APPENDIX B2
Stormwater Management Plan

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PRELIMINARY -
STORM WATER MANAGEMENT PLAN -

For -

BALLONA RESTORATION PROJECT -

By -

PSOMAS -

Dated: July 10, 2015 -

PURPOSE:

The purpose of this draft report is to outline the storm water management measures that will be implemented during construction to mitigate soils loss and dust control, as well as a description of the permanent project features and benefits proposed. This preliminary report is intended to provide an environmental impact analysis level discussion which will be expanded upon for the final Storm Water Management Plan to be used during project implementation.

This report is organized to discuss these issues in four categories. First, the storm water pollution prevention elements to be implemented during construction. Second, permanent project features and benefits to be provided and maintained in perpetuity. Third, the establishment periods and phasing that may be necessary for full implementation. And fourth, the maintenance and operations that may be necessary. After these four areas are discussed, an additional section that more specifically describes project specific storm water management elements is included.

I. Storm Water Pollution Prevention During Construction:

The overarching intent of storm water management during construction is to manage the construction activities and site conditions to reduce pollutants of concern from migrating from the site. This goes beyond the measures taken related to storm water events and includes daily operations. During implementation of this project, the majority of the construction involves grading of mass volumes of dirt. These activities generate potential soils migration from the site through surface soils movement activities and airborne dust generation. In addition, other activities will be conducted to include construction of structures, hardscape installation, equipment and signage installation, etc. Best Management Practices (BMP's) will be required to mitigate the potential impacts from these activities. BMP's will include the following daily list of activities and features:

- Application of water on dry soil to reduce losses through airborne dust.
- Placement of physical barriers such as straw waddles, silt fences, etc. to reduce loss of surface soil during rain events and daily cleanup operations.
- Installation and operation of Vehicular Staging Areas that includes wheel washes and oil pan drip collection to reduce the introduction of man-made products onto the site.
- Installation of vehicular dust containment measures, such as tarps or enclosures to limit soils and dust migration.
- Installation of local containment devices such as filter fabric or fiber rolls on existing drain inlets on adjacent streets as a secondary measure to further reduce the possibility of soils migration into downstream infrastructure or waterways.

Other BMP measures that will be implemented on a longer term, but still temporary basis, may be necessary. This would primarily be for areas that are graded but must be left in an unfinished condition until final construction is completed. For example, there may be a gap in time between grading of the levee and installation of the maintenance and pedestrian/ bike trail on top of it. Or, for the time between temporary placements of stockpiled soil for future grading fill operations, and its ultimate placement. Where construction phasing or sequencing like this occurs, BMP's may include:

- Application of temporary soil surface coatings, such as applied biodegradable chemicals or fabric.
- Application of temporary vegetation.
- Installation of temporary and removable sheeting material to cover newly graded areas.
- Were unfinished and newly graded areas are located such that rain event runoff might have localized erosion, interim storm water detention and settling areas may be provided.

II. Long Term Storm Water Management Features

The project itself acts as a storm water mitigation feature for the Ballona Watershed. As a wetlands restoration project, this project site will include a storm water cleansing functionality that will help remove constituents of concern through bio-uptake and re-establishment of a viable, sustainable, and natural ecological system. While the project serves this function and benefits the region, there are also many individual local beneficial features. The following lists specific types of permanent storm water management features that will be implemented within the project. More detailed descriptions are provided below:

- Bio-swales will be installed at the toe of all slopes steeper than 10 to 1, and along the non-creek side of the levees. Bio-swales allow the collection of runoff from the adjacent contributing slopes, bio-uptake of constituents in the runoff, and infiltration into the soil of the minor flows collected.
- Grading and installation of pre-treatment basins will be provided. These basins allow storage and controlled discharge of runoff to allow settlement of suspended solids prior to storm water discharge to main water bodies or primary retention areas.
- The project provides full vegetation coverage for bio-uptake of nearly the entire project area.
- For those areas with impervious surfaces, routing of storm water that falls on the impervious surfaces, such as bridges and trails, into vegetated areas will be provided for infiltration and bio-uptake of all localized runoff.

- The existing Fresh Water Marsh is a stormwater treatment BMP for storms events less than the 1-year storm for its upstream developed area. Modifications to the outlet weir will enhance this functionality.

- Erosion mitigation measures will be placed at all storm drainage outlets, on the more erodible portions of the side slopes of the levee, and on areas of pedestrian, bike and vehicular traffic. For the levee and drainage structures, these measures would include strategically located surface and sub-surface armoring. For access ways, the travel way surfaces would include compacted soil, gravel, decomposed granite, asphalt, concrete, or other appropriate surface material depending on the intended use.

III. Establishment Periods, Implementation, and Phasing

Construction will occur over an extended period of time, and in multiple phases and sequences. Temporary erosion control measures will be utilized prior to and during all construction activities, and will be implemented between construction sequences during the life of the project construction. Phasing and sequencing of project elements have been described in other areas of the analysis. Specific sequencing and sub phasing will be determined by the appropriate agencies, design team, and contractor prior to initiation of construction. Flexibility to adjust sub phasing is expected within the perimeters within the impacts and mitigations proposed.

Sufficient time must be allowed to establish the plant palette to the point it is essentially considered self-sustaining. During this establishment period, weekly, monthly, and seasonal evaluation and maintenance will be required.

IV. Operations and Maintenance

Erosion protection measures during construction and establishment periods will be an ongoing effort. After an initial mobilization and installation effort of providing the materials, there will be a constant effort to minimize the amount of erosion and sediment escape from the property. The initial effort will include installation of truck access BMP’s including wheel washing areas, silt fencing and slope protection installation around the edge of the property and adjacent to all public roadways and drainage inlets. Installation of silt fencing and other surface erosion protection will not be required within the property except in localized cases. However, dust control measures throughout the property will be required and ongoing.

Ongoing maintenance during grading will include three primary efforts, dust control by deployment of water trucks, maintenance of the perimeter and local structure containment protection, and vehicular access point cleaning operations. Because the soil is generally in a moist or wet condition it is anticipated that dust control can be accomplish with one water truck and its operator working constantly on a daily basis. However, multiple water trucks may be necessary during peak times and during particularly dry conditions. In addition, on a daily basis another truck and maintenance crew of two people will be utilized to inspect and repair any broken or missing erosion protection equipment or material. Operation of the wheel wash and access areas will require an average of a two person crew at each access location. During transfer of soils between areas, an access control station must be provided in each area. After grading is completed in any particular area, erosion protection will applied to the entire completed area and then inspected and maintained through the plant establishment period. It is anticipated that a crew of four people and one truck will be required for the duration of the plant establishment period.

After the construction and the plant establishment period is complete, the goal is that erosion protection will be accomplished through the natural plant palette in a self-sustaining manner. However, regular inspections and sporadic maintenance is expected.

V. Project Specific Storm Water Management Elements

a. Existing and Proposed Storm Water BMP's

There are a number of existing storm water mitigation features serving the property that will remain or be enhanced as shown on Figures 1 and 2. These include the Fresh Water Marsh, a detention basin in the Culver-Lincoln roadway loop, and a series of depressed areas that act as pre-treatment basins along an old, degraded drainage ditch along the toe of the Westchester Bluffs where a number of low areas exist. The Fresh Water Marsh will remain essentially as is with minor improvements to add additional storage controls. The detention basin in the roadway loop will remain as is. And, the historic drainage ditch will be enhanced with some grading and connectivity for drainage which will reduce the likelihood of erosion.

Proposed BMP's will include bio-swales, pre-treatment basins, discussed below, together with storm drain piping and detention basins. These proposed BMP's are presented on Figures 3 through 6 with details presented on Figures 7 through 13.

b. Bio-Swales

Bio-swales are placed throughout the project in order to serve erosion protection, water quality, and drainage routing functions. Bio-swales will vary in width from approximately three feet to twenty feet, and in depth from a few inches to two feet, Figure 12. Bio-swales will be place at the toes of all slopes greater than a ratio of 10 to 1 horizontal to vertical to collect storm water runoff from the slope face. When the volume of runoff is minor and does not need to be routed to a detention area or conveyance feature, the bio-swale will be sized to contain the volume anticipated for a 100-year storm event. In these cases, the bio-swale may have some minor longitudinal slope but acts more as a detention feature. For Larger volumes and when bio-swales act to convey storm water from the slope to a conveyance, treatment, or storage feature, the bio-swale will be designed to contain the flow and protect against erosion. Longitudinal slope will be very shallow, generally less than one percent. Bio-swales will also be utilized along the edges of existing roadways outside of public right-of-way to collect storm water runoff from the adjacent roadway. The additional enhancement to these bio-swales will include elements to address the oils and other vehicular fluids expected in this type of runoff. These elements may include a different mix of vegetation and soils composition to allow the breakdown of the expected runoff constituents without long term loss of vegetation or extra maintenance requirements.

c. Pre-Treatment Basins

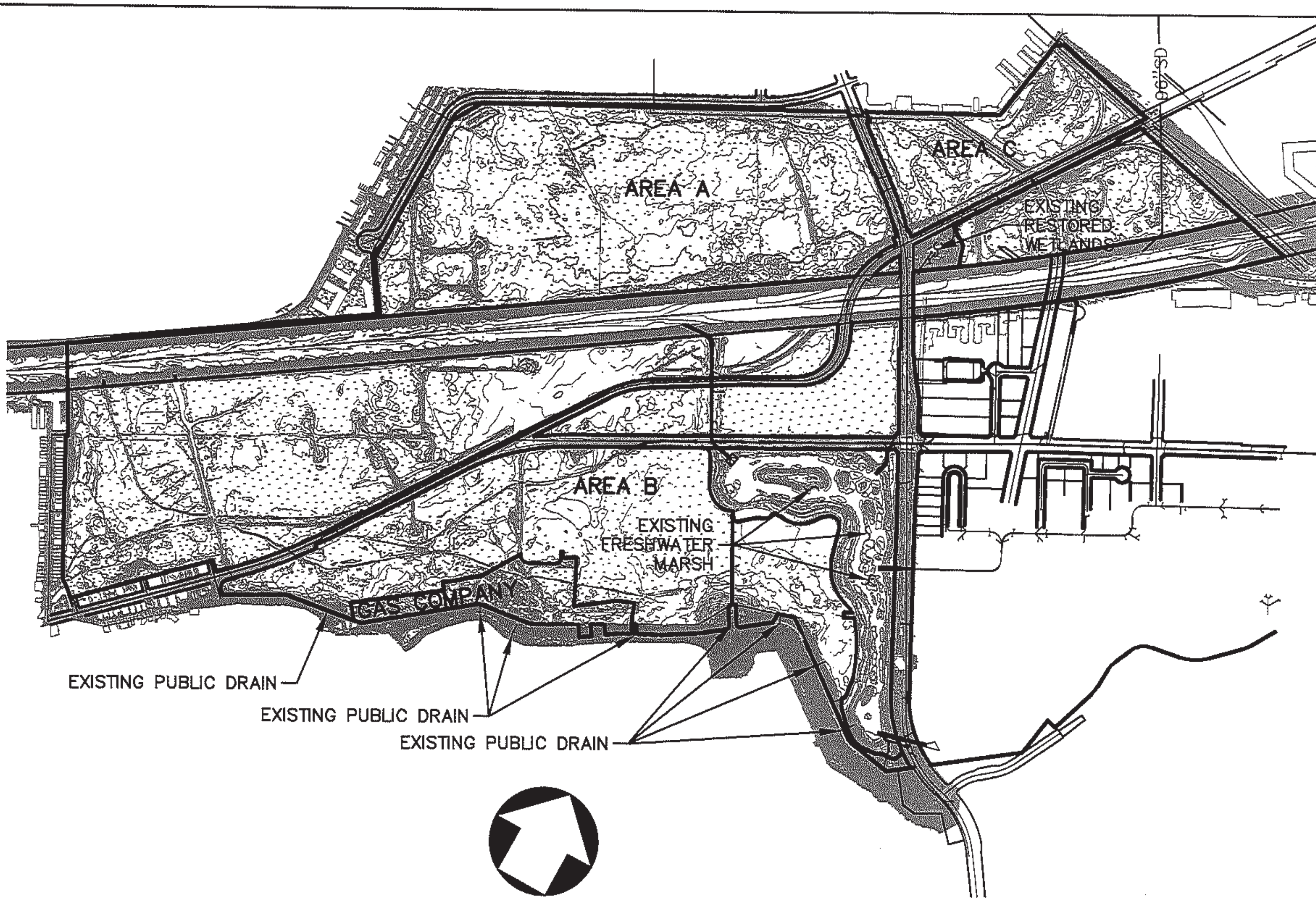
Pre-treatment basins are used throughout the project area where collection of storm water can be impacted by on-site or off-site pollutants and/or sediment runoff. These basins are intended to allow for settlement of suspended solids and reduction of discharge of these solids from the project site. Pre-treatment basins will be provided to mitigate runoff from each localized impervious on-site project feature, and sized and designed to accommodate the pollutants and runoff volume expected. Larger pre-treatment basins for some off-site runoff will also be provided as appropriate. Examples of these include a pre-treatment basin for the Beaches and Harbors parking lot in west Area A, for the existing parking lot on the west edge of Area B (adjacent to Gordon's Market), and for local existing storm drains discharging onto the south edge of Area B along the Westchester Bluffs. In addition, a large pre-treatment basin and detention basin system will be provided at an existing storm drain discharge point in west Area B immediately north of Nicholson Street. For this basin system, in addition to the storm water quality function that all pre-treatment basins provide, this basin system also serves a peak attenuation and volume storage function the 100-year storm event to mitigate an existing flooding situation for the developed properties south and west of the discharge point. Also, another type of pre-treatment basin will be incorporated adjacent to the main channel design to mitigate the minor sediment losses that may be expected from the project uplands areas in Area A where the channel has been realigned. Detention for the Pershing Drain overflow has been calculated at 1.8 acre-feet for the 100-year event. Listing of pre-treatment basins for Area B are shown in Table 1. Volume calculations for the proposed pre-treatment basins are shown in Appendix A with specific detail sheets located in Appendix B.

Basin Number	1 year Storage Volume
3A	0.1386 acre-feet
11D	0.0358 acre-feet
13E	0.0543 acre-feet
15D	0.0922 acre-feet
15C	0.8937 acre-feet
18C	1.3522 acre feet
14B	0.7989 acre feet

Table 1 – Area B Pre-Treatment Basins

d. Re-vegetation Program

A major component of permanent erosion protection and water quality treatment is in the elimination of constituents of concern through bio-uptake. In the natural environment almost all nutrients and heavy metals are used by plants for growth and production. The Ballona Restoration project will provide a natural plant pallet that not only restores habitat, but as a secondary benefit provides water quality treatment through the most natural methodology.



1200' 600' 0' 1200' 2400'

GRAPHIC SCALE

Note: For reduced sized prints, original scale is in inches

CALIFORNIA COASTAL CONSERVANCY

Existing Stormwater BMPs
Figure 1

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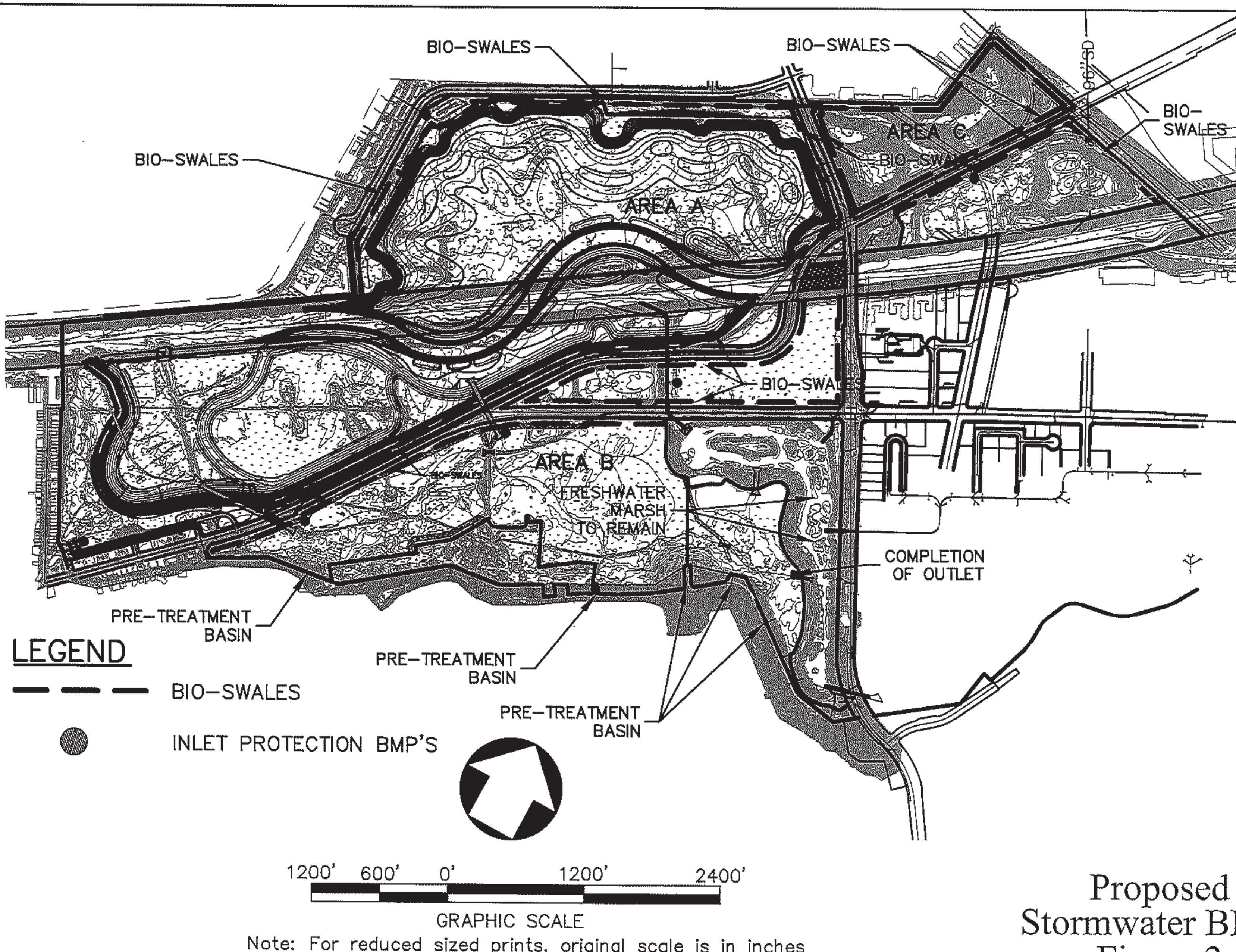

CALIFORNIA COASTAL CONSERVANCY

Proposed Stormwater BMPs
Figure 2

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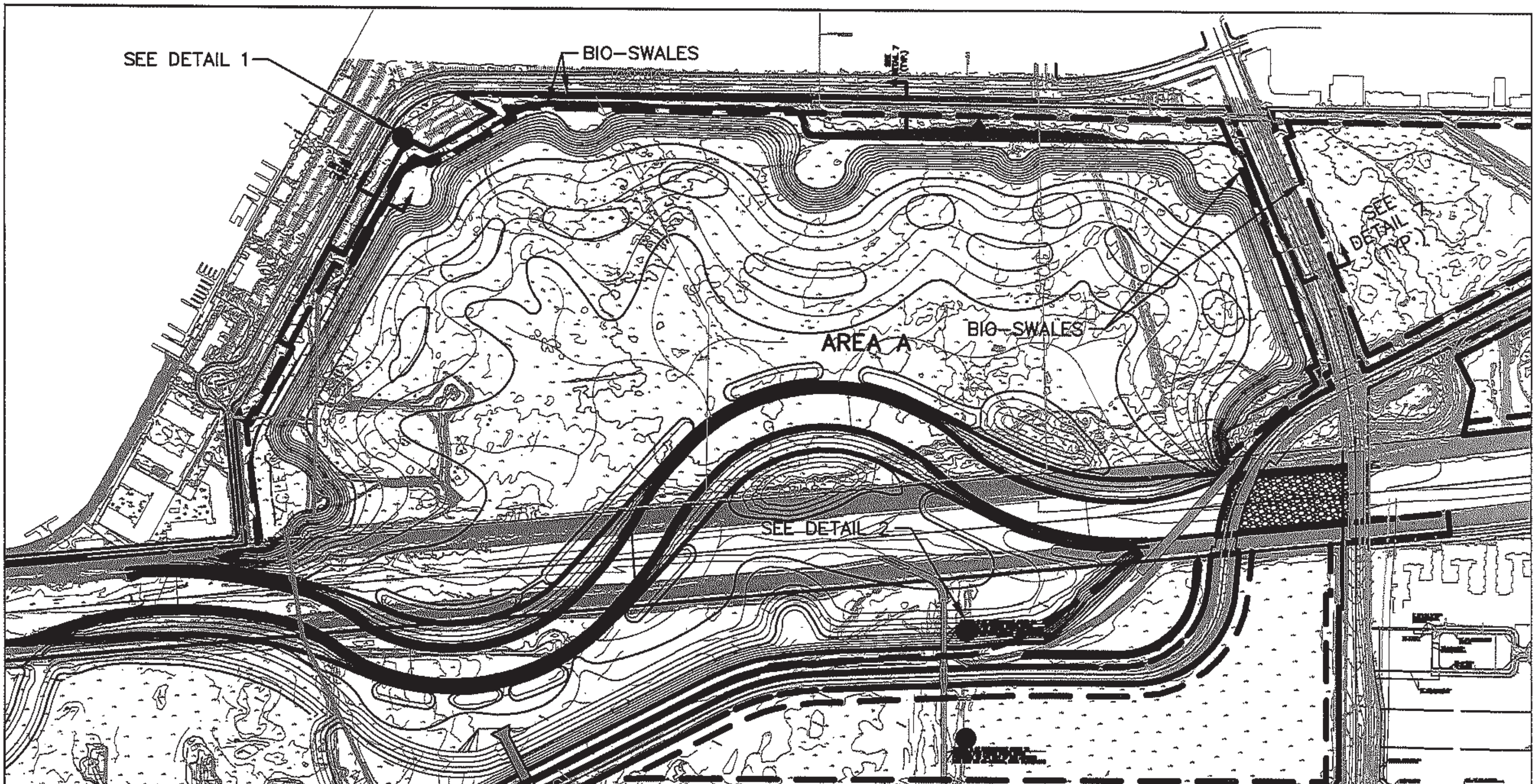

LEGEND

— — — BIO-SWALES

● INLET PROTECTION BMP'S

600' 300' 0' 600' 1200'

GRAPHIC SCALE

Note: For reduced sized prints, original scale is in inches

CALIFORNIA COASTAL CONSERVANCY

Area A
Stormwater BMPs
Figure 3

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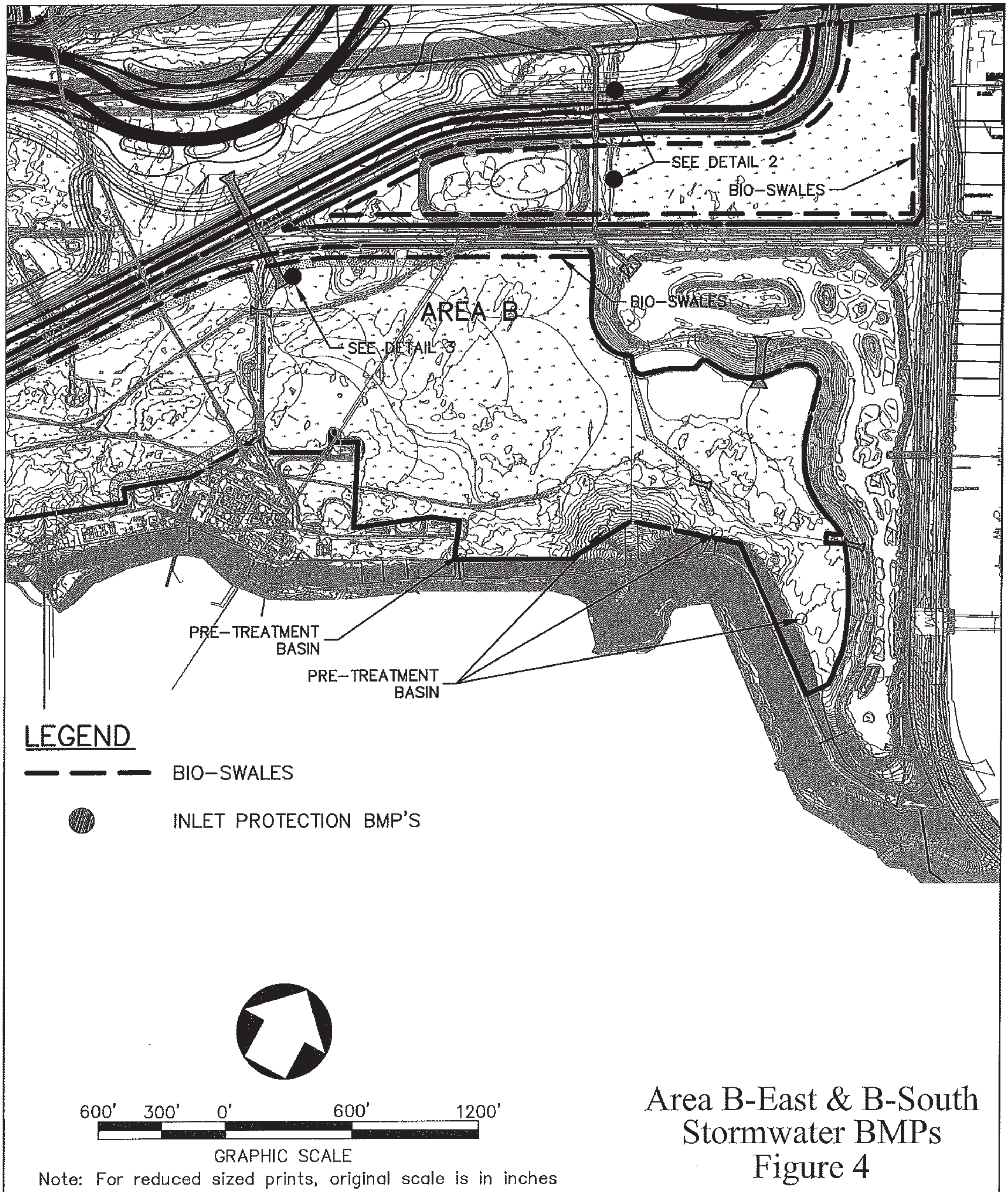

CALIFORNIA COASTAL CONSERVANCY

Area B-East & B-South Stormwater BMPs
Figure 4

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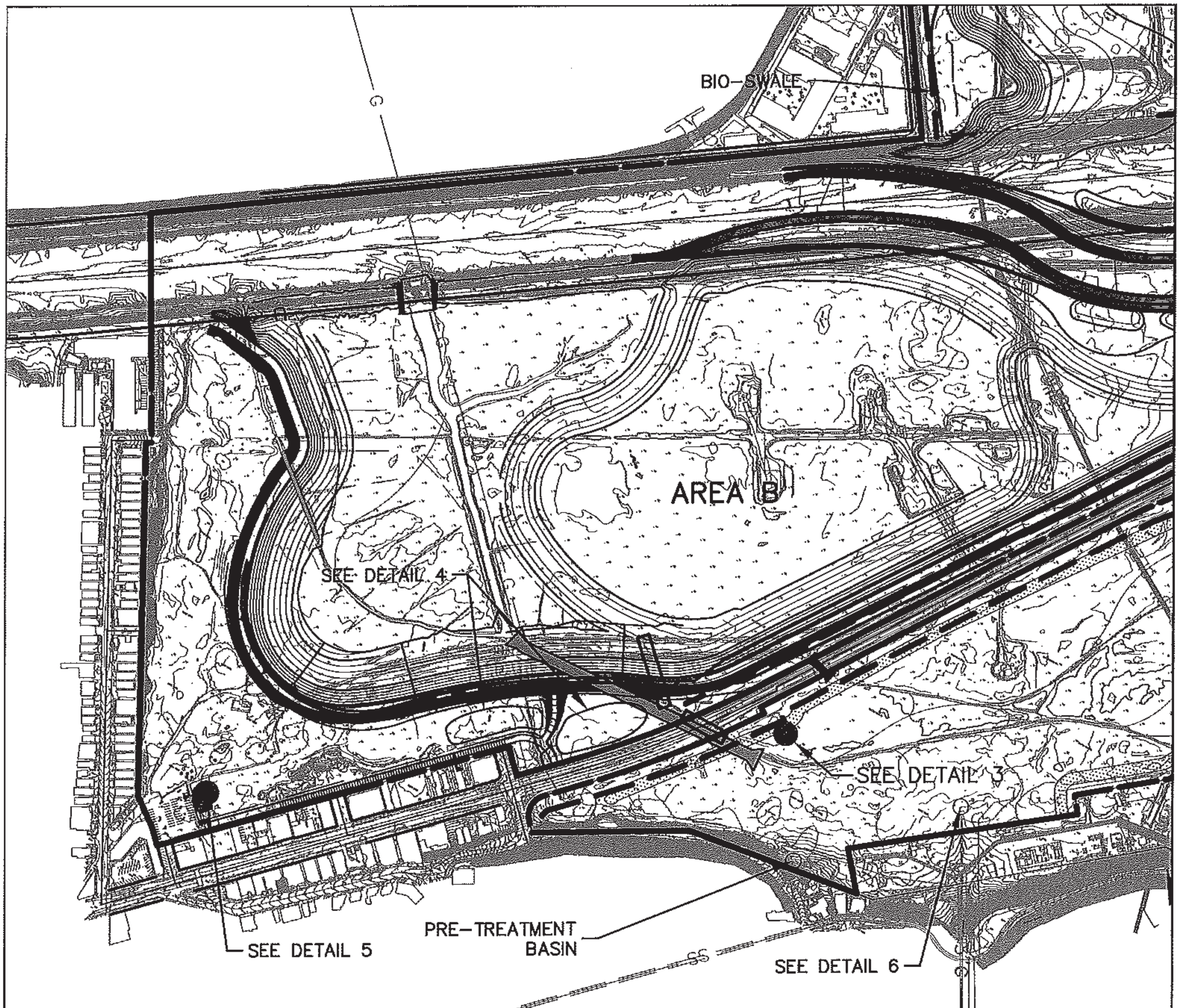

LEGEND

BIO-SWALES

INLET PROTECTION BMP'S

500' 250' 0' 500' 1000'

GRAPHIC SCALE

Note: For reduced sized prints, original scale is in inches

CALIFORNIA COASTAL CONSERVANCY

Area B-West & B-South
Stormwater BMPs
Figure 5

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Area
C
Figure 6

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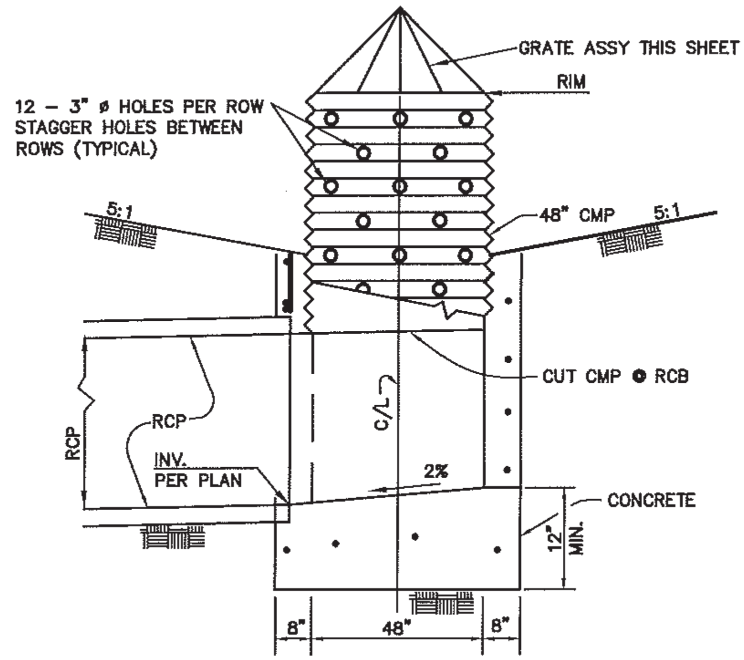
CALIFORNIA COASTAL CONSERVANCY



RISER AND OUTLET

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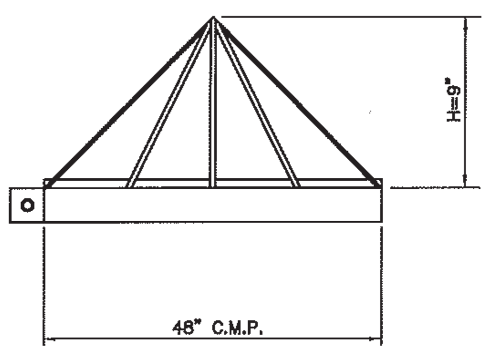

GRATE ASSEMBLY

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EXISTING DEBRIS RISER INLET DETAIL (2)

