prior to restoration and over time after restoration. These studies go beyond simple calculations like changes in habitat area and would aim to quantify functional lift. An example of a before/after type of study that would be valuable at the LCW would be to collecting quantitative data on bird usage in different areas by delineating polygons and counting all birds observed in the polygons in a set amount of time (usually a few minutes) multiple times per year. Under pre-project conditions, polygons would be in existing wetlands and in uplands. Continuing the surveys post restoration would demonstrate how bird usage changes with improved tides in existing wetlands, where uplands were preserved, and where uplands are graded to restore tidal wetland. Continuing the counts would also demonstrate how bird usage changes as the restoration project matures and over even longer timelines as SLR start to alter habitats.

It will also be important to identify reference sites in other tidal marshes. Once the extent of tidal muting is modeled for the Refined Restoration Plan for the South LCWA Site, one or more natural high-functioning marshes with similar tidal regimes should be identified. Prior to construction, monitoring data from reference sites should be used to support the refinement of the restoration design in the next phase of planning. Things like topography, water quality, vegetation composition and structure, and fish and wildlife usage should be monitored in the reference site(s). This will not only inform the design, but will help in setting realistic performance standards for the restored marsh. It is likely that monitoring data from the SONGS Mitigation Monitoring program[14] would be useful (and perhaps sufficient) to help refine the plan and serve as a model for setting and assess performance standards.

Finally, all restoration projects must deal with uncertainty. Adaptive Management and Adaptive Restoration are effective during the implementation and monitoring phases. There may be opportunities to identify and address key uncertainties prior to project construction. One example would be to study Lewis' evening primrose populations at the site and investigate strategies for mitigating potential impacts. These studies might include pilot seeding or planting projects in potential mitigation areas, seed bank studies, and seed viability versus storage time studies. The goal would be to demonstrate to the agencies that mitigating impacts to this poorly understood species are feasible or already working.

10.3 Public Access and Visitor Experience

The details of the public access components of the project will need to be worked out in further detail in the next round of planning. The LCWA and the CCC see public access and education as important goals of the restoration projects at the LCW. Details will need to be

[14] https://marinemitigation.msi.ucsb.edu/mitigation_projects/wetland/index.html

worked out around trail designs, locations, and accessibility, interpretive installations (*e.g.*, educational signs), and built infrastructure (*e.g.*, visitor center). This planning should occur with appropriate amounts of public and stakeholder input. Access in the South, Isthmus, and Central Areas could be integrated as envisioned in the CRP and PEIR or proceed on separate tracks.

10.4 Permitting and Approvals

As the LCWA develops more detailed designs to implement the proposed program projects, the LCWA will evaluate those projects using an approach similar to a CEQA Initial Study to determine if the PEIR provides adequate CEQA coverage for all of their potential impacts. If the project requires additional CEQA analysis, the LCWA would conduct that analysis and prepare additional CEQA documentation, such as a Supplemental EIR or an Addendum to the PEIR.. Restoration activities associated with the more detailed design would require discretionary approval from multiple agencies. These agencies and their permits/approvals are described in the PEIR. The specific permits/approvals expected for the South LCWA Site are provided in Table 10-1.

Table 10-1. Possible permits and approvals

Approving Agency	Approval
City of Seal Beach	Site plan review, grading permits, encroachment permits
City of Los Angeles Department of Water and Power	Encroachment permits
Orange County Public Works	Encroachment permits
South Coast Air Quality Management District	Permits to construct and operate
Santa Ana Regional Water Quality Control Board	Permits to construct and operate, Clear Water Act 401 Permit
California Department of Fish and Wildlife (CDFW)	Section 1602 Streambed Alteration Agreement, California Endangered Species Act consultation, Take permits
California Coastal Commission	Coastal Development Permit in City of Seal Beach
U.S. Army Corps of Engineers	Clean Water Act Section 404 Permit, Rivers and Harbors Act Sections 9 and 10 Permits, Clean Water Act Section 408 Permit
U.S. Fish and Wildlife Service and National Marine Fisheries Service	Endangered Species Act Section 7 Consultation

10.5 Timeline

Implementing restoration in the South LCWA Site will be a complicated undertaking that will take at least several more years. There is considerable uncertainty built into timelines surrounding funding availability and CEQA and permitting. Completely unforeseen challenges to progress can arise. Table 10-2 is a very approximate timeline that outlines major steps and about how long they might realistically be expected to take.

Table 10-2. Approximate timeline for the South LCWA Site assuming funding is available in a timely manner. This timeline assumes two phases of construction with design and permitting of both phases followed by two phases of construction and monitoring. The phases would ideally be combined into one if agreements were in place to connect to the HCC.

Action	Approximate Start Date	Approximate End Date
Informal agency consultations	Mid 2020	Late 2020
Additional, bio, cultural, soil, etc. studies	Late 2020	Late 2021
Revised restoration design and 65% engineering drawings	Late 2020	Mid 2022
Project environmental review and permit applications	Late 2021	Mid 2022
Stakeholder, TAC and public outreach	Mid 2021	Mid 2022
Implementation and monitoring plans	Late 2022	Late 2023
Final design and construction bid documents Phase 1	Late 2022	Early 2024
Final permits and CEQA certification	Late 2022	Early 2024
Construction of Phase 1	Mid 2024	Early 2025
Monitoring Phase 1	Early 2025	Late 2030
Final design and construction bid documents Phase 2	Late 2027	Early 2028
Construction of Phase 2	Mid 2028	Early 2029
Monitoring of Phase 2	Early 2029	Late 2034

Figure 10-1. Geo Probe soil coring rig.

Figure 10-2. Geo Probe soil core being analyzed.

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