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Detail Sheet
Figure 7

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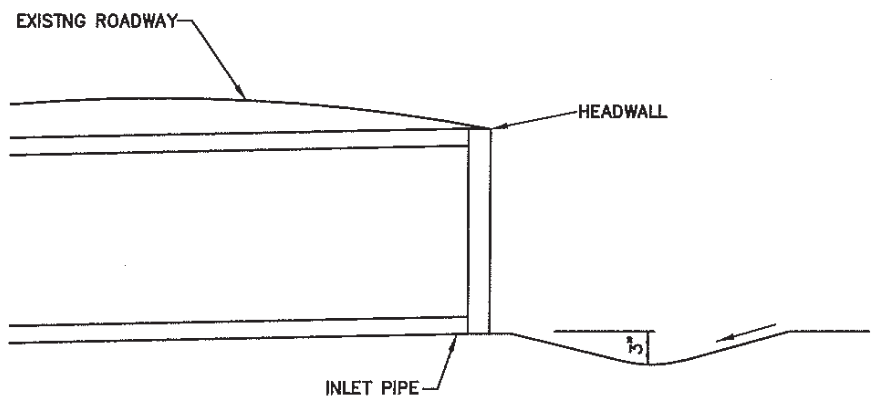
CALIFORNIA COASTAL CONSERVANCY



INLET PIPE CONTROL

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Detail Sheet
Figure 8

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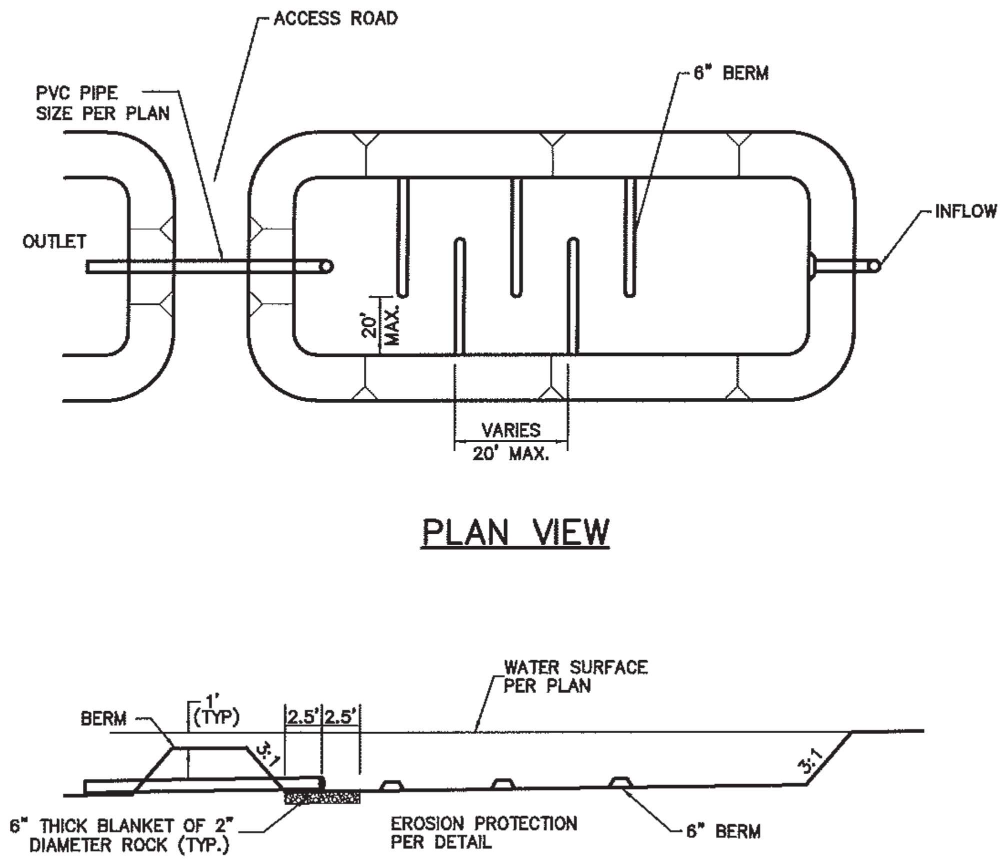
CALIFORNIA COASTAL CONSERVANCY



RETENTION BASIN DETAIL

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Detail Sheet
Figure 9

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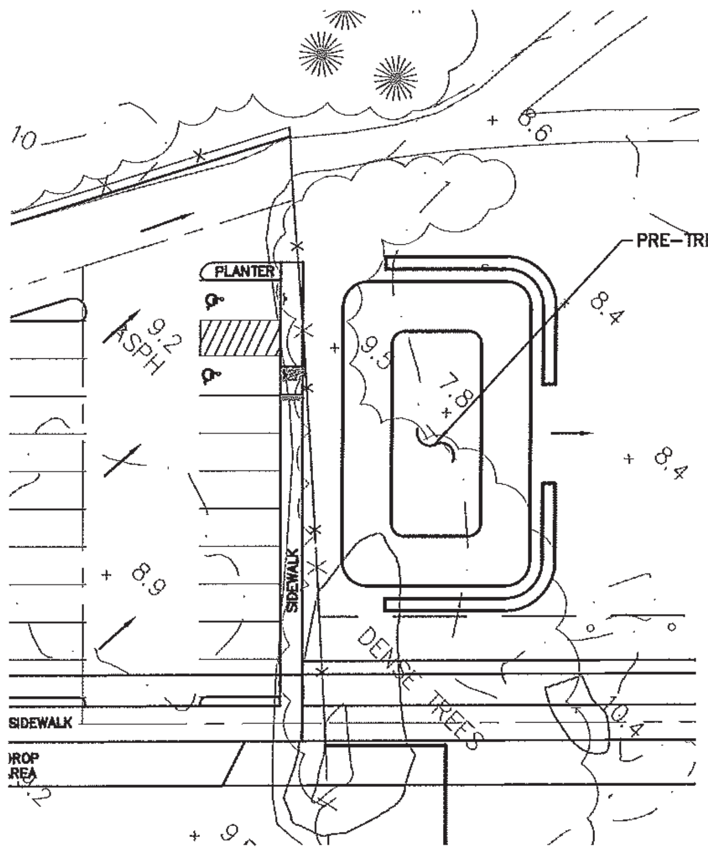
CALIFORNIA COASTAL CONSERVANCY



PARKING LOT PRE-TREATMENT BASIN

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5

Detail Sheet
Figure 10

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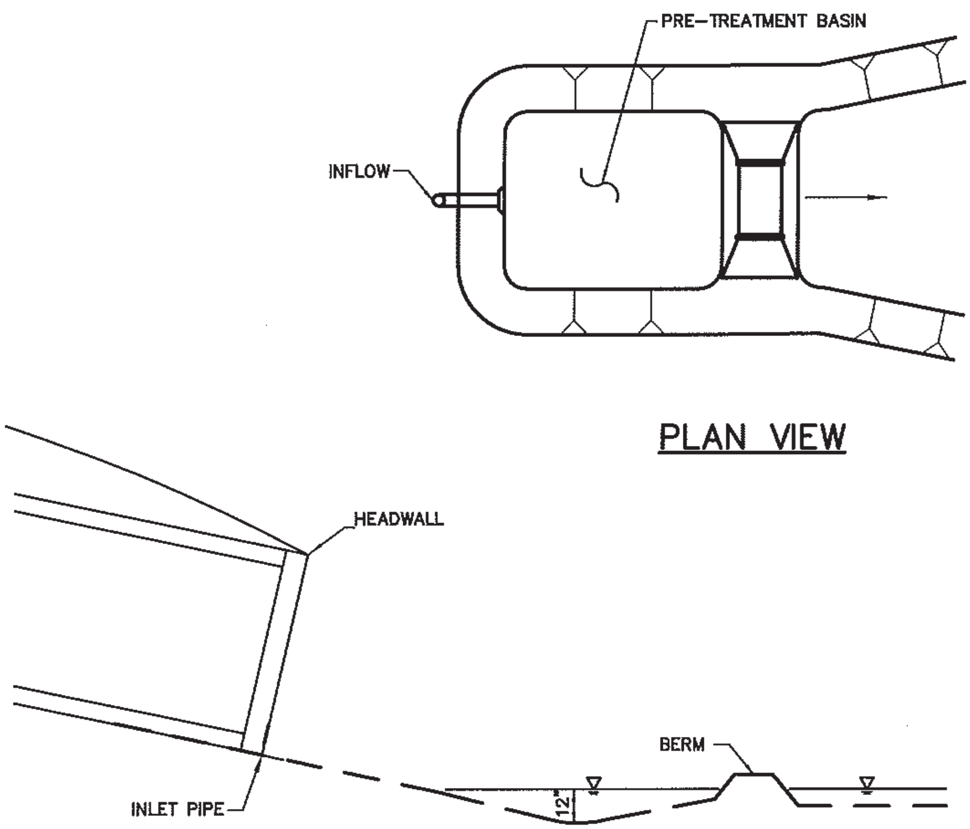
CALIFORNIA COASTAL CONSERVANCY



HILLSIDE DR – PRE-TREATMENT BASIN (6)

NOT TO SCALE

Detail Sheet
Figure 11

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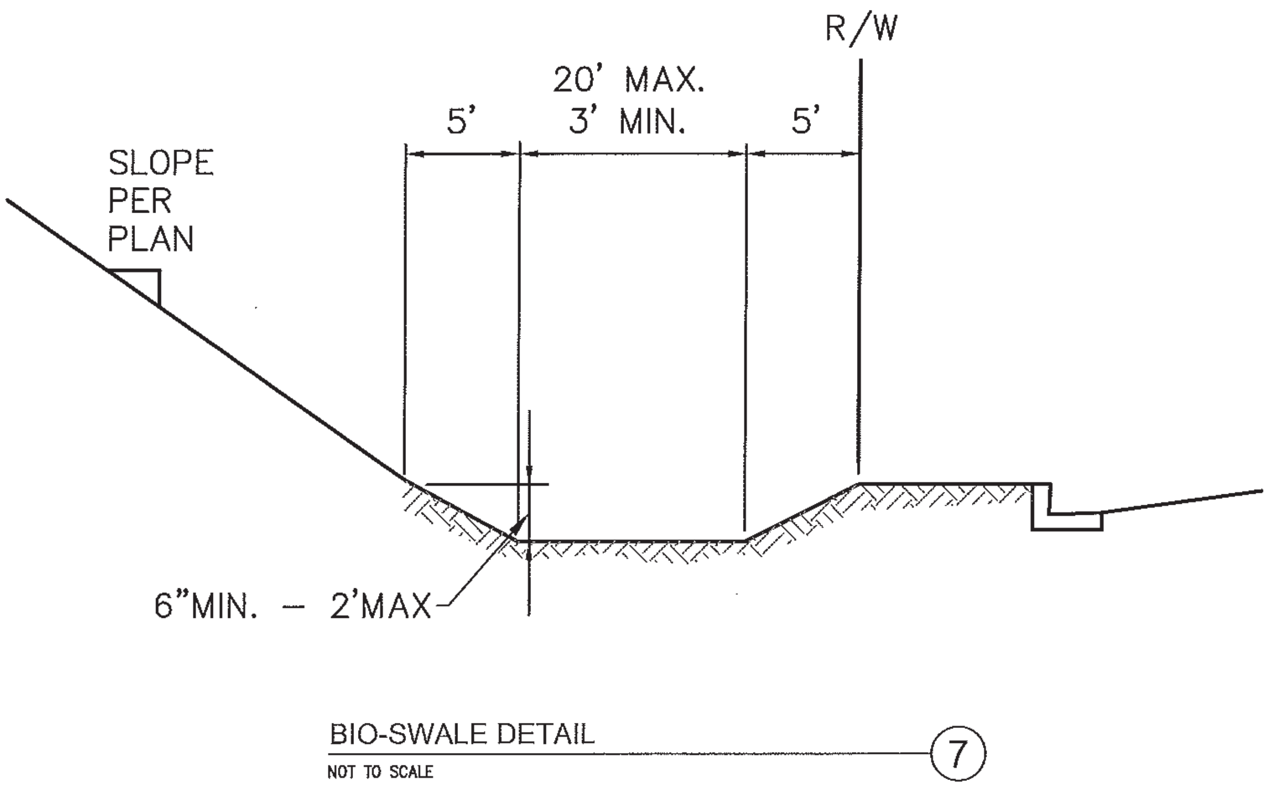
CALIFORNIA COASTAL CONSERVANCY



Detail Sheet
Figure 12

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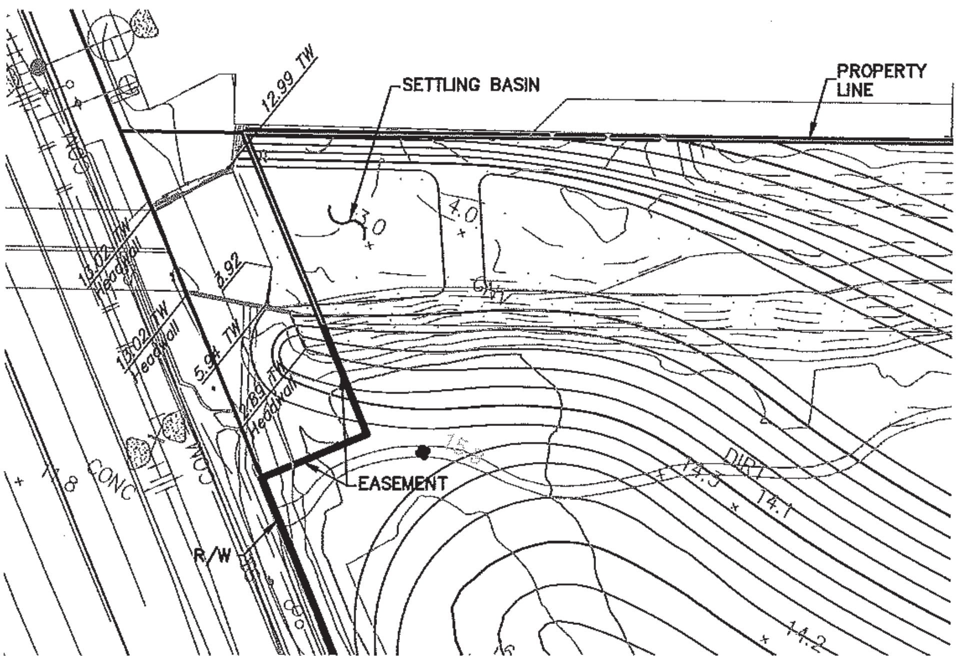
CALIFORNIA COASTAL CONSERVANCY



FIJI DITCH SETTLING BASIN

NOT TO SCALE

8

Detail Sheet
Figure 13

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CALIFORNIA COASTAL CONSERVANCY

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APPENDIX A -

Peak Flow Hydrologic Analysis

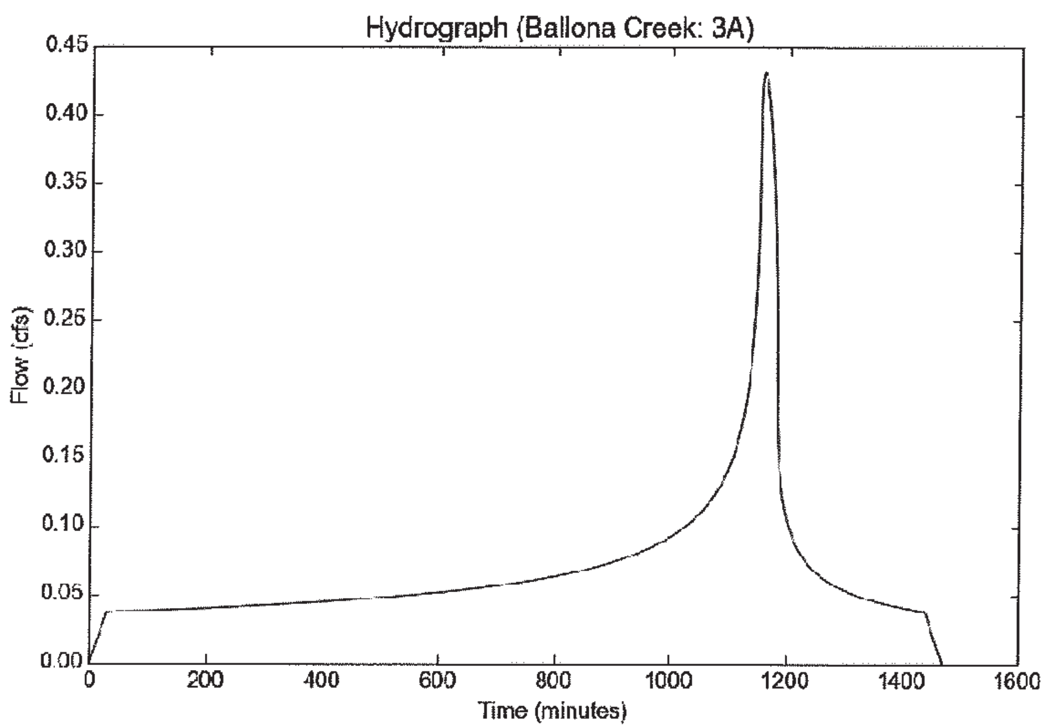
File location: C:/Steve/Psomas Projects/Ballona/Storage Calculations/Ballona Creek - 3A - 1-yr.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Ballona Creek
Subarea ID	3A
Area (ac)	5.3
Flow Path Length (ft)	958.0
Flow Path Slope (vft/hft)	0.1
50-yr Rainfall Depth (in)	6.5
Percent Impervious	0.09
Soil Type	10
Design Storm Frequency	1-yr
Fire Factor	0
LID	False

Output Results

Modeled (1-yr) Rainfall Depth (in)	1.8395
Peak Intensity (in/hr)	0.4728
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.172
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	0.431
Burned Peak Flow Rate (cfs)	0.431
24-Hr Clear Runoff Volume (ac-ft)	0.1386
24-Hr Clear Runoff Volume (cu-ft)	6036.8668



Peak Flow Hydrologic Analysis

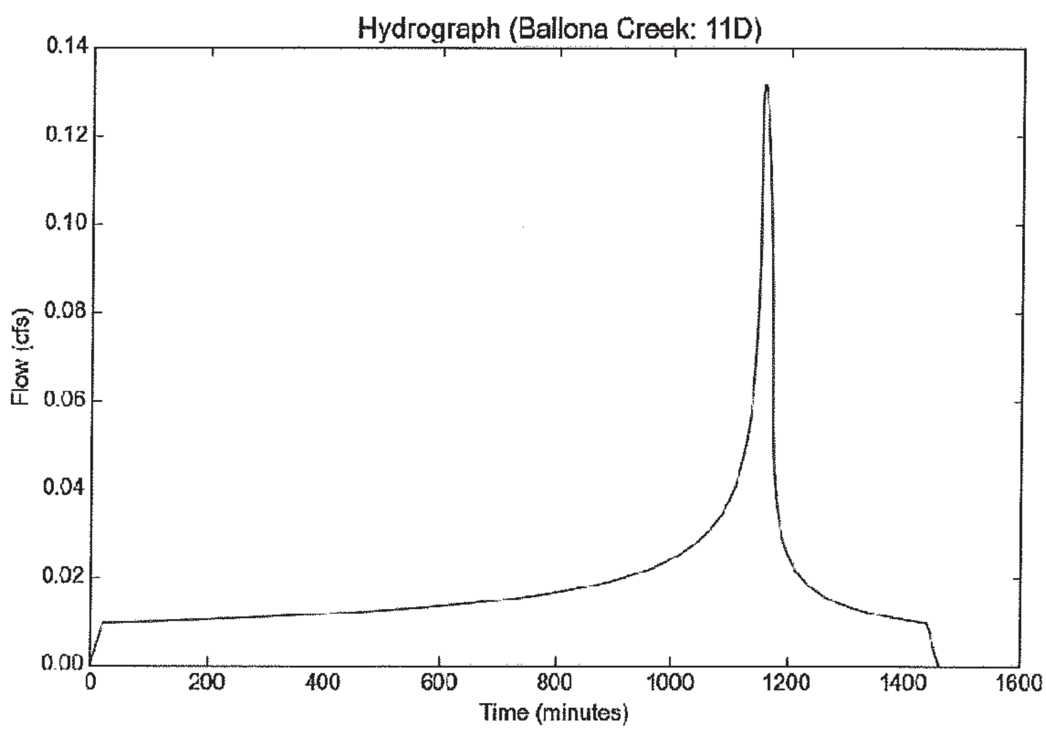
File location: C:/Steve/Psomas Projects/Ballona/Storage Calculations/Ballona Creek - 11D.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Ballona Creek
Subarea ID	11D
Area (ac)	1.2
Flow Path Length (ft)	395.0
Flow Path Slope (vft/hft)	0.242
50-yr Rainfall Depth (in)	6.5
Percent Impervious	0.12
Soil Type	10
Design Storm Frequency	1-yr
Fire Factor	0
LID	False

Output Results

Modeled (1-yr) Rainfall Depth (in)	1.8395
Peak Intensity (in/hr)	0.5591
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.196
Time of Concentration (min)	21.0
Clear Peak Flow Rate (cfs)	0.1315
Burned Peak Flow Rate (cfs)	0.1315
24-Hr Clear Runoff Volume (ac-ft)	0.0358
24-Hr Clear Runoff Volume (cu-ft)	1557.5502



Peak Flow Hydrologic Analysis

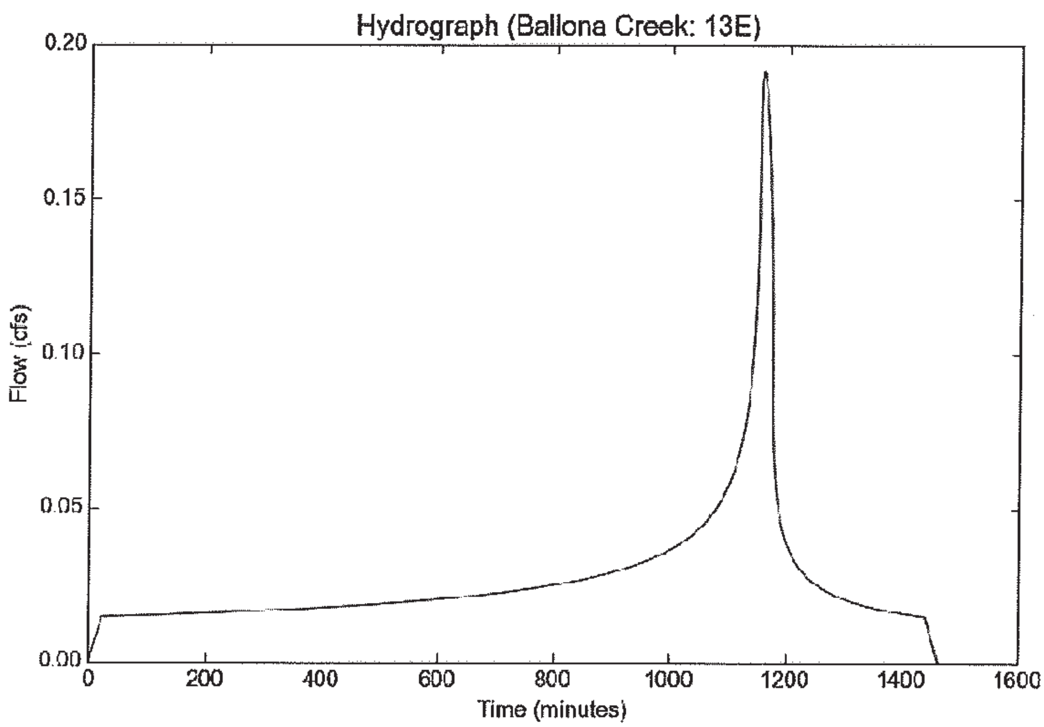
File location: C:/Steve/Psomas Projects/Ballona/Storage Calculations/Ballona Creek - 13E - 1-yr.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Ballona Creek
Subarea ID	13E
Area (ac)	1.9
Flow Path Length (ft)	406.0
Flow Path Slope (vft/hft)	0.219
50-yr Rainfall Depth (in)	6.5
Percent Impervious	0.11
Soil Type	10
Design Storm Frequency	1-yr
Fire Factor	0
LID	False

Output Results

Modeled (1-yr) Rainfall Depth (in)	1.8395
Peak Intensity (in/hr)	0.5357
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.188
Time of Concentration (min)	23.0
Clear Peak Flow Rate (cfs)	0.1913
Burned Peak Flow Rate (cfs)	0.1913
24-Hr Clear Runoff Volume (ac-ft)	0.0543
24-Hr Clear Runoff Volume (cu-ft)	2365.4657



Peak Flow Hydrologic Analysis

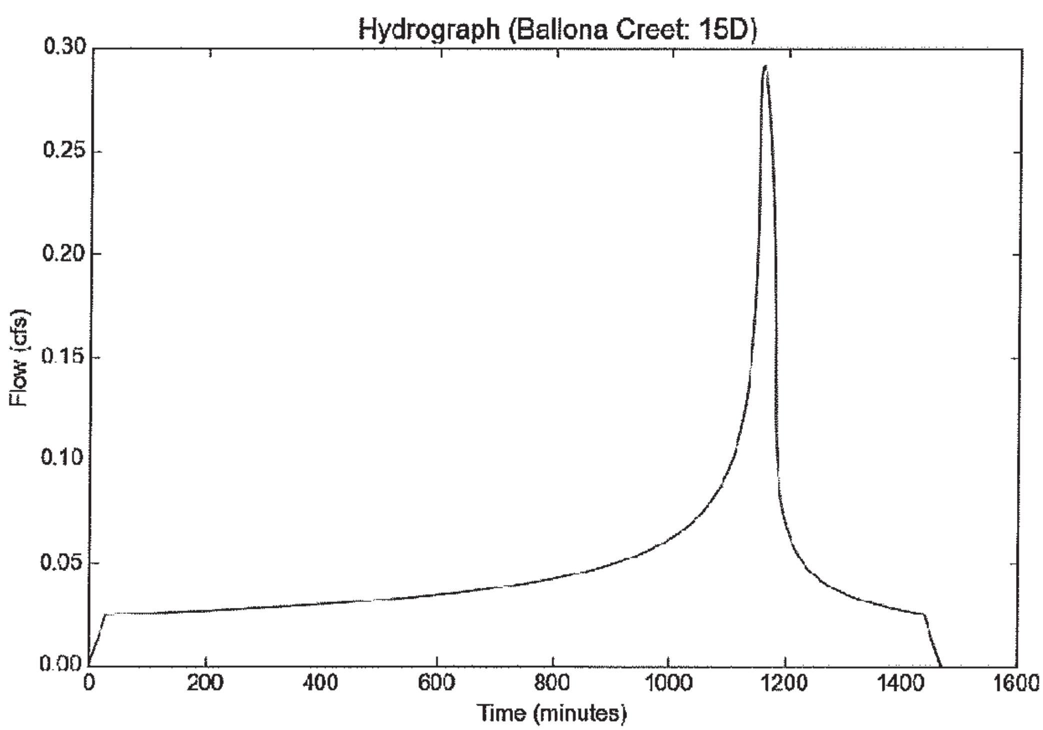
File location: W:/1CCC010100/ENGR/CALCS/Storage Calculations/Ballona Creek - 15D - 1-yr.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Ballona Creet
Subarea ID	15D
Area (ac)	3.7
Flow Path Length (ft)	494.0
Flow Path Slope (vft/hft)	0.177
50-yr Rainfall Depth (in)	6.5
Percent Impervious	0.08
Soil Type	10
Design Storm Frequency	1-yr
Fire Factor	0
LID	False

Output Results

Modeled (1-yr) Rainfall Depth (in)	1.8395
Peak Intensity (in/hr)	0.4804
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.164
Time of Concentration (min)	29.0
Clear Peak Flow Rate (cfs)	0.2915
Burned Peak Flow Rate (cfs)	0.2915
24-Hr Clear Runoff Volume (ac-ft)	0.0922
24-Hr Clear Runoff Volume (cu-ft)	4018.394



Peak Flow Hydrologic Analysis

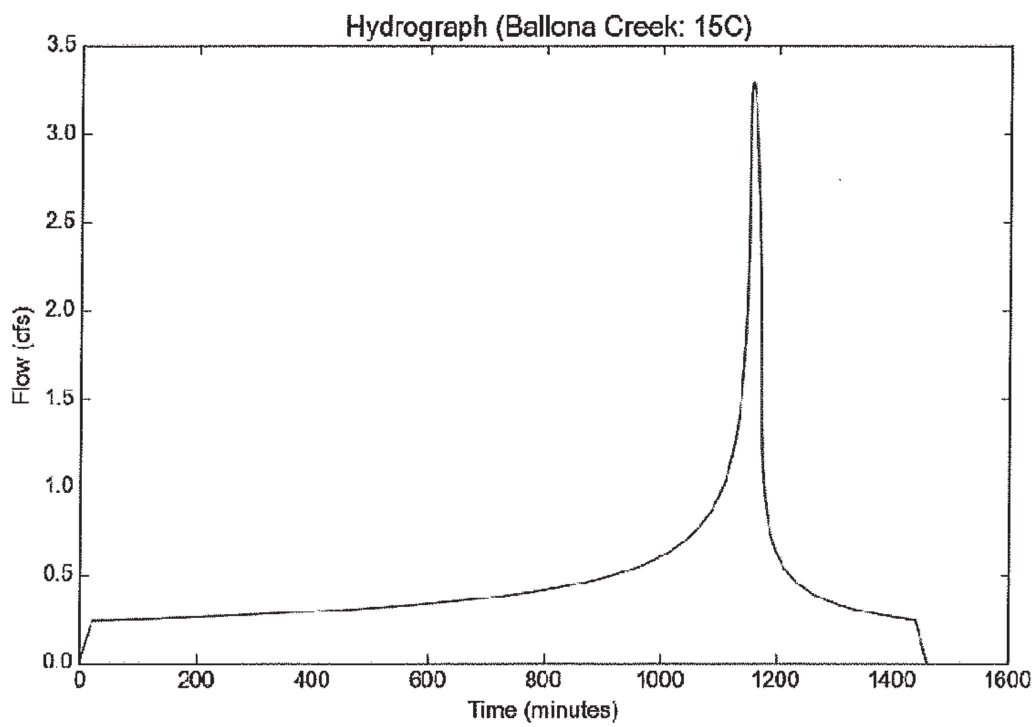
File location: C:/Steve/Psomas Projects/Ballona/Storage Calculations/Ballona Creek - 15C - 1-yr.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Ballona Creek
Subarea ID	15C
Area (ac)	7.1
Flow Path Length (ft)	774.0
Flow Path Slope (vft/hft)	0.013
50-yr Rainfall Depth (in)	6.5
Percent Impervious	0.91
Soil Type	10
Design Storm Frequency	1-yr
Fire Factor	0
LID	False

Output Results

Modeled (1-yr) Rainfall Depth (in)	1.8395
Peak Intensity (in/hr)	0.5591
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.828
Time of Concentration (min)	21.0
Clear Peak Flow Rate (cfs)	3.2867
Burned Peak Flow Rate (cfs)	3.2867
24-Hr Clear Runoff Volume (ac-ft)	0.8937
24-Hr Clear Runoff Volume (cu-ft)	38930.8071



Peak Flow Hydrologic Analysis

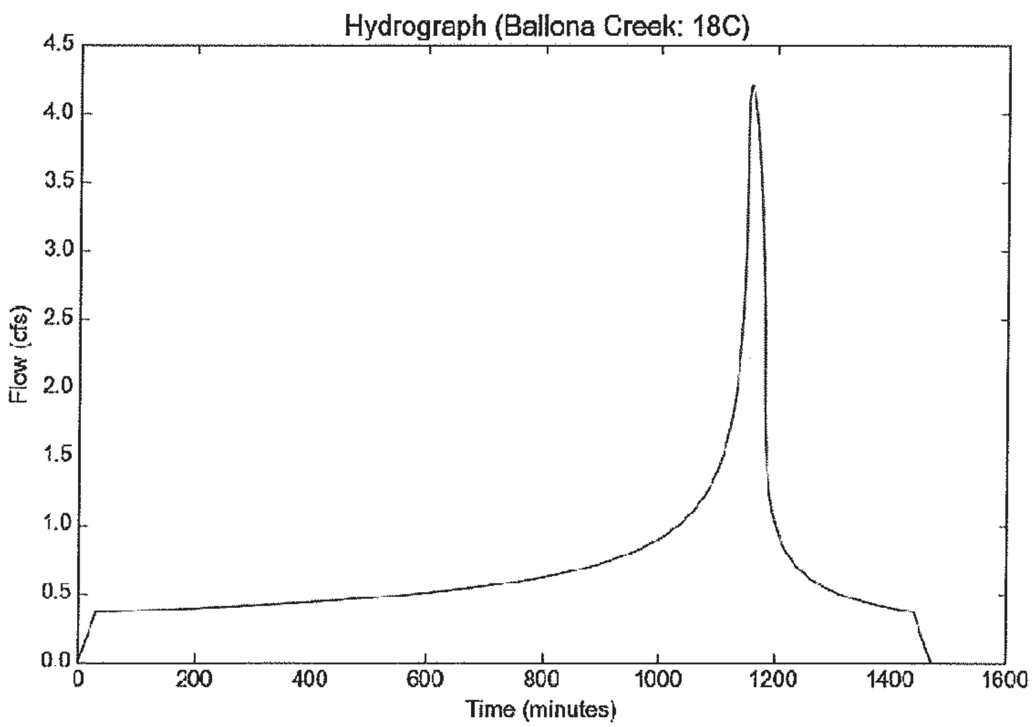
File location: C:/Steve/Psomas Projects/Ballona/Storage Calculations/Ballona Creek - 18C - 1-yr.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

Project Name	Ballona Creek
Subarea ID	18C
Area (ac)	20.4
Flow Path Length (ft)	1334.0
Flow Path Slope (vft/hft)	0.031
50-yr Rainfall Depth (in)	6.5
Percent Impervious	0.42
Soil Type	10
Design Storm Frequency	1-yr
Fire Factor	0
LID	False

Output Results

Modeled (1-yr) Rainfall Depth (in)	1.8395
Peak Intensity (in/hr)	0.4728
Undeveloped Runoff Coefficient (Cu)	0.1
Developed Runoff Coefficient (Cd)	0.436
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	4.2052
Burned Peak Flow Rate (cfs)	4.2052
24-Hr Clear Runoff Volume (ac-ft)	1.3522
24-Hr Clear Runoff Volume (cu-ft)	58901.1719



Peak Flow Hydrologic Analysis

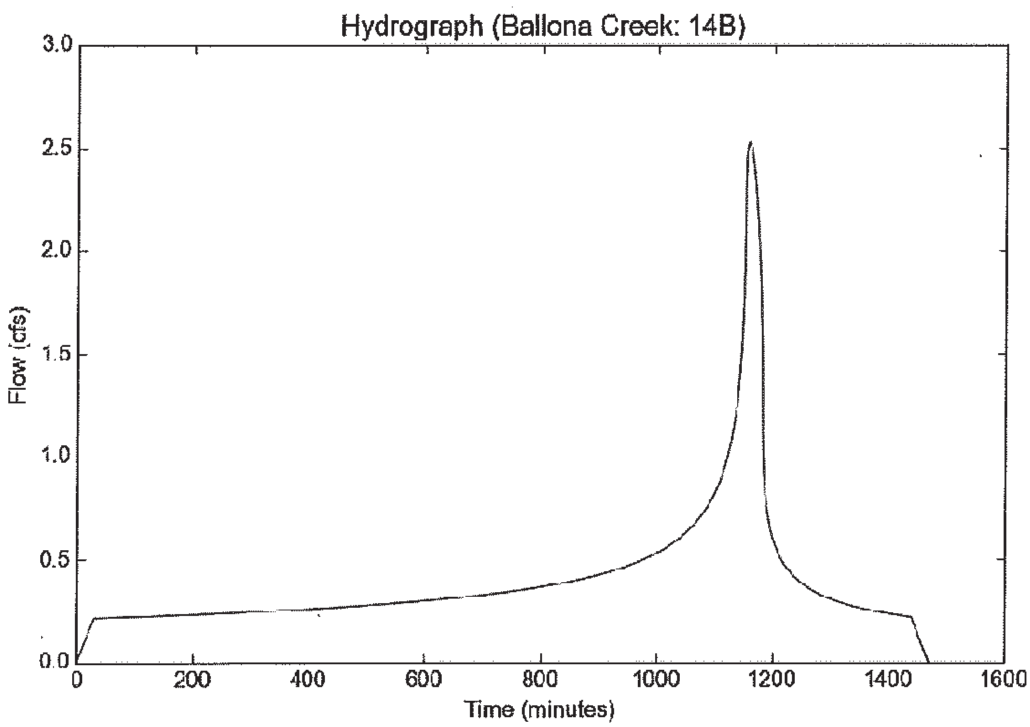
File location: W:/1CCC010100/ENGR/CALCS/Storage Calculations/Ballona Creek - 14B - 1-yr.pdf
Version: HydroCalc 0.3.1-beta

Input Parameters

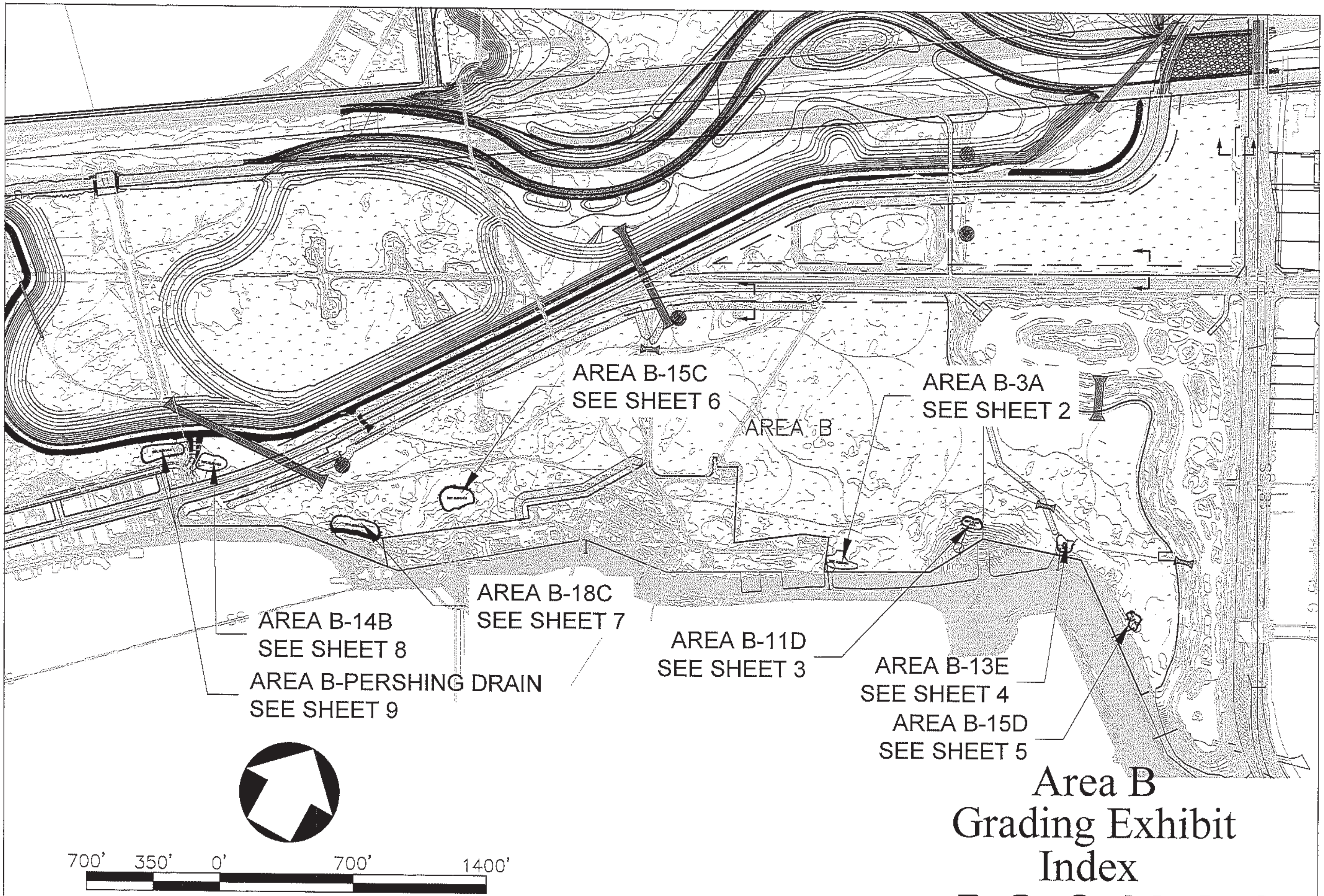
Project Name	Ballona Creek
Subarea ID	14B
Area (ac)	6.1
Flow Path Length (ft)	2043.0
Flow Path Slope (vft/hft)	0.001
50-yr Rainfall Depth (in)	6.5
Percent Impervious	0.95
Soil Type	17
Design Storm Frequency	1-yr
Fire Factor	0
LID	False

Output Results

Modeled (1-yr) Rainfall Depth (in)	1.8395
Peak Intensity (in/hr)	0.4728
Undeveloped Runoff Coefficient (Cu)	0.4151
Developed Runoff Coefficient (Cd)	0.8758
Time of Concentration (min)	30.0
Clear Peak Flow Rate (cfs)	2.5257
Burned Peak Flow Rate (cfs)	2.5257
24-Hr Clear Runoff Volume (ac-ft)	0.7989
24-Hr Clear Runoff Volume (cu-ft)	34798.2985



APPENDIX B -



Note: For reduced sized prints, original scale is in inches

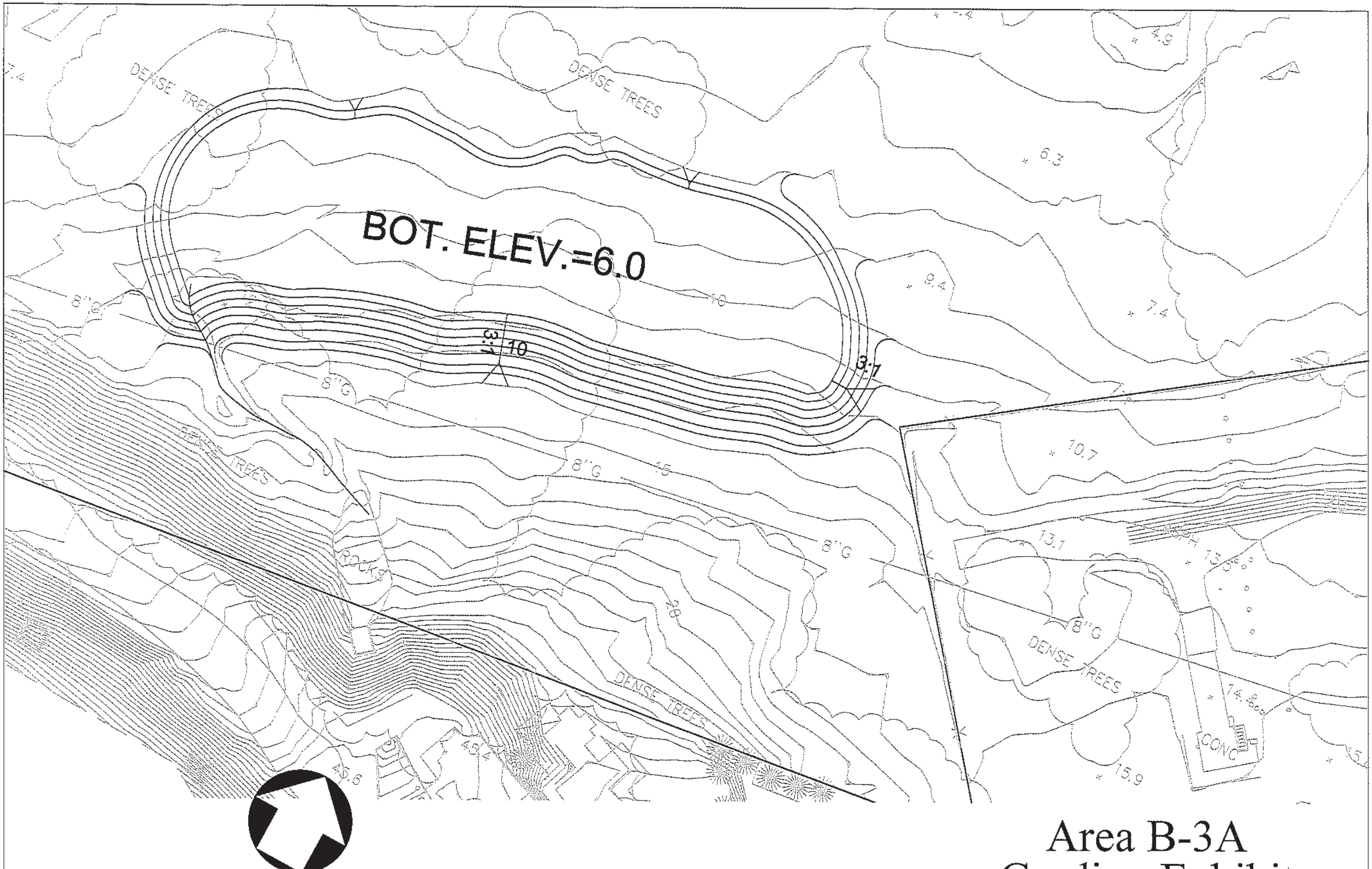
Area B Grading Exhibit Index

PSOMAS

CALIFORNIA COASTAL CONSERVANCY

DATE: 05-21-15 REVISED ON: 06-11-15
JOB No:1CCC010100

SHEET 1 OF 9



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GRAPHIC SCALE

Note: For reduced sized prints, original scale is in inches

CALIFORNIA COASTAL CONSERVANCY

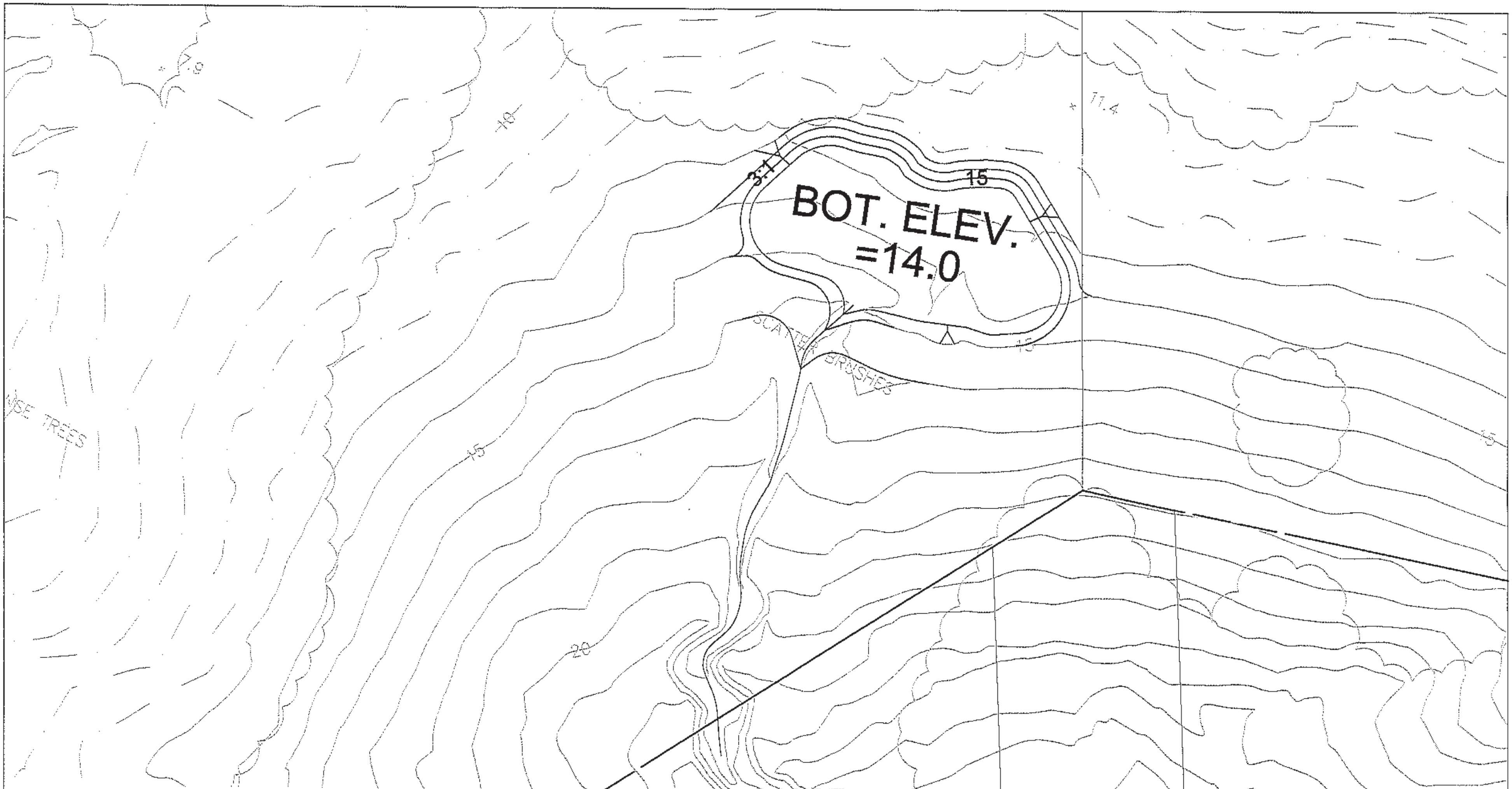
Area B-3A Grading Exhibit

PSOMAS

DATE: 05–21–15 REVISED ON: 06–11–15

JOB No:1CCC010100

SHEET 2 OF 9



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GRAPHIC SCALE

Note: For reduced sized prints, original scale is in inches

CALIFORNIA COASTAL CONSERVANCY

Area B-11D Grading Exhibit

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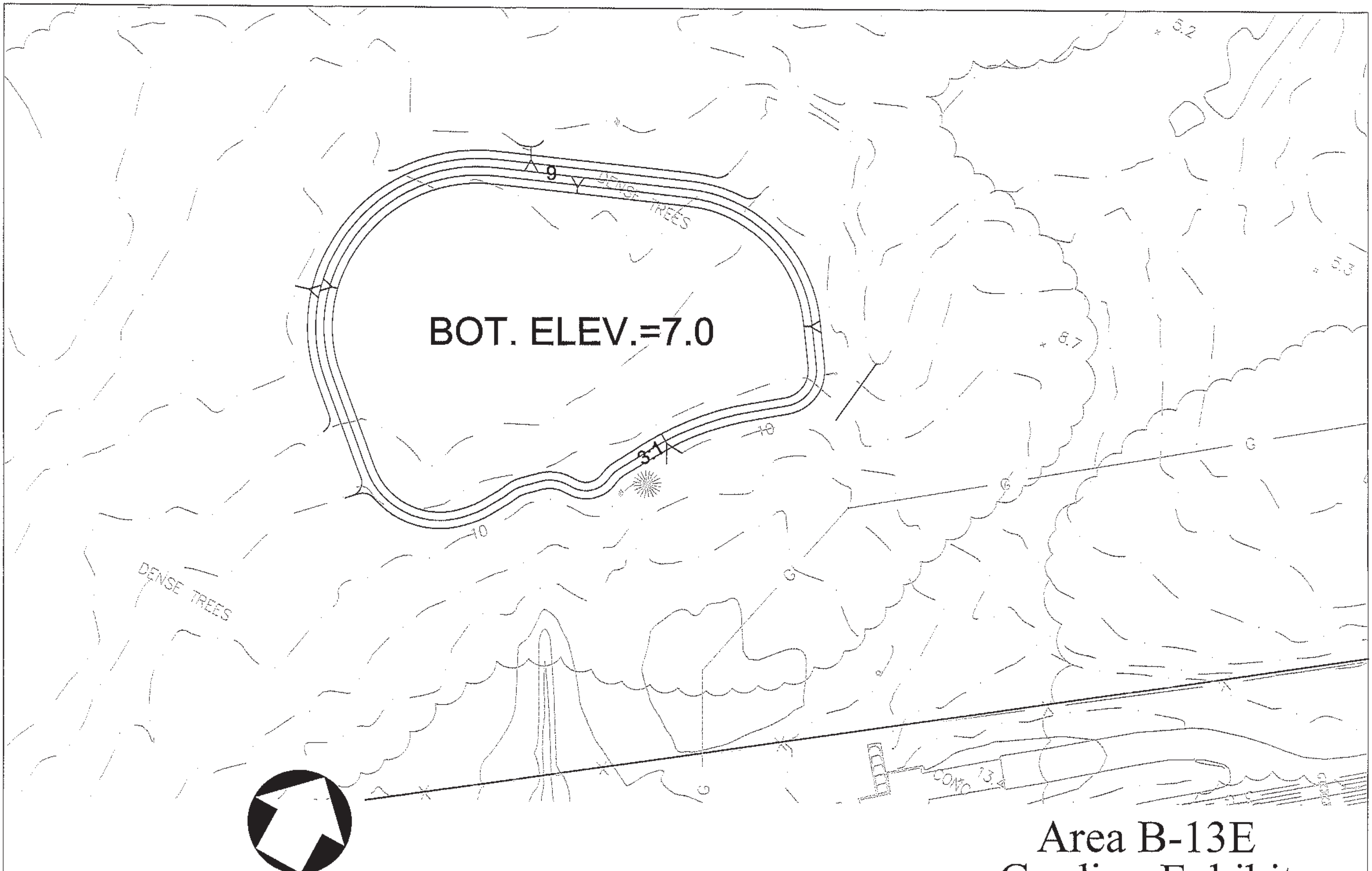
DATE: 05–21–15 REVISED ON: 06–11–15
JOB No:1CCC010100

SHEET 3 OF 9



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CALIFORNIA COASTAL CONSERVANCY

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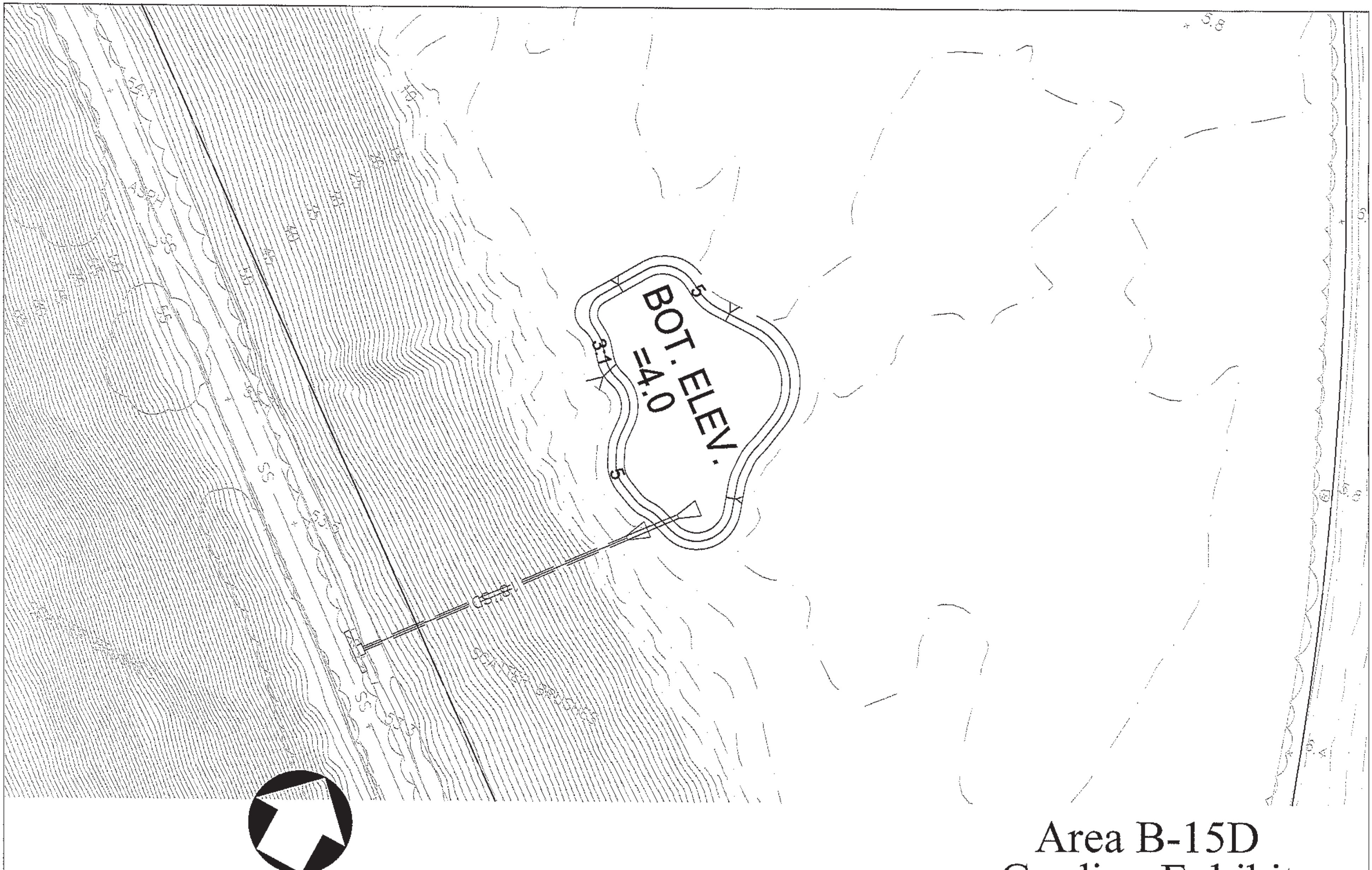
DATE: 05–21–15 REVISED ON: 06–11–15
JOB No:1CCC010100

SHEET 4 OF 9



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GRAPHIC SCALE

Note: For reduced sized prints, original scale is in inches

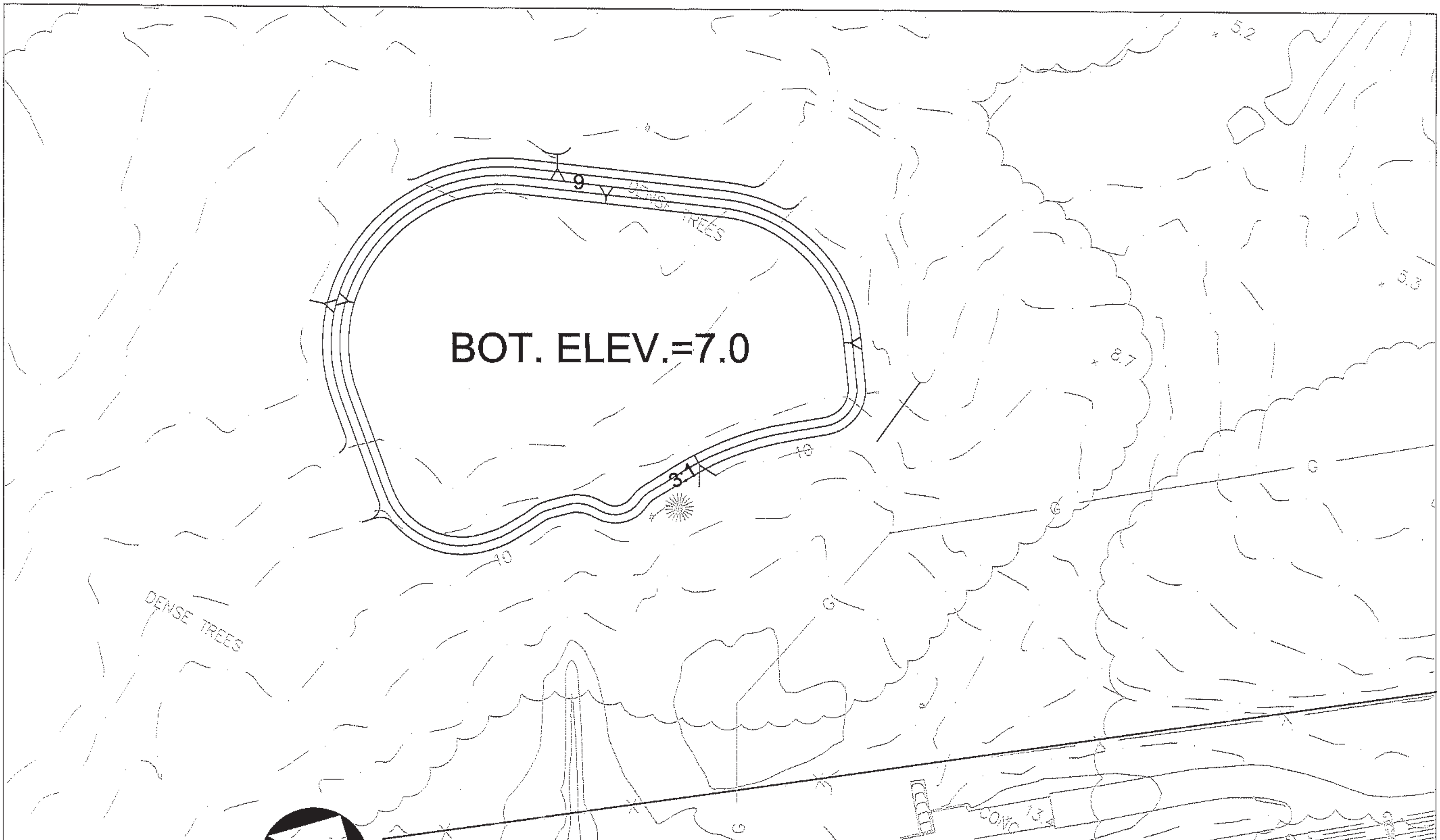
CALIFORNIA COASTAL CONSERVANCY

Area B-15D Grading Exhibit

PSOMAS

DATE: 05-21-15 REVISED ON: 06-11-15
JOB No:1CCC010100

SHEET 5 OF 9



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GRAPHIC SCALE

Note: For reduced sized prints, original scale is in inches

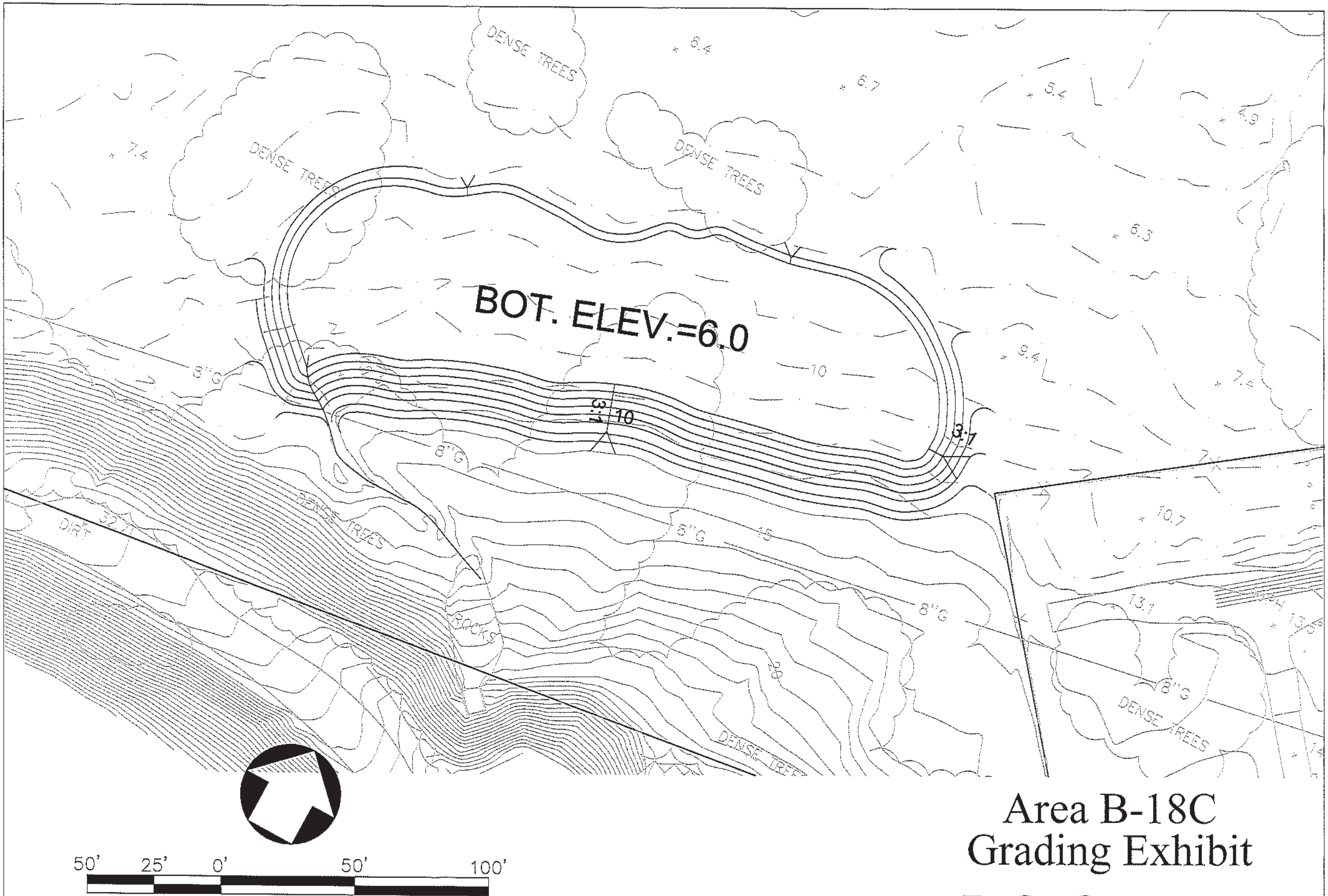
Area B-15C Grading Exhibit

PSOMAS

DATE: 05-21-15 REVISED ON: 06-11-15
JOB No:1CCC010100

CALIFORNIA COASTAL CONSERVANCY

SHEET 6 OF 9



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Area B-18C Grading Exhibit

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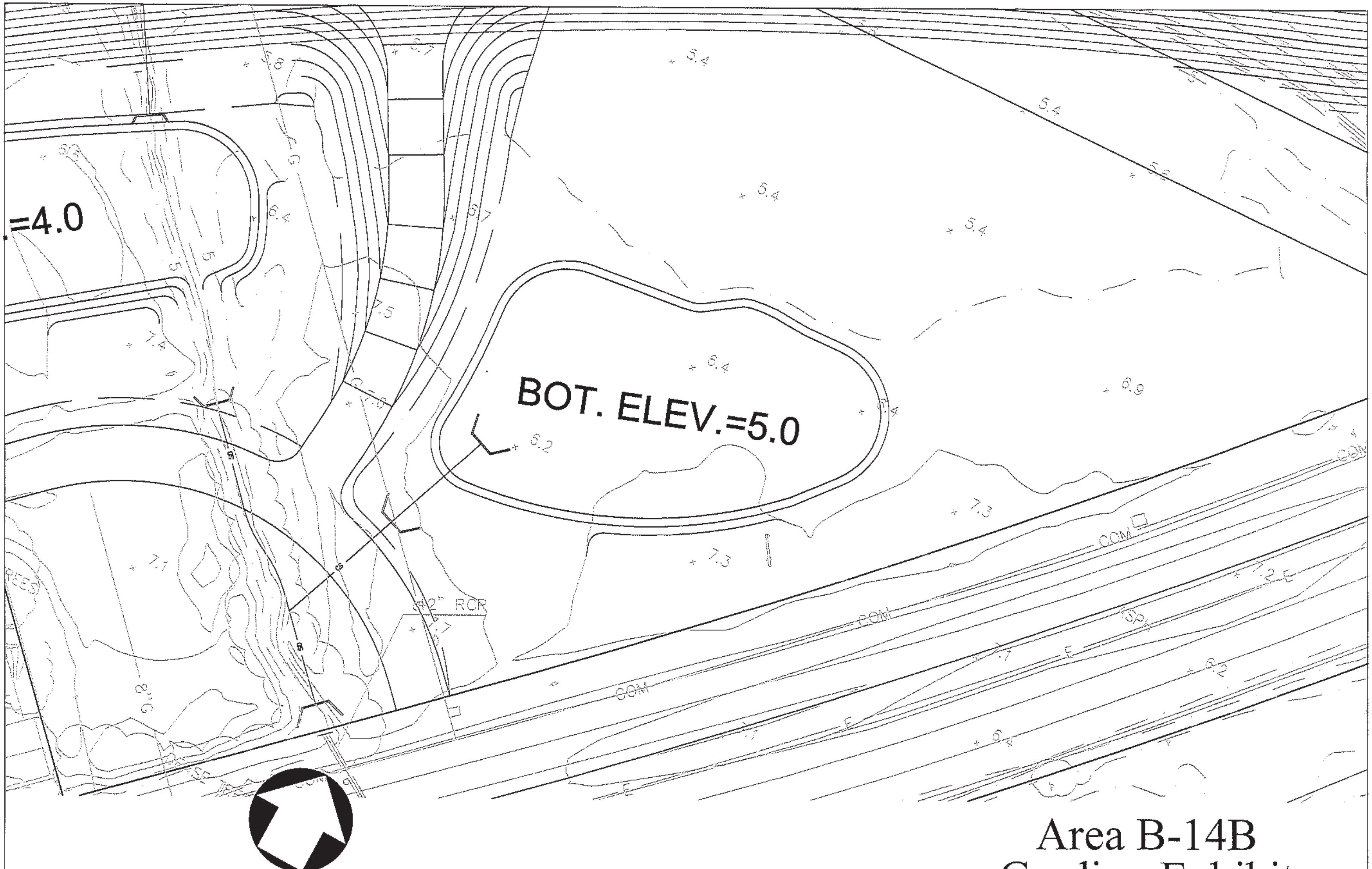
DATE: 05-21-15 REVISED ON: 06-11-15
JOB No:1CCC010100

SHEET 7 OF 9

CALIFORNIA COASTAL CONSERVANCY



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GRAPHIC SCALE

Note: For reduced sized prints, original scale is in inches

Area B-14B Grading Exhibit

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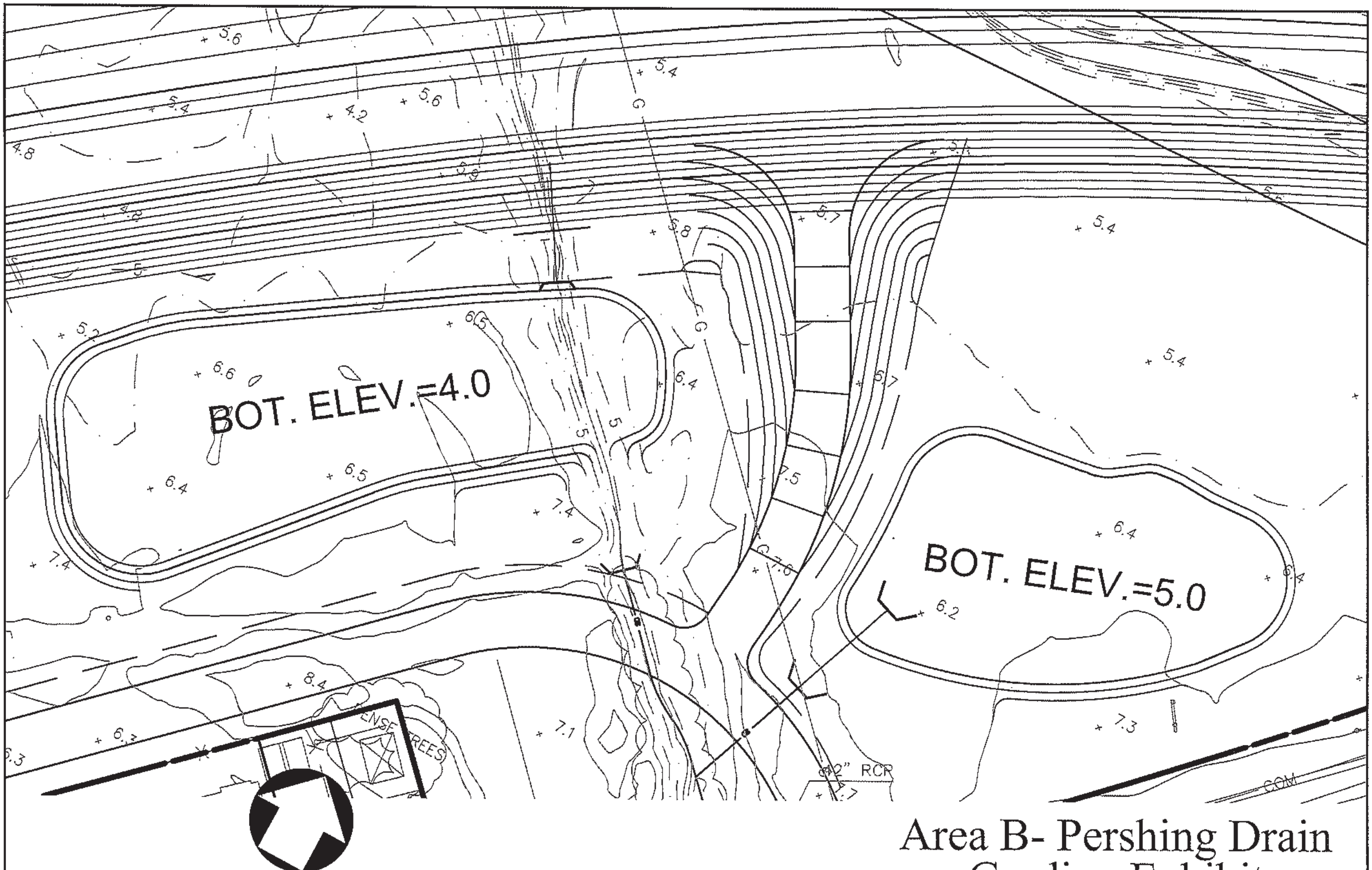
JOB No:1CCC010100

SHEET 8 OF 9

CALIFORNIA COASTAL CONSERVANCY



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GRAPHIC SCALE

Note: For reduced sized prints, original scale is in inches

CALIFORNIA COASTAL CONSERVANCY

Area B- Pershing Drain Grading Exhibit

PSOMAS

DATE: 05-21-15 REVISED ON: 06-11-15
JOB No:1CCC010100

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BR079-08

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APPENDIX B3
Conceptual Habitat Restoration and Adaptive Management Plan

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LIST OF ACRONYMS

BWER	Ballona Wetlands Ecological Reserve
CDFG	California Department of Fish and Game (now California Department of Fish and Wildlife)
CDFW	California Department of Fish and Wildlife (formerly California Department of Fish and Game)
CEQA	California Environmental Quality Act
CNPS	California Native Plant Society
Conceptual Plan	Ballona Wetlands Ecological Reserve Conceptual Habitat Restoration and Adaptive Management Plan
Corps	U.S. Army Corps of Engineers
GIS	Geographic Information System
HMMP	Habitat Mitigation and Monitoring Plan
msl	Mean sea level
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PAR	Property Analysis Record
PMT	Project Management Team
PWA	Phillip Williams and Associates
Reserve	Ballona Wetlands Ecological Reserve
SCC	California State Coastal Conservancy
SLC	California State Lands Commission
SMBRC	Santa Monica Bay Restoration Commission
USFWS	U.S. Fish and Wildlife Service

1.0 INTRODUCTION

This Conceptual Habitat Restoration and Adaptive Management Plan ("Conceptual Plan") presents conceptual guidelines for biological components of habitat restoration within the Ballona Wetlands Ecological Reserve ("BWER" or "Reserve") using principals of adaptive management. The purpose of this document is to provide a conceptual outline of the restoration from a habitat perspective and guide the development of more detailed elements of the restoration such as the final grading plan, the planting/landscape plan, the operations and maintenance plan/long-term management plan, and the habitat mitigation and monitoring plan ("HMMP"). The final design and implementation of the proposed restoration at the BWER will be informed by the biological components presented here as well as the hydrological and geomorphological design components developed by ESA PWA (2011a-d, 2012a-c) and will be refined through the associated California Environmental Quality Act ("CEQA") and National Environmental Policy Act ("NEPA") analysis of alternatives and regulatory agency permitting for the project.

The information presented in this document is based on an extensive body of previous research and planning documents and represents input from a large team of scientists, engineers, conservation planners, and regulators. Where possible, clear direction is given on how activities will proceed; however, in some cases, not enough information is available to make a decision at this point. For these cases, we purposefully use "should" rather than "shall" or "will" to show the intended uncertainty.

The project aims to restore one of the largest remaining tracts of tidal marsh in southern California and is of particular significance considering that coastal wetlands in Los Angeles County have been reduced upward of 96 percent relative to pre-development conditions (PWA et al. 2006). The land, approximately 600 acres (242 hectares) of an original 2,000-acre (809 hectares) tidal marsh in Los Angeles County, is jointly owned by the California Department of Fish and Wildlife ("CDFW"; formerly the California Department of Fish and Game, "CDFG") and the California State Lands Commission ("SLC"). The CDFW, the SLC, the California State Coastal Conservancy ("SCC"), and the Santa Monica Bay Restoration Commission ("SMBRC") are working together to develop the restoration with the following overarching goals:

> *Restore, enhance, and create estuarine habitat and processes in the Ballona Ecosystem to support a natural range of habitat functions, especially as related to estuarine dependent plants and animals.*

Create opportunities for aesthetic, cultural, recreational, research, and educational use of the Ballona ecosystem that are compatible with the environmentally sensitive resources of the area.

The proposed restoration aims to reestablish a once vibrant tidal wetland system, increasing the ecosystem function and flood protection values of this degraded site. The restored wetlands will feature a mosaic of tidal wetland, dune, scrub, and grassland habitats with numerous opportunities for public enjoyment and education.

1.1 Restoration Background

The BWER site consists of approximately 600 acres (242 hectares) of open space in the Marina del Rey area of Los Angeles, in Los Angeles County, California (Figure 1). Of these 600 acres (242 hectares), 540 acres (218 hectares) are owned by the CDFW and 60 acres (24 hectares) are owned by the SLC. The 60 acres (24 hectares) belonging to the SLC was leased to the CDFW and the entire property was named the Ballona Wetlands Ecological Reserve. Funds for the purchase were acquired from Proposition 12 which set aside $300 million for coastal wetland acquisition and restoration in southern California. Funds for the planning and restoration of the property were also provided by Proposition 12. Together, the CDFW, SLC, and SCC are working with stakeholders, scientists, and other agencies to restore the wetlands.

1.2 Restoration Goals and Objectives

Goals developed for the restoration include the following:

Restore, enhance, and create estuarine and associated habitats and processes to support a natural range of habitat structures and functions in the Reserve.

Establish processes and functions within the Reserve to support estuarine habitats by improving tidal circulation into the wetlands to enlarge the amount of area that is tidally inundated, increase tidal prism and excursion, lower residence time of tidal water, ensure a more natural salinity gradient, and create a dynamic interaction between Ballona Creek, Ballona Wetlands, and the Santa Monica Bay.

Create a self-sustaining estuarine system by providing large, contiguous areas of diverse intertidal wetland habitat with wide transition and buffer areas to allow for adaptation to sea level rise, minimize the need for active management, and reduce negative impacts associated with human activities and invasive species.

Figure 1. Location Map

Provide landscape-level functions sustaining the multiple levels of biodiversity associated with estuarine systems by strategically preserving, restoring, enhancing, and developing multiple habitats and incorporating transitional and upland habitat links to the wetlands to support recruitment and the various life stages of a diverse native flora and fauna.

Establish a restored estuarine system that protects and respects cultural and sacred resources, enables cultural use of the site by Native Americans, and provides appropriate interpretive information about prior uses of the site.

Develop and enhance public access, recreation, environmental education, and interpretation opportunities within the Reserve through the development of appropriate visitor facilities and connections to regional and local trail networks.

Protect existing and planned roadways, utilities, and adjacent properties and uses by maintaining or improving flood protection and stormwater management, ensuring consistency with future regional plans, and limiting the need for significant modification to regionally important infrastructure.

Ensure public safety, resources protection, and security while minimizing security and maintenance costs by facilitating adequate law enforcement, providing for safe traffic movement and parking, reducing hazards, and providing appropriate access.

Ecological objectives include creating, restoring, and enhancing wetland and upland habitats in the Reserve to both increase and improve habitat for tidal wetland plant and wildlife species and to improve ecological services such as flood control and water quality improvement. Cultural objectives include protection of Native American cultural resources within the Reserve. Public access objectives include preserving and increasing public access to the Reserve in a manner compatible with sensitive habitats and special-status species. Public education objectives include increasing awareness of the value of wetland systems and increasing public involvement in the protection and restoration of sensitive habitats and the protection of special-status plants and animals. The goals and objectives presented above have been further refined during the development of this Conceptual Plan. These objectives are discussed in more detail in the following sections.

It should be noted that the proposed restoration includes elements of both habitat *restoration* and habitat *creation*. Our understanding of the historical ecology of the Ballona region is largely inferred from historical accounts of the Los Angeles coast (e.g., Dark et al. 2011); few hard data exist regarding historical habitat composition or ecosystem function at the BWER. Moreover, development within the Ballona Creek watershed and the associated need for flood control greatly limit the options available for restoration. Some aspects of the restoration plan involve “restoration” in the sense of recovering historical conditions. However, most aspects of the restoration plan involve reestablishment of natural processes and ecological functions and either habitat creation (i.e., creating a particular type of habitat where it previously did not exist) or habitat enhancement (i.e., modification of existing conditions). However, to avoid over-complicating the Conceptual Plan, the term “restoration” is used throughout the text and is meant to encompass all of these elements and not only the re-creation of a historical condition.

1.2.1 Habitat Objectives

The restoration will improve the quality and diversity of native plant communities within the Reserve. An appropriate mix of upland and wetland plant communities will be necessary to maintain or increase numbers of special-status plant species and to maintain or increase use of the Reserve by special-status wildlife species. The specific focus for upland habitats will be on the preservation and enhancement of dunes; however, enhancing grassland and coastal scrub will also be important. The specific focus for wetland habitats will be on increasing and enhancing tidal marsh habitat. Improving freshwater wetlands and riparian habitat will also be addressed. In addition to improving habitat for special-status plant and wildlife species, native plant abundance and diversity will be increased throughout the Reserve.

Impacts from invasive species will be minimized throughout the Reserve. Complete eradication is not achievable, and efforts to control invasive species will be prioritized based on the level of threat posed to sensitive habitats and special-status plant and wildlife species. Preventative measures will be taken to ensure that disturbance during construction does not increase levels of invasive species at the Reserve.

1.2.2 Wildlife Objectives

The restoration will improve overall habitat quality for native wildlife species, with the goal of increasing abundance and diversity of native animals that use the Reserve. The specific focus will be on improving habitat for wildlife species associated with tidal wetland habitat, including birds, fish, and benthic invertebrates. Non-native urban predators will be controlled to allow populations of native wildlife species to expand and occupy newly restored habitat. Similarly, human- and pet-related disturbances will be minimized throughout the Reserve to encourage use by sensitive wildlife species.

1.2.3 Special-Status Species Objectives

The restoration will preserve and enhance habitat for special-status plant and wildlife species that currently occur in or make use of the Reserve. The establishment of additional populations of special-status species will be encouraged. Potential disturbances to sensitive habitats or wildlife species will be reduced through effective design of public access areas, predator management, and other management tools.

1.2.4 Cultural Resource Objectives

To the extent feasible, cultural resources within the Reserve will be avoided by project construction and will be protected. The approach for avoiding and protecting cultural resources will be outlined in the cultural resources report to be prepared for the project.

1.2.5 Public Access, Education, and Involvement Objectives

Levels of public access to the Reserve will be maintained or increased. Public access will be limited to uses compatible with plant and wildlife resources in the Reserve, and special care will be taken to avoid impacts to sensitive habitats or special-status plant and wildlife species. Exclusion from some areas will be necessary to achieve this goal. Opportunities for public awareness and education will be provided through the use of interpretive signs, viewing areas, and other means. To the extent practical, public involvement will be encouraged during the restoration, monitoring, and long-term management of the BWER.

1.2.6 Flood Control and Ecological Service Objectives

The restoration will maintain or increase existing levels of flood protection and water quality improvement functions provided by wetlands in the Reserve. Increasing tidal input to the wetlands as well as increasing the overall acreage of wetlands within the Reserve will increase the capacity of the wetlands to absorb floodwaters. Increasing the acreage and overall quality of wetlands within the Reserve will increase the water quality improvement functions of the wetlands. Improvements to Ballona Creek will help reduce scour and additional sediment loading.

1.3 Purpose of the Conceptual Plan

The purpose of this Conceptual Plan is to provide conceptual guidelines for the long-term restoration and management of the BWER using adaptive management practices to preserve and enhance the ecological and social values of the Reserve. The Conceptual Plan focuses primarily on the biological component of the restoration design and implementation. The geotechnical components of the design and implementation have been addressed in numerous technical documents produced by ESA PWA, Phillip

Williams and Associates ("PWA"), Psomas and Associates, and Group Delta Consultants, Inc. (ESA PWA 2011a-d, 2012a-c; PWA 2008, 2010; PWA et al. 2006). Together, the biological and geotechnical components will be used to guide the overall design and implementation of the restoration. Specifically, this Conceptual Plan serves to:

Provide an overview of the Reserve, including its relevant physical, ecological, and biological features and processes, and cultural values.

Provide a description of physical structure and biological composition of target habitats which will serve to guide the restoration.

Provide the framework for developing a detailed monitoring and adaptive management plan to be implemented at the Reserve.

The Conceptual Plan provides the framework for achieving the goals and objectives discussed above in Section 1.2. The Conceptual Plan includes an overview of the restoration process which highlights pertinent environmental, ecological, and cultural issues. The Conceptual Plan also includes a monitoring program and adaptive management framework designed to guide the development of a more detailed Monitoring and Adaptive Management Plan.

1.4 Overview of Adaptive Management Practices

The restoration and long-term management of the Reserve will be based on principles of adaptive management. Adaptive management is an iterative process whereby restoration practices are guided by best available technologies and hypothesis testing followed by implementation and monitoring to evaluate results. This approach allows for restoration and management under changing conditions and with uncertainties in the course of habitat development. Adaptive management involves six primary steps: (1) research and planning, (2) design, (3) implementation, (4) monitoring, (5) evaluation, and (6) modification or adaptation. Most importantly, adaptive management is a reflective process in which management actions are continuously monitored and evaluated and necessary changes in management are planned and implemented, followed by continued monitoring and evaluation.

For a more detailed discussion of adaptive management see Atkinson et al. (2004) or Fischenich et al. (2011).

2.0 SUMMARY OF EXISTING CONDITIONS

Existing conditions and baseline ecological data at the BWER have been extensively documented (e.g., PWA et al. 2006; Johnston et al. 2011, 2012). The following sections summarize existing conditions at the BWER to provide context for the restoration and this Conceptual Plan.

2.1 Property Description

2.1.1 Geographical Setting and Site Overview

The Reserve is located in coastal Los Angeles County, California (Figure 1). The site is located northwest of Los Angeles International Airport, near the Marina del Rey area. The Reserve can be accessed by four major roads intersecting or abutting the site: Lincoln Boulevard, Jefferson Boulevard, Fiji Way, and Culver Boulevard. The Reserve is bisected by Ballona Creek and is generally discussed as three areas (A, B, and C; Figure 2). Area A lies north of Ballona Creek, west of Lincoln Boulevard, and south of Fiji Way. Area B lies south of Ballona Creek, west of Lincoln Boulevard, and north of Cabora Drive; the area is bounded on its western side by dunes bordering homes along Vista del Mar. Area C is bounded by Ballona Creek, the Marina Expressway, Lincoln Boulevard, and mixed-use development between the Expressway and Lincoln Boulevard.

The BWER comprises approximately 600 acres (242 hectares) of which 540 acres (218 hectares) are owned by the CDFW and 60 acres (24 hectares) are owned by the SLC. Of the 60 acres (24 hectares) owned by the SLC, 24 acres (10 hectares) , known as the Expanded Wetlands Parcel, are operated by the CDFW and are covered by this Conceptual Plan. The remaining 36 acres of SLC property, known as the Freshwater Marsh, are managed by the Ballona Wetlands Conservancy under a separate conservation easement and are not covered under this plan. Adjacent land use is primarily residential with some commercial development and institutional/government use. Land use adjacent to Area A is dominated by Marina del Rey which is one of the largest small craft harbors in the world and is the source of the majority of the fill material historically placed in Area A.

2.1.2 Cultural Features

A detailed discussion of cultural resources at the BWER is provided in the Existing Conditions Report for the Ballona Wetlands (PWA et al. 2006) and the Archaeological Survey Report (ICF International 2011). Cultural resources at the BWER will be preserved to the extent practicable during the restoration; for Native American resources, this will be done in consultation with the appropriate tribe. Details regarding

Figure 2. Site Overview

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cultural resources at the site and the approach to protecting such resources during the restoration can be found in the Archaeological Survey Report (ICF International 2011).

2.1.3 Existing Infrastructure

Various transportation, utility, and flood control infrastructure elements currently exist on the BWER property. Some of these elements will be left in place or modified as part of the proposed restoration. Other infrastructure elements will need to be removed to accommodate restoration efforts. In addition, new infrastructure will be created such as a visitor center, parking areas, pedestrian paths, lighting, fencing, and related elements. Members of the project management team ("PMT") have met with agencies, businesses, and organizations that have an interest in infrastructural elements within and adjacent to the BWER to discuss future infrastructure plans under the proposed restoration. Detailed descriptions of existing infrastructure can be found in the *Preferred Alternatives Memorandum* (PWA 2010) and the *Existing Conditions Report* (PWA et al. 2006).

2.2 Environmental and Ecological Description

The information provided in the following sections comes from a range of sources including the existing conditions report (PWA et al. 2006), the baseline conditions study (Johnston et al. 2011, 2012), and other sources. This information is intended to provide a contextual background for the other elements of this report.

2.2.1 Regional Climate

Southern California experiences a Mediterranean climate with moderate seasonal temperature fluctuation influenced by the Pacific Ocean and seasonal precipitation occurring predominantly in the winter and spring. The BWER experiences mild year-round temperatures with an average summer temperature of 69 degrees Fahrenheit (21 degrees Celsius) and an average winter temperature of 57 degrees Fahrenheit (14 degrees Celsius), with seasonal coastal fog and an average winter precipitation of 8.26 inches (20.98 centimeters).

2.2.2 Historical Ecology

The historical extent of the Ballona Lagoon is estimated to range from 2,120 acres (858 hectares) (PWA et al. 2006) to 4,288 acres (1735 hectares) (Dark et al. 2011). The Lagoon was part of the larger Ballona Creek watershed which historically covered a large swath of western Los Angeles from the Santa Monica Mountains to the coast (Dark et al. 2011). Natural shifts in the flows of the Los Angeles River and the subsequent channelization of the River in the 1880s resulted in Ballona Lagoon transitioning from an expansive wetland complex at the terminus of the Los Angeles River watershed to a more discrete wetland associated with the smaller Ballona Creek watershed (Dark et al. 2011; Ambrose and Bear 2012). This shift in the hydrologic regime of the Ballona region was further intensified by subsequent flood control efforts and commercial development in the area up through the early 2000s (Dark et al. 2011; PWA et al. 2006), the most important of these being the installation of flood control structures along Ballona Creek in the 1930s (Ambrose and Bear 2012; PWA et al. 2006).

Identification of dominant historical vegetation and habitats in the BWER is complicated by the lack of systematic surveys in the area prior to development. Focusing on the Ballona Creek watershed from approximately 1850 to 1890, Dark et al. (2011) determined that the BWER area was dominated by (in order from greatest to least extent) alkali meadows, tidal marsh, wet meadows, salt flats, willow thickets, beach and dune habitats, open water, and perennial freshwater ponds, with vernal pools occurring further inland. Species such as cordgrass (*Spartina* spp.), which are typically found in perennially open tidal wetlands (e.g., tidal channels and low marsh habitat), are not found in the older records. However, records indicate that species commonly associated with brackish, freshwater, dune, and salt marsh habitats were present (Dark et al. 2011). Ambrose and Bear (2012) determined that the habitat composition of the BWER shifted from being dominated by salt marsh and mudflats in 1876 to being dominated by grassland, coastal scrub, muted-tidal marsh, and non-tidal marsh habitats as occur today.

Mattoni and Longcore (1997) describe for an extensive Los Angeles coastal prairie extending from Playa Del Rey south to the Palos Verdes penninsula and extending inland to east of Torrance. Although the study focuses on the coastal headlands and does not specifically discuss the Ballona Lagoon, many of the annual prairie and vernal pool plant species they list would likely have occurred in the lowlands around the Ballona Wetlands where soil conditions were likely similar. Mattoni and Longcore developed a plant list for the Los Angeles coastal prairie based on herbaria records and historical literature, and the list shares marked similarities with characteristic southern coastal needlegrass grassland, southern coastal grassland, and pristine California grassland, with the coastal prairie list being differentiated by the presence of vernal pool-associated species. They concluded that the Los Angeles coastal prairie contained extensive vernal pool habitat based on historical topography and herbaria records, historical descriptions including photographs and place names, and identification of physical remnants of pools by the authors.

The lack of specific, systematic surveys of the historical BWER area makes it difficult to determine the historical composition of vegetation in the area. Mattoni and Longcore's list was compiled using herbaria records, historical records including amateur botanical collections and anecdotal accounts, habitat descriptions from early floras of southern California, and consultation with local botanists. However, the authors note that the only available source of quantitative data for the Los Angeles coastal prairie was a photograph taken in 1938 which was then compared to later photographs to measure species frequency and percent cover. Dark et al. (2011) discuss the Ballona Lagoon more specifically, but note that they, like Mattoni and Longcore, utilized a variety of sources including historical maps and surveys in combination with photographs, historical reports, herbaria records, and bird observations to draw their conclusions. Although Dark et al. (2011) provide a list of plants they believe were historically present in the Ballona Wetlands region, they do not draw conclusions as to likely dominant species or associations. Ambrose and Bear (2012) compared topographic maps (t-sheets) generated by a precursor of the National Oceanic and Atmospheric Administration ("NOAA") with a modern survey by the CDFW to determine the change in the extent and composition of habitat types at the Ballona Wetlands from 1876 to 2007; however, they do not discuss vegetation in detail.

The alternative restoration plans for the BWER have been developed with consideration of the historical ecology of the BWER; however, given the lack of detailed knowledge regarding the historical ecology of the area and the major changes that have occurred within the watershed, restoration to historical conditions is not possible. Centuries of surrounding development and other major alterations to the watershed, the flood control requirements of the project, the habitat requirements of special-status wildlife and plant species currently at the site, and the funds available for restoration are all factors that influence the opportunities for restoration at the BWER.

2.2.3 Geology, Soils, and Hydrology

Bedrock geology in the vicinity of the Reserve is characterized by faulting and tectonic activity typical of southern California. The Charnock and Overland faults are the closest faults to the BWER, at 1.3 miles (2.1 kilometers) northwest and 2.5 miles (4 kilometers) northeast, respectively (PWA et al. 2006). Native soils at the BWER are of fluvial and marine origins and include a wide range of particle sizes and textures (PWA et al. 2006). Sand becomes a more prevalent constituent in the upper layers of the soil approaching the ocean-side of the Reserve. Native soils in Areas A and C are overlain at a depth of 0 to 18 feet (0 to 5.5 meters) by sediments dredged during the construction and maintenance of Marina del Rey and Ballona Creek (PWA et al. 2006). Soil testing has revealed high levels of a number of elements of concern throughout the Reserve, but particularly in the salt panne, tidal marsh, and freshwater habitats in the eastern portion of the Reserve and in illegally dumped fill soils in the northeastern portion of Area B. Elements of concern include boron, selenium, vanadium, zinc, copper, sulfur, and lead (PWA et al. 2006; Johnston et al. 2011). Additional investigations will be necessary to fully document the concentration and distribution of these elements throughout the Reserve and to determine whether remediation will be necessary.

Hydrology at the BWER is influenced by tidal action from Santa Monica Bay as well as groundwater, urban runoff, and stormwater from within the Ballona Creek watershed. Mixed semidiurnal tides bring two high and two low tides of unequal height each day which propagate through the mouth of Ballona Creek and Marina del Rey. Area A receives tidal inflow via a culvert connected to Marina del Rey. Area B receives muted tidal inflow via self-regulating tide-gates in Ballona Creek. The Ballona Creek watershed includes approximately 130 square miles (337 square kilometers) of largely urbanized land. The majority of the Ballona Creek drainage network occurs as storm drains, underground culverts, and concrete channels. Inflow from these sources is particularly important in the Freshwater Marsh located along Lincoln Avenue and in freshwater habitats in Area B. Groundwater from the Ballona Creek watershed is a particularly important source of inflow for the wetlands. Groundwater is present in both confined and unconfined water table aquifers under Area B, with water table levels ranging from 1 foot (0.3 meter) above mean sea level ("msl") to 2.0 feet (0.6 meter) below msl. Areas A and C do not receive major hydrologic input from groundwater discharge, although observations of a perched water table have been made in Area A. Groundwater recharge is largely through infiltration through the soil profile following rainfall and during inundation by surface water.

Descriptions of soils and hydrology for each area of the BWER are presented below. A more detailed accounting can be found in the Existing Conditions Report (PWA et al. 2006).

<u>Area A</u>

Area A has been almost entirely modified from its natural state by the placement of fill and dredged material from numerous projects including construction of the Pacific Electric Railroad levee, platforms created for oil production facilities, and dredging of Marina del Rey and Ballona Creek. The placement of fill material has resulted in wide variation in topography and the distribution of sediments throughout Area A. Fill material ranges in thickness from 9 to 18 feet (2.7 to 5.5 meters) in the western portion of Area A and to 0 feet (0 meters) in the eastern portion, within the Marina Ditch. Fill material is underlain by the original marsh soils comprised of silty clay and clay. Bore data indicate potential subsidence of the original marsh surface due to the placement of fill material, with the original surface ranging from 2 feet (0.6 meter) below msl to 4 feet (1.2 meters) above msl.

Historically the overall elevation was less than 5 feet (1.5 meters) above msl; it now ranges from a low of 9.3 feet (2.8 meters) above msl in an area 600 feet (183 meters) south of the intersection of Admiralty Way and Fiji Way to a high of about 17.4 feet (5.3 meters) above msl at the far western end of the site. Variations in topography and the composition and structure of fill materials have led to varied hydrological regimes throughout Area A. Water infiltrates through the soil profile or flows downslope in areas with steep topography and coarse fill material and tends to collect in low-lying areas with more fine-grained fill material. Surface drainage in Area A either ends up in numerous closed depressions or in Marina Ditch which runs along the northern boundary of the Reserve and is connected to Marina del Rey via culverts under Fiji Way. The majority of Area A drains into the former “stilling basin” in the center of the Area. Water inputs in Area A come from tidal action which is contained in the Marina Ditch and from precipitation. As such, ponding generally only occurs during the wet winter months, and Area A consists largely of upland habitat.

Area B

Area B was not filled as extensively as Areas A and C and retains much of its original topography. The area is bisected by several roads which greatly affect its hydrology and have resulted in four distinct wetland areas: (1) the north wetland located north of Culver Boulevard, south of Ballona Creek, and east of Playa del Rey; (2) the south wetland located north of Del Rey Bluffs, west of the Gas Company road, south of Culver Boulevard, and east of Playa del Rey; (3) the east wetland located north of Del Rey Bluffs, west of the Freshwater Marsh, south of Jefferson Boulevard, and east of the Gas Company road, including the alluvial fan at Hastings Canyon and the lower portions of the Del Rey Bluffs; and (4) the northeast wetland located north of Jefferson Boulevard, south of Ballona Creek, and east of the Gas Company road. Sediments in these areas are mostly fine-grained. The western portion of Area B is richer in sand whereas the eastern portion is rich in silt and clay. Detailed descriptions of the individual wetland areas are provided in the Existing Conditions Report (PWA et al. 2006).

Elevations in Area B range from 2.4 to 5 feet (0.7 to 1.5 meters) above msl and extend to 50 feet (15 meters) above msl along the property line on the southern bluffs. The Del Rey bluffs continue upward to approximately 160 feet (48.8 meters) above msl. Marsh flat elevations range from 0.6 to 1.6 feet (0.2 to 0.5 meters) above msl with channels at 2.2 feet (0.7 meter) below msl. The wetlands in Area B were isolated from the regular tidal influence of Santa Monica Bay when the Ballona Creek levees were constructed in 1932. Currently, a series of flap-gated culverts and self-regulating tide-gates provide for muted tidal influence in Area B. Although tidal channels provide some hydrologic input to a large portion of the wetlands in Area B; the area does not receive normal tidal flushing due to a series of tide gates which connect this area to Ballona Creek. Outflow of water from the site through the tide gates is unrestricted, but inflow from the channel is partially controlled. These tide gates allow local canals to fill and keep the marsh areas adjacent to Ballona Creek generally wetted. Additional sources of inflow in Area B include precipitation and runoff from surrounding areas.

Area C

Area C received substantial fill during the construction of the Pacific Electric Railroad levee (early 1900s), the dredging of the Marina del Rey (1960s), and more recent highway construction. The largest impact occurred during the dredging for Marina del Rey when hydraulically placed slurry was pumped onto Area C. Marina Ditch is an open channel that runs along a portion of the northwest edge of Area C and then extends diagonally to the southeast across the northern half of Area C. The Marina del Rey dredging process left Area C with a high center sloping down to its perimeter, causing the area to no longer retain water for extended periods of time. Fill materials range from 3.5 to 15 feet (1.1 to 4.6 meters) above msl and consist of sand, silt, and clay with variable amounts of construction-related debris. Bore data indicate that, like Areas A and B, the fill material in Area C is underlain by Holocene alluvium consisting of various layers of sand, silt, and clay.

Current elevations range from 4.6 feet (1.4 meters) above msl in a man-made depression south of Culver Boulevard and east of the on-ramp from east-bound Culver Boulevard to north-bound Lincoln Boulevard, to 25.6 feet (7.8 meters) above msl at several mounds in the southwestern portion of the area. Additional depressions are present in the eastern portion of the site, north of Culver Boulevard, where elevations range from 7.4 to 9.4 feet (2.3 to 2.9 meters) above msl. Elevations of the ditch in the northern portion of the area range from 2.4 to 4.1 feet (0.7 to 1.2 meters) above msl. Aside from these specific areas, the majority of the site sits at elevations ranging from 12 to 20 feet (3.7 to 6.1 meters) above msl.

Direct precipitation, runoff from surrounding areas, and storm drain overflows dominate the hydrology of Area C. Additional flows from Marina Ditch and water backed-up behind tidal flap-gates in Ballona Creek also contribute to the hydrology of the area. However, current hydrologic connectivity between Ballona Creek and Marina Ditch allow for only minimal tidal exchange. Storm drains in the area collect water from off-site properties, and overflows from these storm drains sometimes enter Area C.

2.2.4 Plant Communities and Aquatic Habitats

The Ballona Wetlands contain a wide array of aquatic, wetland, and upland habitats including subtidal and intertidal channels, estuarine marsh, brackish marsh, freshwater wetland, seasonal wetland, riparian scrub and woodland, salt panne, dune, grassland, and scrub habitats. The CDFW mapped 57 specific plant alliances or mapping units within 16 major habitat types for the Reserve (CDFG 2007). Many plant alliances and mapping units are dominated by one or more non-native species. No alliances or associations are considered rare or endangered; however, one alliance (*Leymus triticoides* Alliance) and one association (*Frankenia salina-Distichlis spicata* Association) are considered vulnerable (S3) in California (Sawyer et al. 2009).

Descriptions of the plant communities and other habitat elements in the three main areas of the Reserve are provided in the following sections. Plant communities and habitat types at the BWER are shown in Figure 3. This figure has been adapted from the mapping conducted by the CDFW and is included here for contextual purposes only—it is not intended for any planning purpose or for analysis of project impacts. In addition, this adapted figure shows all areas dominated by non-native plant species as such, and does not distinguish between dominants.

<u>Area A</u>

Elevations were raised in Area A with the disposal of dredged materials from the construction of the Ballona Creek Channel and Marina del Rey. The topography and salinity of Area A are presumably the cause for the current vegetation zonation present within this area. Internal drainage carries salts leached from old marsh soils from marginal areas at elevations of 15 to 18 feet (4.6 to 5.5 meters) above msl to central areas ranging from 9.3 to 11 feet (2.8 to 3.4 meters) above msl (PWA et al. 2006). One large area of non-tidal salt marsh habitat occurs within the central portion of Area A and consists of intermixed mudflat habitat and hydrophytic vegetation, with a broad transition to upland habitat. The central and northern portions of Area A are dominated by pickleweed species (*Salicornia pacifica* [*S. virginica*], *S. europaea*, and *Arthrocnemum subterminale* [*S. subterminalis*]), big saltbush (*Atriplex lentiformis*), slender-leaf iceplant (*Mesembryanthemum nodiflorum*), annual bluegrass (*Poa annua*), and open, unvegetated bare ground and salt scald areas. The southwestern portion of Area A contains dense patches of alkali heath (*Frankenia salina*).

Many areas are heavily disturbed, largely due to the presence of encampments of homeless people throughout this area. Due in part to the high levels of disturbance in these areas, vegetation is dominated primarily by non-native, invasive species such as mustards (*Brassica* spp., *Hirschfeldia incana*) and crown daisy (*Glebionis coronaria* [Chrysanthemum *coronarium*]). Large patches of sea fig (*Carpobrotus* spp.) with stands of mulefat (*Baccharis salicifolia*) and coyote brush (*B. pilularis*) are also present along the western boundary of Area A.

Area B

Area B is the only area within the Reserve that contains unfilled salt marsh habitat. Dominant plant species in moist habitat types in Area B include bristly ox-tongue (*Helminthotheca echioides* [*Picris e.*]), alkali ryegrass (*Leymus triticoides*), annual bluegrass, brass buttons (*Cotula coronopifolia*), toad rush (*Juncus bufonius*), pickleweed species, salt grass (*Distichlis spicata*), broadleaf cattail (*Typha latifolia*), narrow leaf willow (*Salix exigua*), arroyo willow (*S. lasiolepis*), and Italian rye grass (*Festuca perennis* [*F. perenne*, *Lolium multiflorum*, *L. perenne*). In addition, many patches of coast buckwheat (*Eriogonum parviflorum*) occur along the western boundary of Area B. Some parts of Area B are heavily disturbed and harbor a number of non-native species such as eucalyptus (*Eucalyptus* spp.) in the south central area, pampas grass (*Cortaderia selloana*) in the southeast corner, and sea fig along most of the area south of the slough. Stands of willow (*Salix* spp.), coyotebrush, and acacia (*Acacia* spp.) are present along the western boundary near the levee. Area B currently supports the greatest number of native salt marsh plant species of all the areas (Hendrickson 1991).

Area C

Similar to Area A, Area C has been filled with dredge spoils and other material from various sources. The majority of Area C contains large amounts of trash and other debris and a number of encampments of homeless people. These areas are mostly dominated by non-native species such as acacia and mustards. Dominant vegetation within ditches and wetland areas include bristly ox-tongue, curly dock (*Rumex crispus*), Italian ryegrass, large saltbush, slender-leaf iceplant, and alkali heath. In the northeastern corner of the upper portion of Area C, the wetlands contain patches of bare ground as well as areas dominated by hydrophytic vegetation including large saltbush and pickleweed species. The eastern portion of Marina Ditch is dominated by large saltbush. Two areas of remnant dune habitat were identified within Area C by the CDFW (CDFG 2007). These areas are located adjacent to Culver Boulevard, near Jefferson Boulevard. Four developed baseball fields with associated infrastructure are present in the central portion of the southern part of this area and are primarily devoid of vegetation. Lastly, the drainage ditch located along the northeastern side of the baseball fields is dominated by bristly ox-tongue, curly dock, Italian rye grass, and black mustard (*Brassica nigra*).

Despite the degradation of Area C, it still contains some, albeit small, areas inhabited by native species within depressional areas. Newly established populations of native species such as pickleweed and alkali heath have colonized these depressional areas, and speak toward the resilience of such native species.

Figure 3. Biological Communities

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Ballona Creek

Ballona Creek has been channelized and is currently a lined, trapezoidal creek from its mouth at Santa Monica Bay to the intersection of Venice Boulevard and Pickford Street, approximately 9 miles (14.5 kilometers) upstream. The creek varies in width from 80 to 200 feet (24.4 to 61 meters) and in depth from 19 to 23 feet (5.8 to 7 meters) from the top of the levee. The side slopes are composed of concrete, paving stones, and riprap. The bottom of the creek is only open in the lower, tidally influenced portion, whereas the remaining portions are armored. The vegetation growing along the side slopes consists primarily of ruderal, weedy plant species including bristly ox-tongue, slender-leaf iceplant, and crown daisy. Limited native vegetation including pickleweeds and fleshy jaumea (*Jaumea carnosa*) are present in the western portion of Ballona Creek. Ballona Creek is tidally influenced within the Reserve area.

2.2.5 Floristics

Plant species within the BWER have been well documented throughout the years. Multiple botanical surveys have been conducted within the Reserve for various projects over the past two decades (e.g., Hendrickson 1991; Psomas and Associates 1995; Dorsey and Bergquist 2007; WRA 2011). These studies have included comprehensive floristic inventories and targeted rare plant surveys, as well as transect-based studies aimed at documenting changes in plant communities over time. Johnston et al. (2011) provide a detailed list of the plant species that have been documented at the Reserve. Currently, the BWER contains a mix of upland and wetland habitat types, many of which are dominated by non-native and invasive plant species.

Six special-status plants have been documented from the site: Lewis' evening primrose (*Camissoniopsis lewisii*), Orcutt's pincushion (*Chaenactis glabriuscula* var. *orcuttiana*), South Coast branching phacelia (*Phacelia ramosissima* var. *austrolitoralis*), southern tarplant (*Centromadia parryi* ssp. *australis*), suffrutescent wallflower (*Erysimum suffrutescens*), and woolly seablite (*Suaeda taxifolia*) (WRA 2011). To the extent feasible, occurrences of these species will be preserved during the restoration. If it is not possible to preserve existing occurrences of these species, a mitigation and monitoring plan will be developed to reestablish the impacted species in restored habitat elsewhere in the Reserve.

2.2.6 Animal Species

Animal occurrences at the BWER have been documented in a number of reports and are summarized in both the existing conditions report (PWA et al. 2006) and the baseline study reports (Johnston et al. 2011, 2012). In general, animal communities at the Reserve are composed of common native and non-native species. However, a number of special-status wildlife species have been documented from the Reserve, although many of these species do not currently occur there. The following sections summarize what is known about the animal communities at the Reserve.

Benthic Invertebrates

Benthic invertebrates provide a reflection of the state of the environment at the transition from water to land and may represent a useful index for the ecological health of an area (Hilty and Merenlender 2000). The presence or absence of certain infaunal taxa within tidal channels can serve as indicators of water quality, anthropogenic stressors to the estuary, and the potential of the estuary to support other trophic levels (Wetlands Recovery Project 2006). Censuses of distribution and abundance have been conducted before and after hydrological modifications within the Reserve to assess the impacts of such projects. Specifically, surveys were conducted before and after the replacement of flapgates (Chambers Group 1996, 1999) and after the installation of the east channel (main) tidegate (City of Los Angeles 2005). Additional benthic surveys of the Reserve include those by Clark (1979), Reish (1980), Ramirez and McLean (1981), Carter (1991), Boland and Zedler (1991), WRA (2004) and Weston Solutions (2005), among others. Benthic invertebrate surveys have primarily focused on Area B; limited surveys have been conducted in Area A, and no surveys have been conducted in Area C.

Benthic invertebrate species observed in one or more surveys are listed in Johnston et al. (2011). Although dominant species were not consistent between reports, the most common species found included: the polychaete worm *Streblospio benedicti* and members of the *Capitella capitata* complex (also polycheates), California hornsnail (*Cerithidea californica*), bent-nosed clam (*Macoma nasuta*), rude barrel-bubble (*Acteocina inculta*), and unidentified oligochaetes. The most commonly represented taxa were annelids, mollusks, and arthropods. Overall, the Reserve has a benthic community dominated by taxa characteristic of southern California coastal wetlands, but with lower species diversity than what might be expect of larger, less disturbed wetlands (Chambers Group 1996). Although no Federal- or State-listed benthic invertebrates have been reported from the Reserve, one species of special concern has been documented. The California brackishwater snail (*Tryonia imitator*) is considered imperiled globally (G2G3) and in California (S2S3) and was reported from Ballona Creek in 1974 (CDFW 2013; NatureServe 2013). The original report was based on the presence of empty shells of this species and there have been no subsequent reports of this species, despite several benthic invertebrate surveys.

Insects

Insects provide a vital link in the food web within a wetland system and are used as indicators for particular species or the overall health of a system (Zedler 2001). The destruction of coastal saltmarsh habitat in southern California has resulted in the decline of the diverse insect communities that rely upon this habitat (Nagano et al. 1981; Mattoni 1991). Invertebrate-based metrics of ecosystem function have centered on taxonomically cataloging the biodiversity of a community (Anderson 2009). In lieu of time-consuming species-level identifications, metrics aimed at describing function or rates may ultimately be better indicators of the current status of a marsh as well as better forecasters of subsequent marsh health (Anderson 2009). These metrics can often be employed rapidly across habitat types, as well as being useful from a management perspective.

The study by Nagano et al. (1981) represents the most comprehensive insect survey of the BWER to date; however, additional surveys include those by Boland and Zedler (1991), Mattoni (1991), Hawks Biological Consulting (1996), and Friends of Ballona Wetlands (2008, 2009, 2010). Insect surveys have primarily focused on Area B, specifically the dune habitats; limited surveys have been conducted in Areas A and C. Insect species observed in one or more surveys are listed in Johnston et al. (2011).

Seven special-status insect species have been observed at the Reserve in recent times: monarch butterfly (*Danaus plexippus*), wandering skipper (*Panoquina errans*), Dorothy's El Segundo dune weevil (*Trigonoscuta dorothea dorothea*), globose dune beetle (*Coelus globosus*), Lange's El Segundo dune weevil (*Onychobaris langei*), Belkin's dune tabanid fly *(Brennania belkini*), and El Segundo blue butterfly (*Euphilotes battoides alluni)*. Special-status insect species observed at the site, or with potential to occur at the site, are discussed in more detail by Johnston et al. (2011) and PWA et al. (2006). To the extent feasible, habitat occupied by these species will be preserved. Most of these species are associated with existing dune habitat at the Reserve and are likely to benefit from on-going restoration efforts in these areas as well as from the potential creation of dune habitat elsewhere in the Reserve.

Fishes

Use of tidal wetlands at the BWER by fish species is arguably one of the most important aspects of the restoration. Defining the fish assemblage of a wetland can be difficult due to the highly mobile nature of the fauna. However, it is this characteristic of mobility that often makes fish some of the first organisms to colonize restored habitats (Zedler 2001). Swift and Franz (1981) were the first to conduct detailed surveys of the fish species within the Ballona area for the "Biota of the Ballona Region" (Schreiber 1981). This was the first study of an upper marsh fish community in southern California and serves as a good historical reference to past conditions and diversity (PWA et al. 2006). Historically, when the Los Angeles River flooded the wetlands, there would have been a higher ichthyofaunal diversity than currently exists at the BWER, including the possibility of several special concern species that have not been seen during surveys in the past 25 years (PWA et al. 2006). A number of additional fish surveys have been conducted in the tidal channels of the Reserve as well as in Ballona Creek and the adjacent Marina del Rey, including those by Allen (1991), Boland and Zedler (1991), Stoltz (1991), the City of Los Angeles (2005, 2009), Merkel and Associates (2009), and Johnston et al. (2011, 2012). Johnston et al. (2011) provide a detailed list of fish species identified in the open water areas of either Marina del Rey or Ballona Creek and within the tidal channels of the Reserve. No special-status fish species have been documented from the Reserve.

Reptiles and Amphibians

Reptiles and amphibians are an integral part of natural ecosystems (Gibbons et al. 2000; Meyers and Pike 2006). Gibbons et al. (2000) reflect that overall declines in reptile and amphibian populations can be attributed in part to many causes, including, but not limited to, anthropogenic factors, habitat loss, invasive and introduced species, pollution, and disease. Past surveys conducted in Areas A and B have yielded a limited reptile and amphibian species diversity; Area C has not been surveyed for reptiles and amphibians. Throughout the years, there have been several species commonly observed on-site including: Great Basin fence lizard (*Sceloporus occidentalis longipes*), western side-blotched lizard (*Uta stansburiana elegans*), San Diego alligator lizard (*Elgaria multicarinata webbii*), California kingsnake (*Lampropeltis getula californiae*), and San Diego gopher snake (*Pituophis catenifer annectens*) (Dorsey and Bergquist 2007; Hayes and Guyer 1981; Hovore 1991; Impact Sciences 1996; Johnston et al. 2009; Society for the Study of Amphibians and Reptiles 2008). Amphibian diversity at the BWER has historically been limited, consisting of Baja California treefrog (*Pseudacris hypochondriaca hypochondriaca*), California toad (*Bufo boreas halophilus*), and garden slender salamander (*Batrachoseps major major*). These species experienced a major reduction in numbers from the early 1980s to the early 1990s, potentially due to drought conditions in 1991 (Hayes and Guyer 1981; Hovore 1991).

Johnston et al. (2011) list the reptiles and amphibians documented from the Reserve in one or more surveys conducted over the past 25 years. Only one special-status reptile or amphibian species has been documented from the Reserve over the last 25 years: California legless lizard (*Anniella pulchra*). This species is associated with existing dune habitat in the western portion of Area B and is likely to benefit from on-going restoration efforts in this area as well as from the potential creation of dune habitat elsewhere in the Reserve under some proposed project alternatives.

Birds

The avifauna of the Ballona Wetlands has been particularly well-documented, owing to a recent effort to uncover historical bird records and to describe the area's history of landuse change in relation to the extirpation and colonization bird species (summarized in Cooper 2008). Numerous references to Ballona and the "Venice Marshes" (historic, pre-Marina del Rey wetlands which occurred to the north of the present-day BWER) in early ornithological literature (Grinnell 1898; Willet 1912, 1933; Grinnell and Miller 1944), and comprehensive annotated checklists to the birds of the Ballona Wetlands produced at regular intervals (Dock and Schreiber 1981; Corey 1992; Cooper 2006a) have resulted in a record of bird occurrence dating back over 100 years.

Despite the strong historical record, direct comparisons of today's bird community with that of previous eras is made difficult by the lack of systematic observational data. For example, tables of species occurrence by month or season in the public record are sporadic at best. The vast majority of such data is contained in unpublished notes of observers, which have only recently been explored and synthesized (Cooper 2006a, 2006b). The first known published data tables of sightings reflecting regular surveys by observers over set periods of time are from Dock and Schreiber (1981), who performed weekly walking transects of Areas A and B from February 1979 to June 1981. Corey (1992) conducted bi-monthly surveys of open space both east and west of Lincoln Boulevard from April 1990 to April 1991. Neither of these two studies included Ballona Creek, which is an important waterbird site. Only Corey (1992) appears to have investigated the nesting status of bird species, other than anecdotal observations for a select few species by the other authors. Johnston et al. (2011) provide a detailed list of the bird species documented from the Reserve.

Owing to several decades of litigation regarding proposed development on portions of the open space in and around the BWER, the presence of special-status bird species at the site has been repeatedly and thoroughly documented. That said, the actual number of special-status bird species using a given area is difficult to ascertain. Most species are only afforded special-status if engaged in a particular activity, usually breeding. Only two special-status species were confirmed as actually nesting in the BWER proper: least Bell's vireo (*Vireo bellii pusillus*) and Belding's Savannah sparrow (*Passerculus sandwichensis beldingi*). Four additional special-status species are known to breed nearby and visit the Reserve for foraging including: double-crested cormorant (*Phalacrocorax auritus)*, white-tailed kite (*Elanus leucurus*), Cooper's hawk (*Accipiter cooperii*), and California least tern (*Sterna antillarum browni*); these species do not currently breed at the Reserve and thus are not afforded special protections there. Special-status bird species present at the BWER will be protected according to state and federal requirements, and although some temporary loss of habitat may occur, it is expected that these species will ultimately benefit from restoration activities at the BWER. The population of Belding's Savannah sparrow that currently occupies tidal marsh and salt panne habitats in Area B has been specifically targeted in the restoration planning that has occurred to date, and the extent of restoration activities in Area B (i.e., restoration of the full tidal range in the western portion of Area B) will depend on demonstrated use of restored tidal marsh and salt panne habitats in Area A by this species.

Mammals

The Ballona Wetlands region has suffered a decline in populations of native mammals, a reduction in species ranges, and an increase in introduced species throughout the last century (Friesen et al. 1981). Surveys of the past 29 years throughout the Reserve have yielded a comprehensive mammal diversity of 17 species, three of which are CDFW Species of Special Concern (Friesen et al. 1981; Hovore 1991; Impact Sciences 1996; Erickson 2000; Psomas and Associates 2001; Dorsey and Bergquist 2007; Johnston et al. 2009).

Seven of the species identified in past surveys are considered non-native to the Ballona region: black rat (*Rattus rattus*), domestic cat (*Felis cattus*), domestic dog (*Canis familiaris*), house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), red fox (*Vulpes vulpes*), and Virginia opossum (*Didelphis virginiana*). Three of the species identified in past reports are listed as CDFW Species of Special Concern: southern California saltmarsh shrew (*Sorex ornatus salicornicus*), San Diego black-tailed jackrabbit (*Lepus californicus bennetti*), and South Coast marsh vole (*Microtus californicus stephensi*). It is believed that San Diego black-tailed jackrabbit is no longer present at the BWER. In addition, southern California saltmarsh shrew has not been observed at the site since the early 1990s. South Coast marsh vole has been identified from the BWER as recently as 2010 (Johnston et al. 2011), and appropriate measures will be implemented to protect this species during the restoration efforts. Although some temporary loss of habitat may occur, it is expected that this species will ultimately benefit from restoration activities at the BWER.

3.0 RESTORATION DESIGN AND IMPLEMENTATION

The design and implementation elements presented here focus on the biological components of the proposed restoration alternatives. The elements presented here are conceptual in nature and are intended to guide a more detailed level of planning which will be necessary as the restoration effort proceeds. The elements presented here build upon the feasibility studiesand initial impact assessments developed by ESA PWA, the PMT, and other stakeholders. Input from regulatory agencies, interested organizations, and the general public has also been incorporated into the development of this Conceptual Plan. The final design and implementation of the proposed restoration at the BWER will be informed by the biological components presented here as well as the hydrological and geomorphological design components developed by ESA PWA (2011a-d, 2012a-c).

3.1 Target Habitat Composition and Expected Development

The composition of habitats targeted for the restoration at the BWER are primarily based on historical accounts of the habitat previously present at the BWER (Ambrose and Bear 2012; Dark et al. 2011; Mattoni and Longcore 1997; Schreiber 1981) and habitat characterizations provided by Ferren et al. (2008) and Barbour et al. (2007). Given the constraints imposed by the surrounding development, the highly modified nature of the watershed supporting Ballona Creek, existing conditions within the BWER, and projected impacts related to global climate change, re-creation of historical conditions is not possible. Within these constraints, the proposed extent and distribution of habitats in the restored BWER is based on the ecological and biological goals of the restoration (Section 1.2), specifically those related to increasing the total area of tidal wetland habitat and providing high-value habitat for special-status plant and wildlife species.

Physical and biological characteristics of restored habitats within the BWER are expected to develop and evolve over time, particularly given changes expected as a result of global climate change. Restoration will require reliance on natural ecological processes such as sedimentation, erosion, and plant succession. Adaptive management will require an understanding of the expected trajectory of habitat development and the underlying ecological processes involved. The following sections provide an overview of the habitats to be restored at the BWER, including the main ecological drivers of habitat development and a description of the vegetation communities and wildlife populations expected to become established in each habitat.

3.1.1 Tidal Wetland (Tidal Channel, Mudflat, Tidal Marsh)

Tidal action is the primary ecological process responsible for developing and maintaining tidal mudflat and wetland habitats (Kolka and Thompson 2006; Sharitz and Pennings 2006). Wave and tidal action redistribute sediment and determine the topography and evolution of mudflats, marsh, and tidal channels. Tidal inundation, sediment composition, and topography interact to provide the physical conditions that affect the distribution of plant and animal species within a marsh (Mendelssohn and Batzer 2006; Sharitz and Pennings 2006). Tidal marsh plant species vary in their response to the duration and depth of tidal inundation such that each occurs in a unique range of tidal elevations (Zedler et al. 1999). The overlapping distribution of these species is typically simplified and reduced to three marsh vegetation zones in southern California: low, mid-, and high marsh habitats.

Under sediment-limited conditions, tidal marshes typically form by a slow, interactive process of sediment accretion and plant colonization (Kolka and Thompson 2006; Sharitz and Pennings 2006). However, at sites with high sediment loads, the process of tidal marsh development may occur more rapidly (Wallace et al. 2005). As a result of development within the Ballona Creek watershed, sediment loads in Ballona Creek are relatively low, and sediment accretion within restored wetlands at the BWER is expected to be slow. This will necessitate grading of restored tidal marsh and larger channel habitats to near target elevations. Smaller tidal channels are expected to develop over time, and it is expected that all tidal channels will migrate to some degree over the life of the restoration.

Tidal marsh plants can be sensitive to elevated salinity, acidic soil conditions, elevated concentrations of certain naturally occurring elements, and extremes in soil texture. To provide a suitable substrate for marsh vegetation, specifications for marsh soils will be developed and testing of on-site soils will conducted to determine whether there is potential to reuse excavated soils from Areas A and C. Salvage of historic marsh soils buried under dredge spoils placed north of Ballona Creek during creation of the Marina Del Ray harbor may provide a source of suitable marsh soil to use on the marsh surface, although some modification of the soil may be necessary to restore the physical and chemical properties necessary for plant growth.

Because sedimentation rates from the Ballona Creek watershed and from Santa Monica Bay are expected to be low, loss of sediments to the Bay is a potential concern, especially with rising sea levels. Rapid vegetative colonization of low, mid-, and high marsh habitat will be important in reducing the loss of sediments. Planting or seeding of the marsh surface may help speed the colonization process and limit sediment loss. Although a vegetated marsh surface is desirable in terms of reducing sediment loss, some portion of unvegetated mudflat habitat is desired as this provides prime foraging habitat for many wading and shorebirds and provides valuable habitat for benthic invertebrates.

Re-vegetation will rely on natural establishment as much as possible. Some salt marsh species will colonize areas of sediment accretion where dispersing seeds can become buried in sediment until spring germination. However, plant establishment may be limited where seed is unavailable, sediment erosion is active, or salinity is exceptionally high. Studies conducted as part of the restoration of Tijuana Estuary determined that establishment of most common tidal marsh plant species is improved when the species are planted or seeded; pickleweed was the only tidal marsh species that colonized well on its own (Lindig-Cisneros and Zedler 2002). Some level of active planting or seeding will be necessary throughout the tidal marsh habitat, but it will be especially important in the high marsh zone to provide competition with weeds and to reach the high levels of plant diversity generally found in this portion of tidal marshes. Establishment of species such as alkali heath, saltgrass, and other target species in the high marsh and transition zones will require use of container plantings and irrigation. Establishment of pickleweed in the mid marsh may occur naturally given the proximity of propagules in portions of the BWER and surrounding areas. However, planting stands of other mid-marsh target species will be necessary to encourage species heterogeneity in the mid-marsh. Additional planting may be necessary in locations with high erosion potential such as adjacent to inlets and along tidal channels. Pacific cordgrass (*Spartina foliosa*) is often the dominant plant in the low marsh zone of tidal wetlands in southern California (Zedler et al. 1999) and could recolonize naturally given a nearby seed source. However, Pacific cordgrass does not currently occur at the BWER or in the immediate vicinity, and transplanting from nearby marshes would be necessary to create cordgrass stands at the BWER. Other low marsh species such as salt marsh bird's beak (*Chloropyron maritimum* [*Cordylanthus maritimus*]) should also be considered for establishment at the BWER. The federally endangered subspecies of this plant was successfully established in restored habitat at San Diego Bay where suitable host plants and pollinators were present (Parsons and Zedler 1997).

A significant effort to control invasive plant species will be necessary to ensure establishment of native species in the high marsh and transition zones. Regular tidal inundation and elevated salinity levels in the low and mid-marsh zones will help prevent colonization by non-native ruderal species. However, the decreased frequency of tidal inundation in the high marsh and transition zones makes these areas more susceptible to invasion by non-native ruderal species, particularly after rainfall events which may lower soil salinity (Noe and Zedler 2001a, b). This increased susceptibility to invasion will require greater focus of management activities in these areas to maintain the desired native vegetation.

Target habitat acreages for tidal wetlands will be developed in later stages of the restoration based on input from the project design team and regulatory requirements. The primary targeted species for tidal wetland restoration at the BWER include Pacific cordgrass in the low to mid-marsh zones, pickleweed in the mid-marsh to high-marsh zones, and a combination of Parish's glasswort (*Arthrocnemum subterminale*), shoregrass (*Monanthochloe littoralis*), saltgrass, alkali heath, and coastal gumweed (*Grindelia stricta*) in the high marsh zone (see the potential plant palette provided as Appendix A). Additional species will be considered for establishment in each of the marsh zones to increase native plant diversity within the tidal marsh.

The conflicting dynamics of sedimentation and sediment removal and associated shifts in vegetation should be anticipated in the monitoring and management phases of the restoration. Target acreages for specific wetland habitat and vegetation zones should be flexible, and performance goals should emphasize hydrogeomorphic functionality, vegetative cover, and use by tidal wetland-associated wildlife species.

3.1.2 Brackish Marsh

The Freshwater Marsh will be retained and operated as it is at present under all project alternatives. However, a portion of the outflow from the Freshwater Marsh may be redirected to connect with the channel system in the restored managed tidal wetlands south of Jefferson Boulevard and east of the Gas Company road, creating a brackish marsh transition zone between the Freshwater Marsh and the restored tidal wetlands under some alternatives.

Brackish wetlands are formed in portions of tidal marsh receiving seasonal or perennial input of freshwater (Desmond et al. 2001). In southern California, these areas are generally dominated by California bulrush (*Schoenoplectus californicus*), southern cattail (*Typha domingensis*), ditch grass (*Ruppia maritima*), and spiny rush (*Juncus acutus*) (Desmond et al. 2001). At the BWER, the Freshwater Marsh receives runoff from the adjacent development and the Jefferson Boulevard storm drain. Outflow from the Freshwater Marsh is directed into Ballona Creek via a gated culvert. After the proposed restoration, a portion of the outflow from the Freshwater Marsh will be directed to the restored tidal marsh in the eastern portion of Area B. An area of brackish marsh will develop where outflow from the Freshwater Marsh meets inflow from the restored tidal marsh. The degree and extent of brackish conditions will depend on the amount of freshwater entering the restored tidal marsh at any given time. The flow of water from the Freshwater Marsh will be controlled via the existing overflow weir or via gated culverts installed in the marsh levee. In addition, current project plans call for the installation of a tide gate at the inlet to this portion of Area B, thereby providing a means to regulate the flow of saline tidal water into the brackish marsh area. The ability to control the flow of both freshwater entering from the Freshwater Marsh and saline water entering from the tidal marsh provides the means to regulate the degree and extent of brackish conditions and to manage this area to promote species diversity and high-quality habitat for brackish marsh-associated species such as tidewater goby (*Eucyclogobius newberryi*), Pacific staghorn sculpin (*Leptocottus armatus*), longjaw mudsucker (*Gillichthys mirabilis*), or topsmelt (*Atherinops affinis*). However, even with the ability to control the flow of water into the marsh—and thereby control salinity levels and other aspects of water chemistry—it will be difficult to predict the extent to which brackish conditions will develop, and it is likely that such conditions will vary from season to season and from year to year.

The brackish marsh, particularly the upper portions of the marsh which will receive less frequent inundation, will be vulnerable to invasion by non-native weed species. As conditions become less saline and tidal inundation becomes less frequent, a greater suite of invasive species will be able to become established. Maintaining more saline conditions by limiting the amount of freshwater entering the brackish marsh may be one way to minimize the potential for invasion of non-native weeds. The use of densely spaced restoration plantings that will fill in quickly and limit the availability of light and nutrients may also help to reduce potential for invasion.

Due to the variable nature of brackish marshes—including large intra- and inter-annual variations in salinity levels (Desmond et al. 2001)—it is difficult to describe a target area or vegetation community for this habitat. Vegetation should include some combination of California bulrush, southern cattail, ditch grass, spiny rush, pickle weed, saltgrass, alkali heath, and other species typical of habitats ranging from freshwater to tidal wetlands (see the potential plant palette provided as Appendix A). Target acreages for brackish marsh should be flexible, as it is likely that the extent of brackish conditions will shift from season to season and year to year. Performance goals should focus on both the composition of the vegetation and the total area of vegetative cover. Plantings will be required in this area and should focus on dominant species characteristic of brackish marshes. It may be desirable to also plant small patches of non-dominant species to increase native plant diversity in the brackish marsh.

3.1.3 Salt Panne

Salt pannes develop in shallow depressions along the upper edges of the high marsh zone. They occur at elevations high enough to receive only occasional high tides. Salt panne depths are shallow enough that they do not collect excessive amounts of rainfall and can dry down between tide events. Salt pannes are often ponded for long periods during the winter and spring months and dry for longer periods during the summer. The input of saline water combined with successive periods of flooding and evaporation creates hypersaline conditions that exclude most plants (Pratolongo et al. 2009). With changes in salinity levels and the duration and frequency of ponding, salt pannes have the potential to grade into either seasonal wetland or tidal marsh habitats. Two hydrologically distinct forms of salt panne habitat currently occur at the BWER: (1) those that receive water input primarily from spring and other high tides, depending on the levels at which the tide gates are set and (2) those that receive water input from seasonally shallow saline groundwater and stormwater runoff. In both cases, extended periods of evaporation result in the concentration of salts in the upper portion of the soil, resulting in a lack of vegetation over large portions of these habitats. Created salt panne habitat at the BWER will be primarily of the first type, receiving water input primarily from spring and other extreme tides. However, given the presence of saline soils and the likelihood of saline groundwater occurring in many portions of the Reserve, some of areas designed as seasonal wetland habitat may develop high concentrations of salts at the soil surface, thus resulting in the formation of salt panne-like conditions.

It is unclear how long it may take for salinity to reach levels sufficient to exclude most plants, and creation of salt panne habitat at the BWER will benefit from incorporation of high-salinity soils salvaged from existing salt panne habitat that will be lost to tidal wetland restoration or from high-salinity soils excavated from deeper within the soil profile. In addition, it may be desirable to add salt to the pannes to increase salinity levels more rapidly. Given the uncertainty regarding salt panne development and function, a phased approach will be used wherein salt panne design will be tested in Area A, and the results will be carefully evaluated prior to implementation in the other portions of the Reserve.

Target habitat acreages for seasonal wetlands under each project alternative will be developed in later stages of the restoration based on input from the project design team and regulatory requirements. At peak salinity levels, salt panne habitat should exclude the germination and establishment of most plants; however, it is likely that initial post-construction salinity levels may not be high enough to exclude all plants. Moreover, typical tidal marsh plant species such as Parish's glasswort, pickleweed, and saltgrass may become established in a developing salt panne when surface salinities are not yet elevated and then persist as the salt panne develops higher salinity by tapping into lower-salinity water deeper in the soil profile, thereby resisting exclusion by high surface salinities. Weeds with some salt tolerance such as perennial pepperweed (*Lepidium latifolium*) may also become established during the initial years of the restoration when salinity levels are relatively low, and more intensive weed management may be necessary during this time period. As salinity levels rise with each successive dry-down period, plants should be naturally excluded from germinating and establishing within the salt panne habitat, and less weed management will be necessary. Although new plants are likely to be prevented from establishing once salinity levels are sufficiently high, it may be necessary to remove plants which became established when salinity levels were low.

3.1.4 Seasonal Wetland

Seasonal wetlands generally develop in low-lying areas that collect rainfall and other runoff or receive input from seasonally elevated shallow groundwater. These habitats are dependent on ponded conditions that persist for a limited period following the rainy season and which promote the development of hydric soils and hydrophytic vegetation. The duration and depth of ponding is the major determinant of plant community development in seasonal wetlands (Kolka and Thompson 2006). Longer periods and deeper depths of ponding will result in vegetation dominated by wetland-adapted, sometimes perennial species, whereas shorter periods and more shallow depths of ponding may result in vegetation dominated by annual species adapted to fluctuating moisture regimes. At the BWER, soil salinity will also play a major role in determining the plant communities that will develop in seasonal wetlands.

Target habitat acreages for seasonal wetlands will be developed in later stages of the restoration based on input from the project design team and regulatory requirements. Seasonal wetlands will be designed to have a range of inundation depths and durations and will be strategically located throughout the upland and transition habitats throughout the Reserve. The location of these wetlands will be designed to allow for a transition from vernal pool to salt panne habitat in conjunction with expected rates of sea level rise. As sea levels rise, salt panne habitat within the transition zones should undergo natural conversion to tidal marsh habitat and seasonal wetlands located higher in the transition zones and upland habitats will likely undergo conversion to salt panne habitat. This should result in an overall loss of seasonal wetland habitat, but should allow for natural establishment of new tidal marsh and salt panne habitat as sea levels rise.

Historically, seasonal wetlands on coastal terraces in the Ballona region supported a high diversity of freshwater vernal pool plant species (Mattoni and Longcore 1997). The focus of seasonal wetland restoration in areas of low-salinity soils at the Reserve will be on the creation of shallow depressions with appropriate soils for supporting a similar assemblage of southern California vernal pool plant species (see Appendix A). Vernal pools and other seasonal wetlands are formed in two ways: (1) by fine textured low-permeability subsoils which perch shallow groundwater or (2) by seasonal exposure of high water tables through more coarse-grained soils (Zedler 1987; Mitsch and Gosselink 2000; Kolka and Thompson 2006). Investigation of the relationship of topography and soil permeability to surface and subsurface hydrology and salinity at the BWER is necessary to inform the appropriate design of the seasonal wetlands to be created. Analyses will be conducted in existing seasonal wetlands to determine how they function, and theywill also be conducted in the sites proposed for creation of seasonal wetlands to determine what type of seasonal wetlands these areas can support. If the sites selected for seasonal wetland creation contain high water tables, the created seasonal wetlands will be excavated to an appropriate depth to reach this high water table. If the sites selected for seasonal wetland creation do not contain high water tables, the created seasonal wetlands will be designed with a compacted layer of fine-textured soil which will perch shallow groundwater. Additional topographic and hydrological analyses will be necessary to ensure that seasonal wetlands of this design are fed by an appropriately sized watershed.

3.1.5 Riparian Scrub and Woodland

Riparian habitats are shrub- or tree-dominated areas which develop along the edges of ephemeral, intermittent, or permanent streams or rivers (National Research Council 2002; Mitsch and Gosselink 2000). Habitats within the Reserve which have been classified as *riparian* in the existing conditions report prepared by PWA et al. (2006) may be better described as palustrine scrub or shrub wetlands or palustrine forested wetlands (CDFG 2007) as these features occur not along streams or rivers, but rather adjacent to wetlands or within seasonally ponded areas or areas with shallow water tables. Hydrology is the primary ecological driver for these plant communities, and as such, riparian plant communities within the Reserve are vulnerable to changes in hydrology resulting from grading activities associated with the restoration. In addition, many of the species within these communities may be sensitive to salt, and the restoration of tidal marsh habitat adjacent to these habitats may increase exposure to saline groundwater.

Some portion of the mapped riparian scrub vegetation within the southern and eastern portions of Area B will be lost under most project alternatives to the restored tidal and brackish marsh habitats. However, the eucalyptus grove located in Area B, near the terminus of Falmouth Avenue, will be preserved under all alternatives, as these trees are currently used as roosting habitat for monarch butterfly. The trees will be monitored and managed as needed to maintain suitable habitat conditions for the monarch population and will eventually be replaced with native trees suitable for the site and for monarch roosting. Replacement of the eucalyptus trees will occur in phases according to a replacement plan which will be developed in conjunction with the CDFW. During the interim period, the eucalyptus grove will be prevented from increasing in size or extent. Riparian habitat within Area C is may be lost to upland habitat restoration and construction of the interpretive visitor center and associated facilities planned for this area. The final acreage of riparian habitat to be either preserved and enhanced or created will be determined in later stages of the restoration based on input from the project design team and regulatory requirements. Riparian vegetation not removed during the restoration may be vulnerable to dieback resulting from changes in hydrology or salinity resulting from the creation of tidal wetland habitat immediately adjacent to these areas. Any grading to occur in or around preserved riparian habitat will need to be undertaken with consideration of the available sources of water for these habitats and should strive to maintain existing levels of water input to prevent large-scale dieback in these areas. Management of riparian areas will focus on the removal of invasive plant species (exclusive of the eucalyptus grove in Area B) and incorporation of appropriate native riparian plants (see Appendix A) to increase diversity and provide appropriate habitat structure for riparian wildlife species.

3.1.6 Dune

Coastal dunes in their natural condition are inherently dynamic systems changing in response to wind and waves (Nordstrom 2008). Plant species typically associated with dune habitat have evolved a variety of reproductive and competitive strategies to adapt to the constant disturbance of accreting and eroding sand (Pickart and Barbour 2007). Dunes within the Reserve are remnants of a once larger dune system and are relatively isolated from the sand source and prevailing winds that are the ecological drivers which would normally shape these systems. Restoring the dunes to a more natural, self-sustaining condition is not possible given the development that has occurred west of the dunes; however, ongoing planting and invasive species control efforts led by Friends of Ballona Wetlands have restored portions of the dunes with native plant species typically found in southern California dune systems. Within these plant communities are several special-status plants (e.g., South Coast branching phacelia) as well as potential host plants for special-status invertebrates (e.g., El Segundo blue butterfly).

The existing dunes occurring in the western and southeastern portions of Area B will remain under some of the project alternatives. Management activities will focus on limiting anthropogenic disturbances, removing non-native species, and encouraging the establishment of both common and rare native dune species. A limited area of dune creation may be undertaken in several additional portions of the Reserve. Similar to existing dune habitat, the created dunes will not be subject to the ecological drivers which would naturally shape these systems. The goal of dune creation should be to provide suitable sand substrate and habitat structure to encourage the development of dune vegetation similar in structure and composition to the vegetation of the existing dunes. Dunes creation should make use of clean sand of similar grain-size to that of the existing dunes. Sand can be sourced from off-shore dredging or from inland quarries. Dredged sand is more likely to be of compatible grain-size and parent material; however, it is also likely to be too saline for most dune plants and will require extensive leaching or capping with 1 to 2 feet (0.3 to 0.6 meter) of inland sourced sand. Inland sourced sand is more likely to be of less compatible grain-size and parent material; however, salinity should not be an issue. The physical structure of created dune habitat should mimic that of existing dunes at the Reserve.

Target vegetation for existing and created dune habitat will be similar in diversity and structure to stabilized back-dune systems in the region, with high diversity and cover of native species, including both woody perennials and herbaceous annuals. During the initial phases of the restoration when plant cover is low, erosion control measures such as the use of sand fencing, hay bales, crimped straw, or jute netting may be necessary to stabilize the sand (Nordstrom 2008). In addition, plantings may benefit from limited application of slow-release fertilizer and supplemental irrigation. It is important that only slow-release fertilizer be used for these applications, as slow-release fertilizer reduces the potential for eutrophication of adjacent waters. In addition, the slow-release fertilizer should be incorporated into the planting holes, rather than being broadcast over large areas—this will ensure that the fertilizer is used by the installed plants rather than by weeds growing between the plantings.

3.1.7 Upland Scrub and Grassland

The primary goal of upland habitat restoration at the BWER is to provide support functions for the larger tidal wetland restoration, including reducing sediment loads to seasonal and tidal wetlands and providing high tide refuge for tidal wetland wildlife. Target habitat acreages for upland scrub and grassland habitats will be developed in later stages of the restoration based on input from the project design team and regulatory requirements. Upland habitats (exclusive of the dunes) should have high plant cover and a diverse composition of native shrubs and herbaceous plants. The composition of this vegetation may be limited by potentially high salinity levels in soils throughout the Reserve. Target vegetation includes grasslands dominated by species such as California barley (*Hordeum brachyantherum* ssp. *californicum*), purple needlegrass (*Stipa* [*Nassella] pulchra*), saltgrass, and alkali ryegrass (*Elymus triticoides*) and scrub dominated by species such as coyote brush, California sagebrush (*Artemisia californica*), mugwort (*Artemisia douglasiana*), big saltbush, lemonade berry (*Rhus integrifolia*), and seacliff buckwheat (*Eriogonum parvifolium*). Additional species will be included in both upland habitat types to increase overall native plant diversity. It should be expected that non-native annual grasses will also form a major component of both grassland and scrub habitats given their prevalence in the seed bank.

If soils used for the creation of upland habitat are highly saline, a 3- to 4-foot cap of clean, non-saline soil may be required to allow for establishment of salt-intolerant species. Even with a cap of non-saline soil, there is potential for saline groundwater to move up through the soil profile and for saline conditions to develop in the root zone. In the event that this becomes an issue at the BWER, a more limited palette of highly salt-tolerant upland plants will be required (see the potential plant palette provided as Appendix A). Given that upland habitat at the BWER will be limited in extent relative to tidal wetland areas, it may be possible for temporary irrigation to be used during the establishment of upland plantings—this would increase the success rate of upland plant establishment, particularly for native bunchgrasses and woody perennials.

3.2 Overarching Elements of the Restoration

The following sections outline the approach to the overarching elements of the proposed restoration, those elements which are common to most or all habitats, including hydrology, soils, vegetation, and public access. This overview is intended to provide context for the subsequent sections of the Conceptual Plan and to provide guidance for the restoration design where appropriate. Details of the proposed restoration activities for each project alternative are provided by PWA (2010) and ESA PWA (2012a) and are subject to modification based on input from the project design team and regulatory requirements. The restoration will be conducted in phases, with the structure of the latter phases being informed by lessons learned during the first phases, and thus the approach presented here may also be subject to change based on outcomes of the first phases of the restoration.

3.2.1 Hydrology

Any restoration of tidal activity will include the installation of culverts and self-regulating tide gates as well as the creation of tidal channel networks in the restored wetlands. Self-regulating tide gates will allow the full range of tidal activity while maintaining required levels of flood control. Tide gates may be closed during extreme tides or during storm events in Ballona Creek. Restoration of tidal activity will bring saline water into restored tidal wetlands which will become the driving force behind ecological processes in these areas.

3.2.2 Soils

A large volume of soil was placed in Area A during the construction of Marina del Rey. This soil will be excavated under some project alternatives to restore appropriate tidal elevations throughout the BWER. Excavated soil will be re-used on-site to the greatest extent possible.

Appendix B provides a summary of the initial soil analyses conducted at the site as they relate to the establishment of plant communities. Based on these initial analyses, it has been determined that soil salinity may be an issue in the excavated soils, with surface soils containing lower levels of salts and subsurface soils containing salts at levels too high for even the most salt-tolerant plant species. In addition, levels of several essential plant nutrients may be too low to support desired levels of plant growth. Specifically, nitrogen, phosphorus, calcium, and zinc were found to be lower than preferred for the establishment of healthy native plant communities. Given the low levels of these plant nutrients in soils at the site, limited application of fertilizer may be needed. Analyses of sodium absorption ratios show an imbalance between sodium and soluble calcium and magnesium, which can negatively affect soil structure and water infiltration in soils used outside of a salt marsh setting (e.g., soils used for upland restoration). Incorporation of gypsum combined with extensive leaching may be necessary to reduce sodium levels and improve sodium absorption ratios. Soil texture was shown to range between sand and loam, with most samples being relatively sandy. The more coarsely textured soils (i.e., sandy soils) will have reduced water holding capacity and may not be suitable for establishing plant communities adapted to mesic conditions. The use of soil amendments to increase the water holding capacity of on-site soil or the use of imported soil may be necessary if sufficient amounts of finely textured soils cannot be sourced on-site.

Due to the extensive volume of soil involved in the restoration, the use of soil amendments to alter soil texture or chemistry may be cost-prohibitive. Similarly, importing soil at the scale required for the restoration may also be cost-prohibitive. Given the expense involved in importing soils to the site, including the potential need to export "unusable" soil from the site, every effort will be made to reuse soil on-site. This will require an extensive analysis of soil texture and chemistry throughout both the areas to be excavated and areas of existing salt-adapted and salt-sensitive vegetation—this will provide a detailed understanding of the range of physical and chemical soil conditions across the site, as well as the range of salinities tolerated by existing plant communities at the site. Analyses will be designed to identify the vertical and horizontal distribution of important physical and chemical soil properties; these data will be used to inform the salvage and re-use of excavated soils during the restoration.

Finer textured soils with high organic content will be incorporated into the top 1 to 2 feet (0.3 to 0.6 meter) of mudflat and tidal wetland habitat up to the mean high water line, above which more coarsely textured soils may be incorporated. Highly saline subsoils, as well as highly saline surface soils, will be used for the construction of salt panne habitat. To the extent feasible, highly saline soils will not be used to create upland habitat. However, it is likely that an insufficient amount of non-saline soil will be available on-site for the creation of upland habitat and it will be necessary to use some amount of saline soil for this purpose. Where saline soils are used to create upland habitat, they may need to be amended with gypsum and extensively leached with freshwater and/or covered with a 3- to 4-foot cap of non-saline soil salvaged from elsewhere at the site or imported from off-site. Although there is potential for salts to be wicked up through the soil profile over time, a thick cap of non-saline soil will allow plants to become established and to acclimate to slowly increasing salinity levels. If the use of soil amendments and/or importation of non-saline soil is cost prohibitive, a salt-tolerant plant palette will be required. Appendix A identifies native salt-tolerant plants suitable for including in the restoration design.

3.2.3 Vegetation

Establishment of vegetation in the restored habitats will be based on a combination of natural revegetation and planting or seeding with native plant species appropriate to the hydrologic, soil, and climatic conditions at BWER. Due to the extensive area involved in the restoration and the potential cost involved in the use of potted plants and plugs, natural revegetation and/or seeding will be used whenever possible. Areas receiving regular tidal inundation are ideal for natural revegetation as tidal waters can contain large numbers of propagules for plants suited to tidally influenced habitats—these include low and mid-marsh habitats as well as brackish marsh habitats. Limited installation of potted plant material or plugs may be used in these areas to speed recolonization of the marsh plain, especially in Area A where input of dispersing seed will likely be low due to the low cover of tidal wetland plants currently present in this portion of the BWER. Subsoils and soils excavated from existing marsh or salt panne habitat may lack a suitable seedbank for natural revegetation in uplands; however, if this is the case, these soils will have the advantage of lacking an upland weed seedbank as well. These areas will require seeding with an appropriate mix of native herbaceous plants with supplemental planting of native shrubs. Alternatively, shrubs may be seeded; however, establishment of shrubs from seed is a slow process and better results are likely to be achieved through the use of potted plants. Given the need for sand stabilization in any created dunes, the use of potted plants and plugs is preferred over natural revegetation in this habitat.

Plantings will require careful phasing to ensure that plants are installed at the correct time of year (ideally at the onset of winter rains) and that plantings occur as soon as possible after final grading. This will help ensure successful establishment with minimal need for irrigation, reduce the potential for erosion, and minimize colonization by weedy non-native species. Plantings in high marsh, transition, and upland habitats (including dunes) are likely to require supplemental irrigation during the first two to three years after planting. Supplemental irrigation greatly improves the success of restoration plantings, and the added cost of installing temporary irrigation should be viewed as an investment in the long-term success of the restoration.

A potential plant palette is provided as Appendix A. This list was developed based on the suite of native species documented in the existing conditions and baseline studies reports (PWA et al. 2006; Johnston et al. 2011, 2012) as well as on historical references and plant lists from other coastal wetlands in southern California (Schreiber 1982; Mattoni and Longcore 1997; Sullivan and Noe 2001; Dark et al. 2011; Sawyer et al. 2009). The species included in the list are all native to southern California. Efforts have been made to limit the species on this list to those historically present in the greater Los

Angeles region; however, some species have been included based their ease of propagation and adaptability to a wide range of environmental conditions.

There is potential to salvage some of the existing vegetation for use in restored habitats; however, use of salvaged plant material will require careful timing to ensure plants are removed from existing habitat and replanted during appropriate phenological stages and during appropriate times of year, both of which are species-specific. Salvaging existing vegetation would require an extensive area of land, either on-site or off-site, devoted to propagation and staging. Because the plants being salvaged or propagated would be adapted to the local climate, heated greenhouse facilities may not be necessary; however, other infrastructure would be necessary. Such infrastructure might include shading structures, raised beds, propagation benches, irrigation, fencing, etc. Although the cost of salvaging plant material from the site could be reduced through the use of volunteers, dedicated staff experienced in large-scale plant propagation would be necessary. Alternatively, the stockpiling and maintenance of salvaged plant material can be contracted out to a reputable nursery or a firm specializing in habitat restoration. It is unlikely that all of the plant material needed for the restoration can come from salvaged plant material, and propagation of additional plant material will be necessary. Plant propagation should be accomplished through collection of seeds and cuttings from healthy populations within the Santa Monica Bay watershed. If suitable donor populations cannot be located within this watershed, plant propagules may be sourced from adjacent watersheds; however, efforts should be made to collect plant material from as close to the BWER as possible to maintain the genetic integrity of the regional flora and to ensure that the plants are adapted to the local climate. A large amount of plant material will be required over the lifespan of the restoration, and it will be important to have ample material available during the initial planting and for supplementary planting in subsequent years as habitats develop. Initial plantings should focus on the dominant species desired in each habitat, with supplementary plantings to increase diversity in later stages of the restoration.

A detailed planting plan will be developed for the restoration and will outline protocols for plant sourcing and propagation, necessary infrastructure and staffing for on-site salvage and propagation, requirements for contracted plant salvage and propagation, specifications for soil amendments and irrigation, specifications and a schedule for planting and subsequent management actions, and a weed control plan to ensure successful establishment and long-term maintenance of plant communities at the BWER.

3.2.4 Special-Status Species

A number of special-status plant and wildlife species have been identified at the BWER; these species are listed in Sections 2.2.5 and 2.2.6, respectively. Except for Lewis' evening primrose and wooly seablite, special-status plant species at the BWER are restricted to the dune habitat in the western portion of Area B (WRA 2011). Lewis' evening primrose occurs in the dune habitat, but also occurs in large numbers in Area C and in smaller numbers in the southeastern portion of Area B (WRA 2011). Wooly seablite occurs along the southwestern edge of Ballona Creek (WRA 2011). Given that work within the dunes in the western portion of Area B will be largely limited to weed removal and planting of appropriate native species, existing special-status species in this area are unlikely to be negatively impacted by restoration activities. Instead, it is likely that restoration activities in the dunes will benefit the special-status plant species present there. It is unclear at this point how restoration activities will affect the occurrences of Lewis' evening primrose outside of the dunes or the occurrences of wooly seablite along Ballona Creek. Occurrences of these species will be protected to the extent feasible. Focused monitoring efforts will be implemented for occurrences of these species that are to be protected, and appropriate management efforts will be undertaken if populations decline significantly. Any impacts to these species will be mitigated on-site through re-establishment of impacted species in restored habitat at the Reserve—this may require collection of seed or other propagules prior to impacting the species. Re-establishment and subsequent monitoring efforts for impacted species will be implemented according to a mitigation and monitoring plan developed in accordance with appropriate local, state, and federal policies or regulations.

Similarly, most special-status insects and the only special-status reptile (California legless lizard) known from the BWER are restricted to the dune habitat in the western portion of Area B. Given the limited extent of proposed restoration activities under the project alternatives in this area, it is unlikely that these species will be negatively impacted by restoration activities. Instead, it is likely that these species will benefit from the on-going restoration activities in this habitat. Focused monitoring efforts will be implemented to ensure that populations of these species either remain at pre-restoration levels or increase in size, and appropriate management efforts will be implemented, as feasible, if populations of these species decline in size.

Although the South Coast marsh vole may experience some temporary loss of habitat during the restoration, it is expected that this species will ultimately benefit from tidal marsh and upland grassland restoration efforts at the BWER. This species will be protected during restoration efforts following protocols approved by the CDFW. Following the completion of restoration efforts, focused monitoring efforts will be implemented for this species to ensure that its population remains at pre-restoration levels or increases in size, and appropriate management efforts will be implemented, as feasible, if the population of this species declines in size.

Given the major grading and other activities planned under some project alternatives in areas occupied by Belding's Savannah sparrow or least Bell's vireo, the restoration has potential to negatively impact these species during project construction. To reduce the potential for negative impacts, appropriate avoidance and minimization measures will be implemented following standard protocols approved by the CDFW. In addition, habitat actively occupied by either of these species will not be impacted until it is demonstrated that these species are making use of restored habitat that was previously unoccupied by the species and that the temporary loss of currently occupied habitat will not have negative impacts on the species. For example, restoration of full the full tidal range in the western portion of Area B—which would require extensive temporary loss and minor permanent loss of tidal marsh and salt panne habitats which are currently occupied by Belding's Savannah sparrow—will not occur until it has been demonstrated that the species is actively using restored tidal marsh and salt panne habitats in Area A and that the temporary and permanent loss of habitat in Area B will not have negative impacts on the species. As with other special-status species, focused monitoring efforts will be implemented to ensure that populations of these species either remain at pre-restoration levels or increase in size, and appropriate management efforts will be implemented if populations of these species decline in size.

In addition to the species discussed above, restored habitats at the BWER have the potential to attract a number of additional special-status plant and wildlife species known to occur in the region. New populations of special-status species will be subject to focused monitoring efforts aimed at identifying trends in population size and habitat use and informing the need for active management of the species or habitats in which they reside. To the extent feasible, monitoring of special-status species will be conducted using established protocols and will be incorporated into existing regional or state monitoring programs for these species.

3.2.5 Invasive Species

A number of non-native, invasive species currently occur at the BWER. Complete eradication of all non-native species in the Reserve is not feasible; however, restoration objectives include the control of those species considered highly or moderately invasive by the California Invasive Plant Council ("Cal-IPC"; 2013); control of such species will be essential for the long-term development and maintenance of desired vegetation communities and high levels of biodiversity. Controlling invasive species will require appropriate pre- and post-construction measures and monitoring to ensure that existing populations of invasive species are handled appropriately and to avoid new introductions of invasive plants. During the pre-construction phase, populations of invasive species should be identified and prioritized for removal. In areas in which soil will be excavated and reused, it may be necessary to remove invasive species prior to excavation to prevent spreading propagules to other portions of the BWER. For some species which are currently present in high numbers (e.g., pampas grass), a significant amount of biomass will have to be removed. This biomass will require special handling and disposal following appropriate best management practices to prevent spreading the plants to areas outside of the BWER and to prevent reestablishment at the BWER (see Appendix C and Cal-IPC 2012a, b). Depending on the depth of soil to be placed in upland restoration areas and other areas receiving excavated soils, it may be possible to place excavated soils directly over existing populations of invasive plants. Similarly, it may be possible to dispose of removed invasive plant material by burying it under a thick layer of excavated material. The depth at which invasive plant species must be buried to ensure that they will not resprout varies by species, but is on the order of 3 to 10 feet (0.9 to 3 meters). Burying large amounts of plant material at the site may cause issues with subsidence as the plant material decomposes—this subsidence would have to be quantified and incorporated into the project design.

Because it is not possible to remove all invasive plants from the BWER or from surrounding areas, post-restoration monitoring and removal of invasive species must be an on-going process as new infestations are likely to arise over time. Limiting sources of soil disturbance within the BWER, combined with the use of best management practices when soil disturbance is required, will help reduce the potential for new invasions. Control methods for selected invasive species currently at the BWER are presented in Appendix B.

In addition to invasive terrestrial plants, there is potential for establishment of invasive aquatic plant and wildlife species. The potential for introduction of invasive aquatic plants will be limited by high salinity levels in aquatic areas throughout the Reserve. However, there is greater potential for introduction of highly invasive aquatic invertebrates such as the New Zealand mudsnail (*Potamopyrgus antipodarum*). Strict best management practices related to the movement of equipment and materials in and out of the BWER will be required to prevent the introduction of invasive plant and wildlife species. This will be particularly important for equipment and materials that have been used in wetted environments prior to entering the Reserve. A general list of potential best management practices to be employed during the restoration is provided as Appendix C.

3.2.6 Public Access and Infrastructure

A wide range of infrastructural improvements will be necessary to accommodate planned levels of public access. The majority of planning related to public access and infrastructure is beyond the scope of this Conceptual Plan and will be developed in further detail by the project design team; however, some discussion of the location of public access relative to sensitive habitats is appropriate here. Public education and access to unique habitats is a key goal of the proposed restoration, and as such, it will be important to provide opportunities for public access into the restored habitats. However, public access to these habitats should be limited to well-defined trails and boardwalks. These features should be designed to accommodate natural flows of foot traffic through the BWER—this will help prevent visitors from deviating from the established paths and creating social trails in sensitive habitats. It may be necessary to include wildlife-friendly fencing, plantings of spiny native plants (James and Zedler 2000), or other elements designed to prevent human access to sensitive habitats. Similarly, seasonal closures may be necessary in certain parts of the Reserve to accommodate the life history of sensitive wildlife species (e.g., during the breeding season for some birds) or to prevent damage to trails during the rainy season.

3.3 Restoration Phasing

The complexity of a restoration of this size as well as the presence of sensitive habitats and species necessitates careful staging. The restoration will occur in three phases, each requiring multiple years to complete. Phasing will be designed to allow for evaluation of biologic (including special-status species), hydrologic, and geomorphic performance of early restoration stages and subsequent refinement of the restoration design for later stages. Details of restoration staging can be found in the technical memoranda prepared by ESA PWA with contributions from Psomas and Associates and Group Delta, Inc. (PWA 2010; ESA PWA 2012a). The final staging will require further development to incorporate the biological components of the restoration at appropriate stages and to accommodate changes to the latter stages of the restoration based on the outcome of the first stages. As noted in Section 3.3.4, phasing for many portions of the restoration will be dependent on the demonstrated use of restored habitats by specific special-status species (*e.g.*, Belding's Savannah sparrow) and the determination that restoration activities will not have negative impacts on such species.

3.4 Restoration Approach

As noted previously, the final restoration plan is still in development, several alternatives are being considered, and it is likely that some aspects of the approach will be changed based on funding constraints and regulatory requirements.

3.5 Planning for Climate Change

Numerous public agencies have prepared policies and guidance for addressing issues related to global climate change with particular emphasis on rising sea levels and increases in storms and other extreme weather events (e.g., California Climate Action Team 2010, 2013; SLC 2009; CDFG 2011). Most guidance focuses on adaptive capacity, or the ability of a system to change in response to rising sea levels. Relative to developed areas, natural habitats such as the Ballona Wetlands generally have an some level of adaptive capacity in that organisms are relatively mobile and habitats can shift, whereas anthropogenic structures such as buildings and roads must be actively protected or relocated. Development adjacent to natural habitats limits this adaptive capacity.

Because our understanding of the potential effects of global climate change is limited, it is difficult to plan the effects that climate change may have, and most planning is aimed at ameliorating the effects of rising sea levels. Bergquist et al. (2012) prepared an extensive analysis of the implications of climate change for the proposed restoration at the BWER. Their analysis indicated that the BWER will be particularly vulnerable to sea level rise due to its low-lying coastal position and that the effects of rising sea levels are likely to outweigh the effects of increased frequency and severity of major storm events.

To accommodate rising sea levels, the proposed restoration alternatives incorporate gentle slopes in tidal wetland and transition habitats with the intent that such gradual slopes will allow tidal marsh habitat to move landward as sea levels rise. As sea levels rise, it is expected that the sequence of tidal marsh, transition, and upland vegetation will shift upslope. This will result in a decrease in upland habitat, but will enhance the ability of tidal marsh habitat and its associated wildlife to persist. This use of broad transitional slopes between wetland and upland habitats is consistent with the State Coastal Conservancy's Climate Change Policy (SCC 2011).

More complex changes in ecological processes are expected with global climate change; however, the extent of our knowledge of climate change and associated adaptation strategies is limited and makes more than generalized predictions impossible. It is likely that a changing climate will result in changes in the distribution of plant and wildlife species as well as the timing of growth and reproduction of these species. The timeframe under which such changes may occur is unclear, as are the implications for the proposed restoration at the BWER. As such, the use of adaptive management strategies will play an important part in managing the BWER in response to climate change. Given the uncertainty in our understanding of the potential effects of climate change, it will be important to be able to address unexpected issues such as deviations in expected habitat development, shifts in the ranges of both native and non-native species, increases in the prevalence of diseases or pest species, and other challenges. The use of an adaptive management approach will allow the land manger to address such challenges and to find solutions consistent with the goals of the restoration.

4.0 MONITORING, PERFORMANCE GOALS, AND ADAPTIVE MANAGEMENT

The monitoring program for the BWER will be designed to evaluate the progress toward achieving restoration goals and to inform the need for adaptive management during the lifespan of the restoration. Because the restoration is not being conducted as mitigation or under mandate from any state or federal judicial body or regulatory agency, the performance goals and associated monitoring may differ from those of standard mitigation projects. That said, many aspects of the restoration will be subject to regulatory oversight, and additional performance goals and associated monitoring requirements may be required by the regulatory agencies. In general, however, performance goals for the restoration will not focus on specific acreages or specific species, but will focus broadly on habitat development, species composition, and, ecosystem function (Short et al. 2000; Zedler and Callaway 2000; Thom et al. 2010). Moreover, the performance goals will be open to revision based on improvements in our understanding of habitat development or species requirements, including lessons learned during the early phases of the restoration or from other similar restoration projects being conducted in the area.

In addition to being broad-based and adaptable, the monitoring program will be of sufficient length to capture long-term trends in habitat development and use by wildlife species—this could be on the order of a decade or longer (Zedler and Callaway 1999). For most variables discussed in this Conceptual Plan, a monitoring period of 10 years is recommended. A 10-year monitoring period was chosen to balance funding limitations with the need to document long-term trends in habitat development. Although a 10-year monitoring period is recommended, it is understood that some aspects of habitat development and function may not be evident within the first 10 years, and for these variables it may be necessary to extend the monitoring period by an additional decade or more.

The goal of monitoring will be to document trends in habitat development and assess progress toward meeting restoration objectives. For cases in which the course of habitat development is relatively uncertain or for monitoring parameters which may be highly variable, it may be useful to assess performance relative to conditions in suitable reference habitats in the region. For more well-understood parameters, the use of absolute performance goals may be sufficient. It should be understood that some level of uncertainty will always be present, and all of the performance goals presented here or those to be developed for the HMMP may require modification based on an improved understanding of habitat development, ecosystem function, or species requirements (Atkinson et al. 2004; Thom et al. 2010; Fischenich et al. 2011). Furthermore, habitat development is an on-going process that is likely to extend well beyond the prescribed monitoring period. Some aspects of the monitoring program will have a definitive end point (i.e., when performance goals have been reached). However, given the highly modified nature of the watershed supporting the BWER and the constraints imposed by the surrounding development, it is likely that the restored wetlands will never be fully sustainable and will always require periodic maintenance (Callaway and Zedler 2004). As such, some level of monitoring and management will be required indefinitely into the future (e.g., monitoring for invasive species or human disturbance).

Finally, the monitoring program will be designed to be simple, cost-effective, and achievable (Atkinson et al. 2004). Because of the potential length of the monitoring period, monitoring should be designed using standard methods and equipment such that monitoring can be conducted by a range of individuals or organizations, including citizen-scientist volunteers where appropriate, with only minimal training required. Monitoring will focus on the major biotic and abiotic factors that drive habitat development and ecosystem function—in particular, those factors that can be manipulated and managed or those parameters that can be used to gauge habitat development and ecosystem function (Thom et al. 2010). Sampling procedures and analyses of monitoring results will be developed to appropriately reflect the level of accuracy achievable with each sampling procedure and the sample size achievable for each monitoring parameter. The end result of the monitoring program will be a simple, clear picture of habitat development at the BWER in terms that can be understood by scientists, regulators, and laymen alike.

It should be noted that because the restoration plan is still in development, many of the details necessary for developing strict monitoring protocols and performance goals are lacking. For example, it has yet to be determined which habitats will be planted and which will be allowed to revegetate naturally. Habitats that are planted would be expected to develop at a more rapid pace than habitats that are allowed to revegetate naturally. As such, it is difficult to develop strict performance goals related to vegetation establishment. The same is true for other aspects of the restoration that are still in development. The information provided in this Conceptual Plan is intended to guide the development of such details; however, many other factors beyond the scope of this document (e.g., funding) must also be considered. As such, many of the elements treated in the following sections are conditional and are subject to change based on the form of the final restoration plan, input from the CEQA/NEPA analysis, and regulatory requirements.

4.1. Developing the Monitoring and Adaptive Management Program

As noted in the Introduction, the purpose of this Conceptual Plan is to outline the general form of the restoration and guide the development of more detailed elements of the final restoration plan such as the grading plan, the planting/landscape plan, the operations and management plan, and the HMMP. Among these plans is the development of a more detailed HMMP based on the guidance provided in this Conceptual Plan, the findings of the CEQA/NEPA analysis, regulatory requirements, and the final plan for restoration staging and implementation. The HMMP will build directly from the guidance developed in this Conceptual Plan, with modifications as necessary. The HMMP will include a timeline for the implementation of the monitoring program based on the final plan for staging and implementation. Although a monitoring period of 10 years is recommended here, the final length of the monitoring period will be based on the phasing to be implemented during the restoration. The HMMP will also include a work plan or schedule for long-term monitoring after the site has achieved the performance goals outlined here and in the HMMP. In addition to a detailed monitoring schedule, the HMMP will provide specific protocols for monitoring, including sample design (e.g., number of replicates, locations for sample points, transects, etc.), sampling methods to be implemented, and statistical methods for analyzing the data.

4.1.1 Reference Sites

As noted above, the use of reference sites may be useful for monitoring parameters which are highly variable, such as for biological parameters closely linked to local or regional climates (e.g., plant response to rainfall levels). The use of reference sites may also be useful for habitats for which the course of development is not well understood (e.g., salt panne habitat). The decision to use reference sites as a control for highly variable monitoring parameters or parameters tightly correlated with local weather and climate patterns should be made prior to the initiation of the monitoring program, with significant input from the Scientific Advisory Committee and the CDFW or other managing agency.

The selection of appropriate reference sites is an important component of the monitoring program, as the use of inappropriate reference sites could lead to misinterpretation of habitat development and ecosystem function and could result in a false sense of success or failure. The use of reference sites to gauge the progress of restoration efforts is generally limited by the availability of suitable sites in the region, the similarity of potential reference sites to the restoration site, and the funding available for monitoring (Neckles et al. 2002). The use of tidal wetland reference sites in southern California is further limited by the availability of natural, undisturbed tidal wetlands. Many of the potential reference wetlands in southern California are either highly degraded or are the subject of on-going restoration efforts and may not function in the same way as undisturbed wetlands in the region. Conditions observed at such sites may reflect a rehabilitated condition rather than pre-disturbance conditions (Spencer and Harvey 2012). However, given the highly modified nature of the watershed supporting the BWER and the constraints imposed by the flood control aspects of the project, it is not possible to restore wetlands at the BWER to their pre-disturbance condition, and a rehabilitated condition may be the most achievable outcome for the restoration. As such, restored reference sites may be appropriate given the general lack of pristine reference sites in the region. In general, any site with remnant or restored wetlands which demonstrate desirable qualities such as high diversity of native species or populations of rare plants or wildlife should be considered as a potential reference site. Despite the general lack of high quality estuarine wetlands and associated habitats in southern California, a number of potential reference sites occur there, including Alamitos Bay in Los Angeles County; Tijuana Estuary, San Dieguito and Poseidon wetlands, and Peñasquitos Lagoon in San Diego County; Upper Newport Bay in Orange County; Mugu Lagoon and Ormond Beach in Ventura County; and Carpinteria Salt Marsh in Santa Barbara County.

A number of authors have put forth recommendations for selecting reference sites (e.g., Short et al. 2000; Neckles et al. 2002; Thom et al. 2010). Horner and Radaeke (1989; *in* Thom et al. 2010) recommend that the following elements be addressed when determining the similarity of potential reference sites to the restoration site:

- Ecological functions
- Climate and hydrology
- Anthropogenic disturbances
- History of and potential for future management actions
- Size, morphology, water depth, wetland zones and their proportions
- Vegetation types
- Soils and non-soil substrates
- Access by fish and wildlife

Short et al. (2000) recommend using principal components analysis (“PCA”) to select appropriate reference sites. Their site selection was based primarily on the geomorphological setting and structural components of the wetland type in question. This approach may be feasible for the BWER given the availability of basic data for wetlands in the region. That said, the pool of potential reference sites may be too limited to warrant such an analysis, and it may be more appropriate to select reference sites based on anecdotal or observational evidence of similarity to the BWER.

Given the limited area and degraded condition of tidal wetlands remaining in southern California, it is unlikely that a single “ideal” reference site will be available. Moreover, it is unlikely that any given reference site will have all of the habitat types and other components necessary for the monitoring program at the BWER. As such, separate reference sites or groups of reference sites may be necessary to accommodate all of the monitoring needs at the BWER. Ideally, more than one reference site would be used for each monitoring parameter as this can improve the power of statistical comparisons (Neckles et al. 2002). In addition, it may be necessary to use different reference sites for each habitat type at the BWER given that many potential reference sites will not contain the full suite of habitat types that are planned for the BWER. However, financial and practical considerations constrain the potential for using multiple reference sites. One way to reduce the cost of monitoring may be the use of data from reference sites which are currently being monitored as part of existing restoration projects. This would require that monitoring parameters and protocols be standardized and that monitoring timeframes be compatible. For example, the ongoing monitoring programs at San Dieguito Wetlands or the South Bay Wetlands in San Diego County could be incorporated into the monitoring program at the BWER. The use of citizen-scientist volunteers may be another way to reduce the cost of monitoring at multiple reference sites.

4.1.2 Monitoring Parameters, Performance Goals, and Adaptive Management

Monitoring Parameters

A wide range of variables have been monitored at wetland restoration sites around the country; however, most authors recommend focusing on variables related to ecological structure and function (Callaway et al. 2001; Neckles et al. 2002; Atkinson et al. 2004; Thom et al. 2010). Ideally, many parameters would be monitored within each habitat at the BWER. In reality, however, most restoration projects, including the restoration of the BWER, have limited funding available for monitoring. Given this constraint, most authors recommend focusing on the core variables affecting habitat development and function and the use of indicators of habitat function such as the development of wetland-associated animal communities (Short et al. 2000). Atkinson et al. (2004) recommend that monitoring variables (1) be relevant to restoration goals and potential management actions, (2) have a strong scientific foundation, (3) be measureable and statistically rigorous, (4) be compatible with existing monitoring and data collection programs, and (5) be easily understood and interpreted.

Extensive lists of potential monitoring variables are provided by Atkinson et al. (2004), Lafferty (2005), Thayer et al. (2005), and Callaway et al. (2001), among others. The monitoring variables presented in the following sections are based on (1) the basic ecological drivers of habitat or community development (or surrogate indicators), (2) the restoration objectives for each habitat (e.g., use by wetland-associated birds), and (3) the variables which are more easily manipulated for management purposes. Within each habitat, there are many potential variables to monitor; the variables chosen for each habitat represent the minimum level of monitoring necessary to gain a basic understanding of the development of biotic communities at the BWER. Given sufficient funding, it may be desirable to include additional variables in the monitoring program. Moreover, additional monitoring variables may be necessary for adaptive management of specific habitats (Neckles et al. 2002). Such additional variables are outlined the adaptive management sections for each habitat type; however, it is not possible to predict the full range of potential impediments to habitat or community development, and it may be necessary to include additional variables not addressed in this Conceptual Plan.

As noted above, it may be useful to monitor for some variables at both the BWER and at one or more reference sites. If reference sites are used, the monitoring protocols should be standardized such that they are the same for both the reference site and the BWER. To the extent feasible, sample sizes should also be the same. Because of the added expense involved in monitoring at both the BWER and at one or more reference sites, it may be desirable to use reference sites that are currently being monitored by other groups. Data sharing or other means of pooling monitoring resources can reduce the time and effort involved in monitoring, thereby reducing the overall cost of the monitoring program. However, data sharing with other monitoring programs may require some modification to the monitoring program outlined in this Conceptual Plan. To the extent feasible, the final monitoring program should be designed such that the data collected is can be shared with the Southern California Wetlands Recovery Project or other regional monitoring programs.

Performance Goals

The restoration efforts at the BWER differ from many other restoration projects in that the restoration is voluntary and not in response to regulatory requirements. Restoration efforts undertaken as required mitigation are often subject to rigid success criteria aimed at determining the success or failure of the project. In this document, the term “success criteria” has been purposefully replaced with the term “performance goals” to avoid creating the impression of a rigid framework for assessing the project’s performance and preemptively determining the success or failure of the restoration (Zedler 2007; Zedler and Callaway 2000). That said, some aspects of the restoration may be subject to regulatory requirements, and the performance goals presented here are subject to change based on the results of the CEQA/NEPA analysis and regulatory requirements.

Performance goals developed for the monitoring program at BWER are based on the primary ecological drivers of habitat development and function (e.g., frequency of tidal inundation for salt panne habitat), the characteristic expression of such ecological drivers (e.g., lack of vegetation for salt panne habitat), and the primary values of the habitat (e.g., bird foraging for salt panne habitat). In some cases, performance goals are based on a more easily monitored surrogate for one or more of these factors. For example, the use of mud-flat habitat for foraging by wading bird species should be correlated with the development of a benthic invertebrate community and may serve as a reasonable surrogate for monitoring the benthic invertebrates.

The use of performance goals relative to conditions at reference sites may provide some ability to overcome uncertainties related to habitat development, of which there are many, and to account for stochastic events which may affect plant and animal communities and ecosystem function at a regional scale. The performance goals presented here are based on our understanding of the development of biotic communities and experiences with other restoration projects in southern California.

Adaptive Management

Adaptive management of habitat development in the restored wetland and upland areas will require frequent monitoring during the initial years to identify and correct any problems in the restoration design. However, some trends in habitat development may not become apparent for many years, and long-term monitoring will be necessary. It is not possible to predict the full range of potential restoration outcomes and associated adaptive management scenarios, and as such, the adaptive management triggers and actions presented in the following sections should be treated as a guide only.

Triggers for adaptive management actions should be based on significant deviation from or a lack of progress toward achieving the performance goals outlined for each monitoring parameter coupled with an evaluation of the trajectories of habitat development or directions of change. For many aspects of biotic community development, it may take several years for trends to become apparent, and changes in management should be delayed until sufficient time has elapsed for trends to become apparent. If it is determined that progress toward performance goals is not measurable or that the habitat appears to be progressing toward an alternative state, an evaluation of the causes involved and the trend toward meeting performance goals should be undertaken to determine whether intervention or mid-course corrections are warranted. In some cases, habitat development may be on track to meet long-term performance goals and no actions may be warranted—in these cases, it may be appropriate to modify the performance goals based on new developments in our understanding of the development of biotic communities. In other cases, it may be determined that additional monitoring parameters are necessary to determine the cause of poor performance. Once the causes of poor performance are identified, appropriate changes in management should be investigated and implemented. Any modifications implemented as a result of this process should be subject to quantitative monitoring and analysis specifically designed to evaluate the effectiveness of such modifications or changes in management.

For some aspects of habitat or biotic community development, intervention or mid-course corrections may be minimal in scale. For instance, if invasive species become a problem, increased management efforts or new management techniques may be necessary. However, some aspects of habitat or biotic community development may require more significant changes. For instance, if salt panne or seasonal wetland habitats fail to meet hydrology performance goals, changes to the grade of the site may be necessary. Similarly, if fish die-offs occur due to low dissolved oxygen levels, modification of tidal circulation patterns may be necessary. Any actions requiring grading or other major site alterations should receive increased scrutiny before implementation. If it is determined that such changes will cause unacceptable disturbances to other habitats or animal populations at the BWER, it may be necessary to reevaluate the restoration goals. All decisions related to adaptive management, including changes in management activities, alteration of the site, shifts in target habitats or performance goals, and the rationale for each decision, should be documented in a central location. This is particularly important given that numerous individuals will be responsible overseeing the operation of the Reserve during its lifetime. Recording management decisions in a central location will provide future land managers with an understanding of the actions of previous land managers, thereby providing an improved basis for making future management decisions.

Special-Status Species

As noted in Section 3.3.4, special-status plant and wildlife species will be subject to focused monitoring efforts aimed at identifying trends in population size and habitat use and informing the need for active management of the species or habitats in which they reside. To the extent feasible, monitoring of special-status species will be conducted using established protocols and will be incorporated into existing regional or state monitoring programs for these species. A separate monitoring plan will be developed for each special-status species or group of special-status species. Where possible, monitoring for special-status species will be integrated with regular habitat monitoring; however, for some species it may be necessary to modify monitoring protocols or to adjust the timing of monitoring events to coincide with important life stages of the species in question. All monitoring and management of special-status species will conform to the policies and guidelines set by the CDFW, CNPS, or other agency or organization with jurisdiction over the species or their habitats.

4.1.3 Data Management and Analysis

Numerous authors highlight the importance of scientifically valid sampling and data analysis and the need for good data management (Atkinson et al. 2004; Thom et al. 2010). Good data management includes procedures for quality assurance and quality control and timely reporting of monitoring results (Atkinson et al. 2004). Methods for quality assurance and quality control will be included in the HMMP and will be consistent with existing CDFW protocols. Similarly, data will be collected and analyzed in a manner that allows the data to be stored in existing databases maintained by the CDFW or other natural resource agencies such as the U.S. Army Corps of Engineers ("Corps"), the U.S. Fish and Wildlife Service ("USFWS"), or the NOAA.

Where appropriate, monitoring data will be analyzed statistically. However, Thom et al. (2010) note that rigorous experimental design which evaluates one or more null hypotheses may not be necessary for documenting the development of biotic communities. They also note that the monitoring implemented for most restoration projects is not conducted with the sample size, replication, or controls necessary for rigorous statistical testing. Although rigorous statistical analyses may be appropriate for some aspects of adaptive management in which management actions are empirically evaluated, in general, simple graphs with error bars or similar analyses may be sufficient to interpret trends in the development of biotic communities (Thom et al. 2010). The use of aerial photographs, permanent ground-based photo-monitoring locations, and Geographic Information Systems ("GIS") analyses are also useful methods for assessing habitat development. The ultimate form of the monitoring program and associated analyses will include some combination of all of the above.

4.2 Tidal Marsh

Monitoring and performance goals for tidal marsh focus on low marsh, mid marsh, and high marsh habitat. Tidal channels and mudflat habitat are treated separately in Sections 4.3 and 4.4, respectively.

The primary ecological driver of tidal wetland habitat development is regular tidal inundation and, related to that, the balance between sediment import and export. The establishment of characteristic tidal marsh vegetation is a relatively good indicator of tidal inundation and marsh plain development and will be the focus of tidal wetland monitoring and performance goals; direct observation of tidal inundation may be needed during the early phases of the restoration when vegetation is sparse and zonation patterns cannot be discerned. Additional monitoring and performance goals will focus on a lack of invasive weeds and the use of tidal marsh habitat by a diversity of birds.

4.2.1. Monitoring

Monitoring of tidal marsh habitat will focus on the establishment of native tidal marsh vegetation, a lack of invasive weeds, and use by bird species. Monitoring for vegetation establishment and invasive weeds should commence at the end of the first growing season following the completion of construction. Although the development of tidal marsh habitat is relatively well understood, it may be useful to base performance goals on conditions relative to one or more reference sites, particularly for monitoring of bird use. Potential reference sites include the tidal marshes at Tijuana Estuary in San Diego County, Upper Newport Bay in Orange County, Mugu Lagoon in Ventura County, or Carpinteria Salt Marsh in Santa Barbara County, among others.

Vegetation and Invasive Plants

Vegetation monitoring will be conducted in two phases. The first phase will make use of orthorectified aerial imagery to document the total cover of vegetation during the initial phases of vegetation establishment. Aerial images should be taken in late summer, after growth has slowed, and should be taken during a low tide sufficient to expose the entire marsh surface. The goal of this monitoring is to document the location and rate of vegetation establishment during the early phases of the restoration when vegetation is likely to be sparse. Total vegetation cover can be calculated through GIS analysis of the aerial images. Limited ground-truthing may be required to verify patterns observed in the aerial imagery.

The first phase of vegetation monitoring will be conducted every one to two years until it is determined that vegetation is sufficiently dense to allow for efficient ground-based monitoring—this level should be between fifteen and twenty percent cover. Once it is determined that vegetation composition can be efficiently measured on the ground, the second phase of vegetation monitoring will commence and will consist of a quantitative method along transects running from high marsh to low marsh. These transects may be the same as those used for other monitoring parameters to reduce impacts to the marsh and make monitoring more efficient. The monitoring design will be similar to that used for vegetation monitoring elsewhere in the Reserve and will be designed to capture both the composition of vegetation and cover by individual plant species. During the second phase, vegetation will be monitored annually, near the end of the growing season when plants have put on most of their growth but are still identifiable. Vegetation monitoring will continue for the duration of the 10-year monitoring period.

Although it is expected that regular inundation by salt water will limit the potential for invasion of the mid- and low marsh zones, there is potential for non-native, invasive species of sea lavender or statice (*Limonium* spp., other than *L. californicum*) or cordgrass (*Spartina* spp., other than *S. foliosa*) to become established in these regularly inundated marsh zones. Because of the reduced levels of tidal inundation received by the high marsh, there is greater likelihood for invasion of this zone. Monitoring for invasive species will be conducted on an annual (or more frequent) basis, during late spring when annual weeds are in flower or at other appropriate times related to weed life cycles. Monitoring for invasive species will be conducted for the duration of the 10-year monitoring period and is likely to be necessary for the lifespan of the restoration. Monitoring for invasive species will be conducted throughout the entirety of the tidal marsh habitat and will be aimed at identifying the location and extent of any populations of invasive species listed as “High” or “Moderate” by the Cal-IPC (2013), exclusive of annual grasses. Although it may be helpful for management purposes, it may not be necessary to quantify invasive species populations. Instead, a simple qualitative assessment including the location and approximate extent and severity of the infestation may be sufficient to inform management actions. That said, the effectiveness of management actions should be assessed quantitatively, and this may require baseline quantification of the infestation prior to initiating management actions.

Bird Abundance and Diversity

Monitoring for bird use of tidal marsh habitat will be conducted in conjunction with bird monitoring in other habitats at the BWER and the methods use will be consistent with the methods used elsewhere in the Reserve. Monitoring will be designed to capture (1) the abundance and species richness of birds observed using the tidal marsh habitat and (2) the activities in which the birds were engaged within the tidal marsh habitat (i.e., foraging, nesting, etc.).

Due to the large seasonal variation in bird migration and breeding patterns, monitoring for bird use of tidal marsh habitat will be conducted at intervals throughout the year, with reduced monitoring during the summer breeding period to limit disturbance to breeding birds. Monitoring will be timed to occur during peak periods of bird activity. Because the ecological factors involved in bird use of tidal marsh habitat are based on a complex set of factors extending well beyond the limits of the BWER, this monitoring will be conducted every year during the 10-year monitoring period to capture the full range of variability and to compensate for stochastic events that may affect bird use in any given year. For similar reasons, the use of one or more reference sites will be considered as this will help capture variations in bird use which may be attributable to environmental factors extending beyond the borders of the BWER.

In addition to general bird monitoring, it will be important to conduct species-specific monitoring for Belding’s Savannah sparrow which is known to use existing tidal marsh habitat in Area B. This monitoring will follow established protocol approved by the CDFW (e.g., Zembal and Hoffman 2010). Restoration activities that will disturb habitat within Area B which is currently occupied by Belding’s Savannah sparrow cannot proceed until it is determined that this species is breeding in the restored salt marsh habitat in Area A and that the temporary disturbance of occupied habitat in Area B will not affect the population at the BWER. As such, surveys for Belding’s Savannah sparrow will need to be conducted in both the restored habitat in Area A and the existing habitat in Area B. Following the completion of restoration activities, this species-specific monitoring should continue for as long as the statewide census is in effect. Because of the sensitivity of this species, performance goals and adaptive management triggers related to this species should be developed by or in close coordination with the CDFW.

4.2.2 Performance Goals

As noted above, performance goals for tidal marsh habitat will be based on (1) establishment of native tidal marsh vegetation, (2) low cover of invasive weeds, and (3) use of tidal wetland habitat by a diverse array of birds.

Vegetation and Invasive Plants

Vegetation performance goals should be based on the establishment and high cover of native tidal marsh plant species and low cover of highly invasive species. Tidal marsh vegetation will be established through a combination of natural recruitment and plantings, and as such, the performance of tidal marsh vegetation is likely to be highly variable, particularly in the first several years of the restoration. Variation is also likely to occur within the low, mid- and high marsh zones due to the variable use of natural revegetation versus planting in these different zones. The performance goals outlined below are presented for the habitat as a whole; however, given the likely variability of plant performance in the initial years and between marsh zones, it may be appropriate to develop and apply these goals to the three marsh zones independently.

Table 1. Tidal Marsh Vegetation and Invasive Plant Performance Goals

Monitoring Year	Performance Goals
1 – 3	**A.** Canopy cover may be low, but native salt marsh species should show signs of establishment and spread. **B.** Cover of invasive species listed as “High” or “Moderate” by the Cal-IPC, exclusive of annual grasses, should remain low.
4 – 7	**A.** Canopy cover of native salt marsh species should be relatively high, approaching 75% or greater by the end of Year 7, and should show signs of significant natural recruitment. **B.** Vegetation should include a mix of native species, although one or two native species may dominate. **C.** Cover of invasive species listed as “High” or “Moderate” by the Cal-IPC, exclusive of annual grasses, should remain low.

Table 1. Tidal Marsh Vegetation and Invasive Plant Performance Goals

Monitoring Year	Performance Goals
8 – 10	**A.** Canopy cover of native salt marsh species should be nearly complete. **B.** Vegetation should include a mix of native species, although one or two native species may dominate. **C.** Cover of invasive species listed as "High" or "Moderate" by the Cal-IPC, exclusive of annual grasses, should remain low.

Bird Abundance and Diversity

Performance goals for bird use of restored tidal marsh habitat will be based on high abundance and species richness of tidal marsh-associated birds observed using tidal marsh habitat for foraging, nesting, etc. Because of the large number of factors involved in the use of a site by birds, it may be useful to assess bird use of tidal marsh habitat at the BWER relative to bird use of tidal marsh habitat at one or more suitable reference sites.

Table 2. Tidal Marsh Bird Performance Goals

Monitoring Year	Performance Goals
1 – 3	**A.** A variety of tidal-marsh associated bird species should be observed foraging in the restored tidal marsh, although the diversity and abundance of birds may be lower than observed prior to the restoration.
4 – 7	**A.** Species richness and abundance of tidal marsh-associated birds should each be within pre-restoration levels and should be increasing with each successive year. **B.** Birds should be observed both foraging and demonstrating territorial behavior within the restored tidal marsh habitat.

Table 2. Tidal Marsh Bird Performance Goals

Monitoring Year	Performance Goals
8 – 10	**A.** Species richness and abundance of tidal marsh-associated birds should each be greater than pre-restoration levels; however, annual increases may slow relative to increases observed in Years 4 – 7. **B.** Birds should be observed both foraging and demonstrating territorial behavior within the restored tidal marsh habitat. **C.** Successful breeding should be documented for at least some tidal marsh-associated bird species.

4.2.3 Adaptive Management

The primary ecological factor involved in the development of tidal marsh vegetation is hydrology—regular inundation by tidal waters (Sharitz and Pennings 2006). Additional factors involved in the establishment of tidal marsh vegetation include sediment characteristics (e.g., soil texture, pH, nutrient levels, organic matter content, soil contaminants, etc.), rates of erosion or sedimentation, and the availability of plant propagules. The development of tidal marsh bird communities is primarily related to vegetation composition and structure, the availability of suitable food sources such as seeds, benthic invertebrates, or fish, and the presence of bird predators (Keddy 2010).

Performance goals for tidal wetland habitat focus on the development of appropriate vegetation and use by birds. Because restoration in each zone of the tidal marsh will rely on some combination of planting, seeding, and natural revegetation, differences are expected in the trajectory of vegetation development within each zone. Marsh zones which are planted should be expected to develop quicker than zones which rely on natural revegetation. For marsh zones which are planted, trends in the development of vegetation should be apparent within three to five years. For marsh zones which rely on natural revegetation, trends in the development of vegetation may take five or more years to become apparent. Use of the tidal marsh areas by bird species is expected to occur immediately following the restoration of tidal action and to evolve over time in conjunction with the development of tidal marsh vegetation. As such, trends in the use of tidal marsh habitat by birds should be apparent within three to five years following the restoration of tidal activity.

If tidal marsh vegetation does not demonstrate a suitable trajectory toward achieving performance goals within the expected timeframe for trends in vegetation development to become apparent, an assessment of overall trends in vegetation development will be conducted to determine whether additional studies or changes in management are warranted. If it is determined that the development of tidal marsh vegetation is on track to meet long-term performance goals, modification of performance goals based on an improved understanding of habitat development may be the most appropriate course of action. However, if it is determined that the development of marsh vegetation is not on track to meet long-term performance goals, the causes of this lack of progress toward meeting performance will be identified and potential solutions will be investigated. Potential causes for a lack of progress toward meeting performance goals are likely to be related to soil physical or chemical properties or hydrological regime, and these should be the first targets for study. Potential corrective actions may include additional planting of tidal marsh species to increase the rate of vegetation establishment, the introduction of soil amendments to alter soil physical or chemical properties, or the addition of temporary irrigation or modifications to the tidal regime to improve plant growth or hinder the establishment of invasive species. If invasive species become a problem, management actions such as physical removal or chemical control may be necessary.

If it is determined that bird use of tidal marsh habitat does not demonstrate a suitable trajectory toward achieving performance goals within the expected timeframe for trends to become apparent, an assessment of overall trends in bird use will be conducted to determine whether trends are specific to the BWER or occur at a regional scale. If it is determined that the poor performance is specific to the BWER, additional studies or changes in management may be warranted. Potential causes for a lack of progress toward meeting performance goals are likely to be related to vegetation composition or structure, the absence of suitable food sources, or the presence of bird predators. Potential corrective actions may include modifications to the management of vegetation, soil properties, or tidal regimes to create appropriate habitat structure for birds or to promote increased use of tidal marsh habitat by benthic invertebrates or fish species. Predator management may also be required and is discussed in further detail in Section 4.12.4.

4.3 Subtidal and Intertidal Channels

The extent of subtidal and intertidal channels will be determined primarily by the initial design and will be modified over time based on the rate of tidal flow entering the wetlands from Ballona Creek. Tidal channels are expected to evolve to some degree over time based on sediment loads, storm events, etc. Although some migration and contraction or expansion of tidal channels is expected and desired, excessive movement and contraction or expansion could negatively affect the flood control aspects of the project or the development of tidal marsh habitat. Monitoring and performance goals will be based on the location, width, and depth of tidal channels relative to the originally designed specifications and the expected development of tidal channels.

In addition to providing some level of flood control protection, tidal channels provide the connection between the open ocean, Ballona Creek, and tidal marsh habitat at the BWER. These tidal channels will be the primary route through which the introduction of benthic invertebrates, fish, and other aquatic organisms will occur. Colonization of mudflat habitat by benthic invertebrates will provide some evidence of this biological function of the tidal channels. A diverse array of fish species and functional guilds in tidal channels will provide an indication of aquatic habitat quality in the tidally influenced portions of the Reserve. In addition to measurements of tidal channel structure, biological monitoring parameters and performance goals will focus on use of tidal channels by fish. Given the high seasonal and annual variability in fish populations, the use of one or more suitable reference sites may be useful for this monitoring parameter. Potential reference sites include the tidal wetlands at Tijuana Estuary in San Diego County, Mugu Lagoon in Ventura County, or Carpinteria Salt Marsh in Santa Barbara County, among others.

4.3.1 Monitoring

Channel Morphology

Monitoring for channel morphology should include both analyses of aerial images to document changes in the extent and location of tidal channels and ground-based monitoring to document changes in channel width or depth. Monitoring should occur after the rainy season, when major storms are no longer expected and annual changes in tidal channel morphology are likely to be slower. Aerial images should be analyzed using GIS software to document any changes in the extent and location of tidal channels. Ground-based monitoring should consist of measurements of channel depth and width and the location of the banks at a variety of locations near and far from the channel openings at Ballona Creek. Monitoring will be conducted annually during the 10-year monitoring period; it may be useful to qualitatively monitor changes in channel morphology following major storms, in addition to the annual monitoring. Although the proposed restoration has been designed to avoid accumulation of sediments at the tidal openings to Ballona Creek and at tide gates servicing the managed tidal areas, there is potential for unforeseen changes in sediment loads or related factors to cause long-term accumulation of sediments in these areas. As such, some level of monitoring may be necessary for the lifespan of the restoration.

Fish Abundance and Diversity

In addition to physical parameters, monitoring of tidal channels will also document the abundance and species richness of fish species found in tidal channels at the BWER. Fish monitoring will be conducted annually, during the summer months when fish abundance and diversity are at their peak. Monitoring will occur at high tide and will occur in each major tidal channel servicing the tidal marsh areas. Monitoring will make use of a variety of sampling methods designed to document the full range of fish diversity at the BWER—these methods may include the use of otter trawls, bag seines, gill nets, enclosures, and other methods. The goal of monitoring will be to capture the diversity and abundance of fish species within each guild expected to be present at the BWER, including demersal fish, pelagic fish, and burrow-inhabiting fish.

Water Quality

Dissolved oxygen will be monitored using a data logging device capable of capturing continuous water quality data or by similar methods. Sampling will occur in a wide range of locations within the tidal channel network to gain a clear picture of dissolved oxygen dynamics. Monitoring for dissolved oxygen levels will be conducted for the duration of the 10-year monitoring period as this monitoring will provide useful data on circulation patterns and residence time, data that will be important for adaptive management.

4.3.2 Performance Goals

Channel Morphology

Performance goals for subtidal and intertidal channels focus on excessive sedimentation, large-scale erosion, and major changes in channel geomorphology. The performance goals presented below assume that changes in channel geomorphology will be greater during the initial phases of the restoration, but will stabilize as vegetation colonizes the marsh plain and rates of sedimentation and erosion reach a balance.

Table 3. Tidal Channel Morphology Performance Goals

Monitoring Year	Performance Goals
1 – 3	**A.** Changes in channel extent or location should be within acceptable design limits. **B.** Erosion and scouring within the main channels may be significant in the first years, but should be within acceptable design limits. **C.** Sedimentation within the main channels and at tide gates and openings to Ballona Creek should be within acceptable design limits.
4 – 7	**A.** Changes in channel extent or location should be within acceptable design limits and should be greatly reduced from rates or extents of change observed during the first years. **B.** Erosion and scouring within the main channels should be significantly reduced from rates observed in the first years. **C.** Sedimentation within the main channels and at tide gates and openings to Ballona Creek should be reduced from rates observed in the first years and should be within acceptable design limits.
8 – 10	**A.** Changes in channel extent or location should be within acceptable design limits and should be negligible. **B.** Erosion and scouring should be minimal throughout the marsh plain. **C.** Sedimentation within the main channels and at tide gates and openings to Ballona Creek should be minimal and should be within acceptable design limits.

Fish Abundance and Diversity

Performance goals for fish abundance and diversity are be based on the development of a relatively stable and diverse native fish population. Because of the large number of variables involved in fish population dynamics, many of which may occur outside of the BWER, it may be appropriate to assess use of the site by fish species relative to pre-restoration levels of fish diversity. Alternatively, one or more reference sites may also be used to assess fish use of tidal channels at the BWER.

Table 4. Tidal Channel Fish Performance Goals

Monitoring Year	Performance Goals
1 – 3	**A.** Species richness and abundance of fish should each be within or approaching pre-restoration levels. **B.** No major fish die-offs should occur.
4 – 7	**A.** Species richness and abundance of fish should each be the same as or greater than pre-restoration levels. **B.** Changes in species richness and abundance of fish should show signs of stabilizing. **C.** No major fish die-offs should occur.
8 – 10	**A.** Species richness and abundance of fish should each exceed pre-restoration levels. **B.** Species richness and abundance of fish should be relatively stable. **C.** No major fish die-offs should occur.

<u>Water Quality</u>

Because dissolved oxygen levels are not expected to evolve over time in the same way vegetation might, a static performance goal is recommended for this monitoring parameter. However, given the expected high daily and seasonal variation in dissolved oxygen levels, in may be useful to develop performance goals relative to the range of dissolved oxygen levels observed at one or more suitable reference sites.

Table 5. Tidal Channel Water Quality Performance Goals

Monitoring Year	Performance Goals
Applicable to All Years	Dissolved oxygen levels should remain within healthy levels for fish and other aquatic organisms; levels should not drop below 2 parts per million for extended periods.

4.3.3 Adaptive Management

The main purpose of subtidal and intertidal channel restoration at Ballona is to provide sufficient tidal flow for the development of high-quality tidal wetland habitat. A secondary function is to provide habitat for wildlife species associated with shallow and deepwater habitats. The structure and function of tidal channels at the BWER will be most influenced by the design process, with additional development based on changes in the tidal prism due to sedimentation or erosion. The development of appropriate animal communities within tidal channels is primarily related to habitat structure, sediment characteristics, water quality, and the availability of food sources. Monitoring and performance goals focus on major changes in channel location or morphology, the development of a diverse fish community, and healthy dissolved oxygen levels. It is expected that the desired function of tidal channels should be achieved immediately following the restoration of tidal activity. Most of the changes in tidal channel morphology are expected to occur within the first year or two, with less extensive changes occurring in subsequent years based on rates of erosion and sedimentation, the occurrence of major storm events, and the rate of vegetation establishment along channel margins, among other factors. Similarly, desired water quality levels (as measured by dissolved oxygen levels) are expected to be achieved through the design process, and as such, problems should be evident within the first one to two years following restoration of tidal activity. Fish use of tidal channels is also expected to occur immediately following the restoration of tidal activity, with subsequent changes in abundance and community composition as habitat structure (e.g., channel morphology or establishment of macroalgae) and food availability evolve within the tidal channels.

If subtidal or intertidal channels show a lack of progress toward meeting performance goals for channel morphology, water quality, or fish use within the first two to three years, an assessment of overall trends will be conducted to determine whether adaptive management is warranted. Potential causes of poor performance in terms of channel morphology and water quality are most likely to be related to tidal prism and the associated rates of tidal velocity, circulation, and residence time. In terms of water quality, problems may also be related to contamination issues in Santa Monica Bay or upstream of the Reserve, contamination from stormwater runoff from developed areas surrounding the Reserve, or sediment contamination within the Reserve. Additional studies may be required to identify problems with tidal circulation or potential sources of water or sediment contamination. If it is determined that changes in management are necessary, potential actions include modification of the tidal inlet or channel morphology to alter tidal prism or circulation patterns or remediation efforts to improve sediment or water quality.

If fish populations within the tidal channels fail to meet performance goals within the first two to three years, an assessment of overall trends will be conducted to determine whether the lack of progress in meeting performance goals is specific to the BWER or is related to a regional condition. If it is determined that the lack of progress in meeting performance goals is specific to the BWER, additional studies should be conducted to determine whether the lack of progress is a result of misguided performance goals or due to habitat conditions within the BWER. If new information suggests that performance goals may be deficient, appropriate modifications will be made. However, if there is no evidence to suggest that performance criteria are deficient, studies will be undertaken to determine the cause of the lack of progress in meeting performance goals. Potential causes include problems with tidal channel design which may affect tidal circulation patterns, water quality, or habitat structure. Other problems may be related to contamination issues or poor development of tidal marsh habitat which will affect the availability of food sources for fish. Potential corrective actions include changes to the channel design, modification of tidal regimes where possible (e.g., in the managed tidal portions of Area B), remedial actions to address water or sediment contamination, or modification of vegetation structure or composition.

As with other habitats and monitoring variables, adaptive management triggers for tidal channels are primarily based on significant deviation from the expected trajectory of biotic community development (i.e., significant deviation from the performance goals). However, for fish use of tidal channels, additional triggers may include abnormal declines in fish populations, evidence of a fish die-off, or large increases in non-native fish species.

4.4 Mudflat Habitat

Monitoring for mudflat habitat will focus on the establishment of a diverse macroinvertebrate population and use of mudflat habitat by wading birds. Because the colonization and use of mudflat habitat by wildlife species is subject to a wide range of unpredictable ecological factors, the use of reference sites may be useful for wildlife monitoring parameters. Potential mudflat reference sites include the tidal wetlands at Tijuana Estuary in San Diego County, Upper Newport Bay in Orange County, Mugu Lagoon in Ventura County, or Carpinteria Salt Marsh in Santa Barbara County, among others.

4.4.1 Monitoring

<u>Macroinvertebrate Abundance and Diversity</u>

To reduce the level of effort involved, monitoring for macroinvertebrate colonization will be conducted at the level of order, suborder, or genus (depending on available funding). Monitoring will be designed to capture the overall abundance (or biomass) and order, suborder, or genus diversity of macroinvertebrates greater than 0.1 inche (3 millimeters) in size—although smaller size classes are often used, this greatly increases the level of effort and cost involved in sampling. This can be accomplished through the use of a suitable number of sediment cores from which macroinvertebrates can be sifted, identified to the level of order, sub-order, or genus, and quantified. Quantification may consist of either counts of individuals or measurements of biomass. Monitoring will begin following one full year after the reestablishment of tidal activity and will be conducted annually for the duration of the 10-year monitoring period.

Identification of macroinvertebrates can be a time consuming process (Callaway et al. 2001), and depending on the funding available for monitoring, it may be necessary to investigate alternative monitoring approaches to assess the health of the macroinvertebrate population at the BWER. One potential alternative includes the use of indicator or umbrella species to assess the overall health of the macroinvertebrate population.

Bird Abundance and Diversity

Monitoring of bird use will be conducted in conjunction with bird monitoring in other habitats at the BWER and will be consistent with the methods used elsewhere in the Reserve. Monitoring will be designed to capture the abundance and species richness of birds observed using the mudflat habitat. Unlike bird use in other habitats, it is expected that bird use of mudflat habitat will be limited to foraging, and thus, there is not a need to capture the activities in which the birds were engaged while using mudflat habitat. Due to the large seasonal variation in bird migration and breeding patterns, monitoring for bird use of mudflat habitat will be conducted at intervals throughout the year. Monitoring will be timed to occur during peak periods of bird activity; in the case of mudflat habitat, this would be at low tide. Because the ecological factors involved in bird use of mudflat habitat are based on a complex set of factors extending well beyond the limits of the BWER, this monitoring will be conducted every year during the first ten years of the monitoring period to capture the full range of variability and to compensate for stochastic events which may affect bird use in any given year. As noted above, it may be useful to also monitor bird use of mudflat habitat at suitable reference sites and to assess conditions at the BWER relative to conditions at the reference sites.

4.4.2 Performance Goals

Macroinvertebrate Abundance and Diversity

Given the complex set of factors involved with macroinvertebrate colonization of mudflat habitat, the performance goals presented here are based on a steady increase in macroinvertebrate abundance and taxonomic richness (at the level of order, suborder, or genus). It is expected that colonization of mudflat habitat will occur within the first year following the restoration of tidal activity; however, it may take a number of years for the macroinvertebrate community to reach pre-restoration levels of diversity and abundance. It may take several additional years for macroinvertebrate diversity and abundance to exceed pre-restoration levels.

Table 6. Mudflat Macroinvertebrate Performance Goals

Monitoring Year	Performance Goals*
1 – 3	**A.** Macroinvertebrate order diversity should be near pre-restoration levels within one to two years following restoration of tidal activity. **B.** Macroinvertebrate abundance or biomass (by order) may be significantly lower than pre-restoration levels but should show a steady increase during the first years following restoration of tidal activity.
4 – 7	**A.** Macroinvertebrate order diversity should be at or above pre-restoration levels. **B.** Macroinvertebrate abundance or biomass (by order) should be at or near pre-restoration levels and should show a steady increase.
8 – 10	**A.** Macroinvertebrate order diversity should exceed pre-restoration levels. **B.** Macroinvertebrate abundance or biomass (by order) should exceed pre-restoration levels.

* Based on sampling of macroinvertebrates greater than 0.1 inch (3 millimeters) in size.

<u>Bird Abundance and Diversity</u>

As noted above, the performance goals for bird use of mudflat habitat are based on the abundance and species richness of birds observed using mudflat habitat. Use of mudflat habitat by birds is likely to be closely linked to colonization of the habitat by macroinvertebrates. As such, the performance goals presented here should be considered in relationship to the observed rates of macroinvertebrate colonization.

Table 7. Mudflat Bird Performance Goals

Monitoring Year	Performance Goals
1 – 3	**A.** A variety of wading and other mudflat-associated bird species should be observed foraging in mudflat habitat, although species richness may be lower than observed prior to the restoration. **B.** The abundance of wading and other mudflat-associated bird species should show a steady increase in conjunction with the development of the macroinvertebrate community.

Table 7. Mudflat Bird Performance Goals

Monitoring Year	Performance Goals
4 – 7	**A.** The species richness of wading and other mudflat-associated birds observed foraging in mudflat habitat should be within pre-restoration levels. **B.** The abundance of wading and other mudflat-associated bird species should observed foraging in mudflat habitat should be within pre-restoration levels.
8 – 10	**A.** The species richness of wading and other mudflat-associated birds observed foraging in mudflat habitat should exceed pre-restoration levels. **B.** The abundance of wading and other mudflat-associated bird species should exceed pre-restoration levels.

4.4.3 Adaptive Management

The primary goal of mudflat restoration at the BWER is to provide foraging habitat for wading birds. Monitoring parameters and performance goals are based on the total area of mudflat remaining in an unvegetated state or being colonized by seaweeds and other macroalgae, colonization by macroinvertebrates, and the use of mudflat habitat by wading birds for foraging. The area of mudflat habitat remaining unvegetated or being colonized by seaweeds will primarily be determined by design elevations and should not change significantly over time. It is assumed that bird species will begin using mudflat habitat immediately following restoration of tidal activity, with subsequent changes in abundance and species composition as the mudflat is colonized by macroinvertebrates. Macroinvertebrate colonization is also expected to occur relatively rapidly following restoration of tidal activity. It is expected that trends in bird use of mudflat habitat will be evident within three to five years following restoration of tidal activity and trends in macroinvertebrate colonization should be evident within five years.

If it is determined that bird use or macroinvertebrate colonization of mudflat habitat does not demonstrate a suitable trajectory toward achieving performance goals within the expected timeframe for trends to become apparent, an assessment of overall trends in bird use will be conducted to determine whether trends are specific to the BWER or occur at a regional scale. If it is determined that the lack of progress in meeting performance goals is specific to the BWER, additional studies or corrective actions may be warranted. Potential causes for a lack of progress in meeting performance goals for birds are likely to be related to low rates of macroinvertebrate colonization or the presence of bird predators. Potential corrective actions for improving bird performance include changes aimed at increasing rates of macroinvertebrate colonization or initiation of predator management. Potential causes of poor performance for macroinvertebrates may include incompatible sediment composition, sediment contamination, or excessive foraging by birds during the early stages of colonization. Although modifying sediment composition of the mudflat habitat may not be practicable, remedial actions to reduce sediment contamination and actions to reduce foraging pressure from birds may be possible.

4.5 Brackish Marsh

Brackish marsh habitat is formed in portions of tidal marsh receiving seasonal or perennial input of freshwater (Desmond et al. 2001). These habitats represent a transition zone between freshwater and saline conditions, and as such, are characterized by an overlapping mix of species adapted either freshwater or saline conditions, as well as a suite of species unique to brackish conditions. Given the high variability among brackish marshes, developing detailed performance goals is not practical. As such, the monitoring and performance goals presented below include only basic metrics of habitat performance.

4.5.1 Monitoring

Brackish marshes are highly variable in terms of hydrology, salinity, vegetation, and wildlife use. The brackish marsh should be treated as a transition zone similar to the upland-wetland transition zone in the sense that it may be difficult to determine the boundary between the brackish marsh and the adjacent habitats and to define a target plant community (see note on monitoring for transition zones in Section 4.11). It is expected that the extent of the brackish marsh “transition zone” may fluctuate from season to season and year to year. Although the primary ecological factors responsible for the development of brackish marsh include hydrology and salinity, these two factors are likely too variable both within and among brackish marshes to be of use in the monitoring program. Colonization of brackish marsh habitat by specific plant or wildlife species is also highly variable. Given this high variability, monitoring in brackish marsh habitat will focus primarily on vegetative cover and a lack of highly invasive weeds.

Vegetation and Invasive Plants

Vegetation monitoring will be designed to capture the cover of vegetation and the presence and extent of invasive weeds within areas considered brackish. Because the area of brackish marsh will change from year to year, it will not be possible set quantitative goals for vegetation cover—instead, monitoring in this habitat will focus on a qualitative assessment of vegetation establishment and a lack of highly invasive weeds. Monitoring for establishment of brackish marsh vegetation will be conducted on an annual basis during the entire 10-year monitoring period.

4.5.2 Performance Goals

<u>Vegetation and Invasive Plants</u>

Vegetation performance goals for brackish marsh should be based on a lack of highly invasive weeds and the establishment of vegetative cover. Given that the area of brackish marsh will vary from year to year, it will be difficult to quantify the percent cover of brackish marsh vegetation. As such, performance goals for vegetation in this habitat are qualitative in nature and have been designed to assess the establishment of vegetation or, conversely, the absence of unvegetated areas. Performance goals are also based on low cover of invasive weeds.

Table 8. Brackish Marsh Vegetation and Invasive Plant Performance Goals

Monitoring Year	Performance Goals
1 – 3	**A.** Canopy cover may be low, but vegetation should show signs of establishment and spread. **B.** Cover of invasive species listed as "High" or "Moderate" by the Cal-IPC, exclusive of annual grasses, should remain low.
4 – 7	**A.** Canopy cover should be relatively high, approaching 75% or greater by the end of Year 7, and should show signs of significant natural recruitment. **B.** Cover of invasive species listed as "High" or "Moderate" by the Cal-IPC, exclusive of annual grasses, should remain low.
8 – 10	**A.** Canopy cover should be nearly complete. **B.** Cover of invasive species listed as "High" or "Moderate" by the Cal-IPC, exclusive of annual grasses, should remain low.

4.5.3 Adaptive Management

The primary ecological factors involved in the development of brackish marsh habitat are related to hydrology and the relative proportions of fresh and saline water entering the system (Desmond et al. 2001). Because brackish marsh represents a fluctuating transition zone between fresh and saline environments, it is difficult to define a target biological community for this habitat. As such, performance goals are aimed at general factors such as the development of vegetative cover and the occurrence of invasive plants. As with tidal marsh habitat, it is expected that trends in the development of vegetation should be apparent within three to five years following the restoration of tidal activity.

If brackish marsh vegetation does not demonstrate a satisfactory trend toward meeting performance goals within the first three to five years, an assessment of the causes will be undertaken. Potential causes of poor vegetation establishment are likely to be related to physical or chemical properties of the sediment, including sediment contamination, or deficiencies in the tidal regime. Potential corrective management actions may include additional planting or seeding, the addition of supplementary irrigation or slow-release fertilizers, or remedial actions to reduce sediment contamination or to improve other aspects of sediment quality.

4.6 Salt Panne

Salt pannes are characterized by irregular or seasonal water fluxes—including from both freshwater inputs such as rainfall or groundwater and saline inputs such as tidal inundation during extreme high tides—followed by prolonged dry-down periods which concentrate salts in the soil surface horizons at levels of up to 200 parts per thousand (Vivian-Smith 2001). The resulting habitat is a salt-crusted depression largely devoid of vegetation in the center and often fringed by halophytic plant species along the margins (Sharitz and Pennings 2006). Existing salt panne habitat at the BWER is valued primarily for its use by birds. Created salt panne habitat will also have the potential to host rare species of tiger beetles such as the western mudflat tiger beetle (*Cicindela trifasciata sigmoidea*) which has been previously documented from Area B (PWA et al. 2006).

Performance goals for restored salt panne habitat focus on (1) the primary ecological drivers of salt panne habitat development: hydrology and salinity, (2) the characteristic expression of these ecological drivers: lack of vegetation, and (3) the primary value of salt panne habitat: use by birds for foraging. In terms of bird use, performance goals do not focus on specific species or other taxonomic groups, but instead focus on bird guilds or other broad functional groups of birds such as shorebirds or wading birds. Monitoring for these parameters is relatively simple and can be easily repeated over long time periods and by a variety of individuals or organizations, including volunteers.

As noted in the salt panne habitat description in Section 3.2.3 of this report, two types of salt panne habitat currently occur at the BWER, those fed by irregular tidal inundation by extreme high tides and those fed by shallow groundwater or stormwater runoff. Salt panne creation at the BWER is focused on the former type; however, there is potential for the latter type to develop in areas designed as seasonal wetland habitat. The monitoring and performance goals presented here are aimed at the salt panne habitat designed to receive irregular inundation by extreme high tides. However, it should be recognized that salt panne habitat that unexpectedly forms in areas originally designed as seasonal wetland habitat or in other portions of the Reserve may provide valuable wildlife habitat and should be considered an asset to the overall restoration, not a failure in the creation of seasonal wetlands.

4.6.1 Monitoring

Monitoring for restored salt panne habitat will focus on (1) hydroperiod and salinity, (2) vegetative cover (or lack thereof), and (3) habitat use by guilds or other functional groups of birds. Monitoring will commence after the first full growing season following the completion of construction and will occur for a period of at least 10 years. As noted previously, salt panne habitat may develop in areas not explicitly designed as salt panne habitat—if this occurs, salt panne monitoring should be expanded to include these areas. Because our knowledge of salt panne development is limited, it may be useful to monitor for hydrology, salinity, and bird use at both the BWER and at one or more reference sites containing functioning salt panne habitat such as at Upper Newport Bay in Orange County or Peñasquitos Lagoon in San Diego County. Other potential salt panne reference sites include Point Mugu in Ventura County or the San Dieguito and Poseidon wetlands in San Diego County; however, these sites contain constructed salt panne habitat, and it is unclear whether these salt pannes function similar to naturally occurring salt pannes in the region. During the initial phases of the restoration in Area A, monitoring for these parameters may also be conducted in the existing salt panne habitat in Area B. Monitoring both at reference sites and in existing salt panne habitat at the BWER may provide a better understanding of how salt panne habitat functions within the region as well as useful data to guide adaptive management decisions.

Hydrology and Salinity

The goal of hydrology and salinity monitoring is to determine whether created salt panne habitat receives the frequency and duration of tidal inundation necessary to reach hypersaline conditions. Monitoring for hydrology can be done relatively inexpensively using water level data loggers (however, if salt panne habitat is constructed using a clay layer to reduce percolation, care should be taken not to penetrate the clay layer and cause drainage). Use of such equipment can provide continuous, high-precision monitoring and allows for an understanding of hydrological patterns at multiple time scales. Alternatively, this monitoring can be accomplished by monthly (or more frequent) monitoring using staff gauges or other manual methods. In addition to providing fine-scale data, the use of data logging equipment would require fewer visits to salt panne habitat and reduced disturbance in this habitat. However, there may be security issues involved in leaving scientific equipment at the site. The use of staff gauges would require less up-front cost in terms of equipment and reduced potential for equipment loss or damage; however, this method would require more visits and disturbance to the site and would provide only limited insight into seasonal patterns of inundation frequency and duration. That said, the expense involved in monitoring staff gauges may be reduced by employing volunteers for this task. If staff gauges are used, monitoring should occur following extreme tides and heavy rainfall events and at appropriate intervals thereafter to determine the duration of inundation following such events. The appropriate interval for monitoring following such events will depend on the size of the event (i.e., height of the tide or amount of rainfall) and the rates of percolation, evaporation, and transpiration (assuming the presence of vegetation) unique to each panne. As such, the most appropriate interval for hydrology monitoring should be based on observations of the depth and duration of inundation made during the first year following the restoration of tidal activity.

Soil salinity can be measured by taking soil cores from within the potential plant rooting zone (to a depth of approximately 4 to 6 inches [10 to 15 centimeters]) along a transect from the edge of the salt panne to the lowest point in the center of the salt panne. Collecting soil cores along an elevation gradient from the edge of the salt panne to the center will provide a detailed understanding of salinity patterns as they relate to inundation depths as inferred by elevation within the salt panne (i.e., lower elevations are assumed to have greater depth and duration of inundation). Soil cores can be either analyzed in-house or sent to a soil testing laboratory for analysis using standard protocols for determining soil salinity. Soils cores should be analyzed for salinity in 1- to 2-centimeter intervals as salinity levels can vary dramatically within the soil profile and will differentially affect plants based on their salt-tolerance and rooting depth.

To avoid excessive disturbance in these sensitive habitats, monitoring for soil salinity will be conducted once annually, when the pannes are dry. This will be done toward the end of the dry season, when salt concentrations are expected to be at their highest (Pratolongo et al. 2009). However, if salt panne soil salinity is to be compared to salinity levels from reference salt pannes, sampling should occur at the same time of year to ensure that results are comparable. Using randomly positioned transects may help reduce impacts associated with sampling along a permanent transect year after year. Given the potential for large variations in soil salinity due to rainfall levels, it may be useful to monitor precipitation at both the BWER and one or more reference sites and to incorporate rainfall into the analysis of soil salinity. Comparing rainfall levels between both years and sites will allow for an analysis of salinity levels weighted by rainfall which may be a better indicator of habitat function than salinity levels alone.

Modifications to this monitoring scheme may be necessary if salt panne habitat is not developing as expected. For instance, if weeds or other unwanted vegetation become established within the salt pannes, it may be necessary to monitor salinity levels during the growing season (as opposed to the peak of the dry season) to determine what conditions are like when the plants are germinating or actively growing.

Vegetation and Invasive Species

The goal of vegetation monitoring in created salt panne habitat is to (1) determine whether vegetation within the salt panne habitat is expanding, receding, or remaining stable and (2) identify the presence of invasive plant species that may require control.

Monitoring of vegetative cover within salt panne habitat can be combined with vegetation monitoring in other habitats at Ballona and is easily accomplished through GIS analysis of vegetation data collected on the ground. Such monitoring would consist of delineating the area of unvegetated salt panne habitat using a handheld GPS device with sub-meter accuracy and subsequent GIS analysis to calculate the total area of unvegetated salt panne habitat relative to the as-built area of the salt panne habitat. During this vegetation monitoring, the plant species present along the fringes or within the salt panne habitat will be documented and the presence of non-native weeds will be noted. Although species composition and the presence of non-native weeds will not be monitored quantitatively, an understanding of which plant species are encroaching on or establishing within the salt panne habitat will help inform management of these areas. Monitoring of vegetative cover may also be accomplished through GIS analysis of aerial imagery; however, this method would still require on-the-ground monitoring to determine the species composition of any developing vegetation. This on-the-ground monitoring could be combined with hydrology monitoring or annual soil salinity monitoring. The methods chosen for determining the total cover of vegetation will be consistent with the methods used for determining vegetative cover in other habitats within the Reserve.

Monitoring for vegetative cover and the composition of encroaching vegetation will commence following the first full growing season after construction has been completed and will occur in mid- to late summer, after plant growth has slowed but when plants are still identifiable. If aerial imagery is used to determine the total cover of vegetation, the images should be taken during the mid- to late summer for the same reason. Vegetation monitoring will be conducted annually for the first five years following the restoration of tidal activity and thereafter at Year 7 and Year 10, assuming vegetation is on track to meet final performance goals.

Bird Abundance and Diversity

The goal of bird monitoring is to determine whether salt panne habitat will support a diversity of bird species. However, a distinction should be made between the *ability* of created salt panne habitat to support desired levels of bird use and the *actual use* of salt panne habitat by such species. Patterned use of the existing salt panne habitat in Area

B may limit bird use of created salt panne habitat in Area A without being indicative of the suitability of the created salt panne habitat to support birds. This is a particularly important point to consider given that the salt panne habitat planned for Area A consists of many small, scattered salt pannes whereas the existing salt panne habitat in Area B consists of one large, contiguous area. Because of the greater area and reduced perimeter to area ratio of salt panne habitat in Area B, birds may favor this habitat over the smaller areas of salt panne habitat to be created in Area A. If bird use of the created salt panne habitat in Area A is determined to be inadequate, it may be necessary to monitor invertebrate populations or other indicators of the habitat's *ability* to support the desired diversity and abundance of birds.

Monitoring for bird use of salt panne habitat can be conducted in conjunction with bird monitoring in other habitats at the BWER and will be consistent with the methods used for bird monitoring in other habitats throughout the Reserve. Monitoring will be designed to capture (1) the abundance and diversity of bird species observed using the salt panne habitat and (2) the activities in which the birds were engaged within the salt panne habitat (i.e., foraging, resting, etc.).

Due to the large seasonal variation in bird migration and breeding patterns, monitoring for bird use of salt panne habitat will be conducted at intervals throughout the year, with reduced monitoring during the summer breeding period to limit disturbance to breeding birds. Monitoring will be timed to occur during peak periods of bird activity and should occur when the salt panne habitat is inundated or when invertebrates are active at the surface of the salt pannes, as these are the times when birds are most likely to use salt panne habitat for foraging. Because the ecological factors involved in bird use of salt panne habitat are based on a complex set of factors extending well beyond the limits of the BWER, this monitoring will be conducted every year during the first ten years of the monitoring period to capture the full range of variability and to compensate for stochastic events which may affect bird use in any given year.

4.6.2 Performance Goals

As noted above, performance goals for created salt panne habitat are based on (1) hydrology, (2) soil salinity, (3) lack of vegetative cover and invasive weeds, and (4) bird use. The first three parameters are relatively easy to measure and are potentially subject to manipulation, whereas the fourth parameter is less easily measured and may not be subject to manipulation. As such, the first three parameters should be the primary factors used to determine successful development of the created salt panne habitat. As noted above, bird use of salt panne habitat is not well understood and may not be within the control of the BWER land manager. As such, creating strict performance goals for bird use of created salt panne habitat at BWER is not recommended. Bird use of salt panne habitat should be used to determine the general quality of the salt panne habitat created (e.g., high bird use would indicate high habitat quality and vice versa). If it is determined that the salt panne habitat created is of low habitat quality for birds, additional studies and adaptive management actions may be appropriate.

Hydrology and Salinity

Hydrology performance goals for salt panne habitat are be based on the frequency of inundation and the duration of subsequent ponding which should occur at sufficient frequency and duration to create hypersaline conditions within the salt panne habitat. Because hydrologic conditions are not expected to change substantially over time in the same way vegetation communities might develop, the hydrology performance goals presented in Table 10 are the same for each year of the 10-year monitoring period. Because salt panne habitat will receive some proportion of its hydrologic input from rainfall, the assessment of hydrology performance goals should take into account annual and seasonal variation in rainfall levels.

Performance goals for soil salinity should be based on the levels required to preclude vegetation. The goals presented below assume that salt panne habitat will be created using saline soils or by the addition of salt, and that salinity levels will be high from the outset. If non-saline soils are used and/or salt is not added, performance goals will require modification based on the expected rate of habitat development. Ultimately, the desired outcome is for salinity levels to be within the range of levels found within the rooting zone (top 15 centimeters of the soil profile) in functioning salt panne habitat in Area B or from salt panne habitat at one or more reference sites.

Table 9. Salt Panne Hydrology and Salinity Performance Goals

Monitoring Year	Performance Goals
Applicable to All Years	**A.** The frequency of inundation and duration of ponding should be within the range documented from salt panne habitat in Area B or from one or more reference sites. **B.** Soil salinity levels in created salt panne habitat should be on a trajectory toward levels observed in salt panne habitat in Area B or from one or more reference sites.

Vegetation and Invasive Species

Performance goals for vegetation cover should be based on a steady trend toward attaining non-vegetated, periodically-ponded areas due to hypersaline conditions. It is expected that some vegetation may become established along the fringes and within the salt panne habitat during the initial phases of the salt panne development when salinities are lower. It is expected that establishment of new plants will be deterred as salinities rise; however, plants that become established during the early years of salt panne development and that are able to tap into deeper, less saline groundwater, may be able to resist increasing salinity levels at the soil surface and may require physical removal. Given these expected trends, performance goals should be based on a sustained decline in vegetative cover and the assumption that some level of active vegetation management may be necessary, especially during the early years of salt panne development when salinities are lower. The ultimate performance goal should be based on a sustained lack of vegetation in a majority of the area originally designed as salt panne habitat. However, this number should also take into account the development of salt panne habitat in areas not originally designed as salt panne habitat; this will account for salt panne habitat that is lost to sea level rise and a corresponding increase in salt panne habitat resulting from the conversion of seasonal wetland habitat in the transition zones, also due to sea level rise.

In addition to the vegetation cover performance goals, invasive weeds designated by the Cal-IPC (2013) as “High” or “Moderate” (exclusive of annual grass species) should remain at low levels. This performance goal is exclusive of non-native annual grass species which are difficult to control and are a dominant member of most herbaceous vegetation communities in California.

Table 10. Salt Panne Vegetation and Invasive Plant Performance Goals

Monitoring Year	Performance Goals
1 – 5	**A.** A majority of the area originally designed as salt panne habitat should remain unvegetated. Plants that establish during the early years may require physical removal; however, new plants should be prevented from becoming established as salinities rise. **B.** Cover of invasive weeds rated as “High” or “Moderate” by the Cal-IPC, exclusive of annual grass species, should remain low.
6 – 10	**A.** A majority of the area originally designed as salt panne habitat should remain unvegetated. Plants that became established during the early years should no longer be present within the salt panne habitat, and new plants should not become established. **B.** Cover of invasive weeds rated as “High” or “Moderate” by the Cal-IPC, exclusive of annual grass species, should remain low.

Bird Abundance and Diversity

Performance goals for bird use of created salt panne habitat are be based on the abundance and species richness of birds observed using salt panne habitat. It may be useful to base the assessment on conditions relative to suitable reference salt pannes. Bird use of specific habitats is dependent on a wide range of variables, including patterned use of existing habitat and the area to perimeter ratio of certain habitats. As such, the performance goals presented here should be used to evaluate the general quality of created salt panne habitat and to inform the need for corrective management actions to improve habitat quality for birds. As noted in Section 4.6.1, patterned use of salt panne habitat in Area B, as well as the larger area of salt panne habitat in Area B, may limit bird use of smaller salt pannes to be constructed in Area A—this may not necessarily reflect the *ability* of constructed salt panne habitat to support high levels of bird use. If bird use of created salt panne habitat is low, it may be appropriate to develop performance goals based on the *ability* of the habitat to support birds as measured using invertebrate levels or another appropriate surrogate of habitat quality.

Table 11. Salt Panne Bird Performance Goals

Monitoring Year	Performance Goals
1 – 3	A variety of bird species should be observed foraging in the salt panne habitat, although the diversity and abundance of birds may be lower than observed prior to the restoration.
4 – 7	Species richness and abundance of birds observed using salt panne habitat should each be within pre-restoration levels and should be increasing with each successive year.
8 – 10	Species richness and abundance of birds observed using salt panne habitat should each be greater than pre-restoration levels; however, annual increases may slow relative to increases observed in Years 4-7.

4.6.3 Adaptive Management

The primary ecological factor involved in the development of salt panne habitat is hydrology, including the frequency and duration of inundation and the salinity of inundating waters. The primary goal of salt panne restoration at Ballona is to provide high quality foraging and/or resting habitat for bird species associated with salt panne habitat. Performance goals for salt panne habitat are based on aspects of hydrology, soil salinity, vegetation composition and cover, and use by birds for foraging. It is expected that trends in salt panne development may take five or more years to become apparent. Because bird use of salt panne habitat is expected to evolve in conjunction with the development of this habitat, it may take a similar amount of time for trends in bird use to become apparent.

Potential corrective management actions related to the development of salt panne habitat include addition of salt to rapidly increase salinity levels, modifications to salt panne hydrology (through adjustments in grading) to alter inundation frequency and duration, and management of vegetation in the early years of habitat development when salinity levels are low. Other potential management actions may be possible depending on the cause of poor performance. The assessment of salt panne performance should take into consideration the potential for habitat conversion to tidal marsh as a result of sea level rise. This transition is likely to occur over a period of several decades or more. The potential for wetland type conversion due to sea level rise combined with a general lack of knowledge regarding salt panne development makes the monitoring of this habitat type the most nebulous of all of the habitats at the BWER. As such, great care and consideration should be given to any potential management actions related to this habitat.

If the frequency and duration of tidal inundation in the restored salt panne habitat is not sufficient to create hypersaline conditions (i.e., within the range of the same parameters in Area B or at reference sites), an evaluation of habitat development trends will be conducted prior to any modifications related to hydrology. If performance goals for salinity levels and vegetation are being achieved, modifications to salt panne hydrology may not be necessary. However, if the salt pannes demonstrate a lack of progress in meeting performance goals for salinity levels and vegetation, modification of salt panne hydrology may be warranted. In this case, salt panne topography should be assessed in relationship to tidal inundation and appropriate modifications should be made. Because modifications to salt panne hydrology could require the use of heavy equipment which has the potential to cause significant disturbance to other habitats, such management actions will not be undertaken without significant consideration.

If trends in salinity levels are not within the appropriate range identified in the performance goals, an evaluation of trends in salinity levels will be conducted prior to taking any management actions. If salinity levels are sufficiently high to exclude the establishment of vegetation, no management actions may be necessary—instead, adjustments to the performance goals may be warranted based on new information which improves our understanding of salt panne development. If, however, salinity levels are low and do not exclude vegetation, options for increasing salinity will be investigated. The most likely management actions would be to add salt to the salt panne soils or to modify salt panne hydrology through changes in topography.

In the event that trends in vegetation development (or lack thereof) do not demonstrate suitable progress toward meeting performance goals, an evaluation of vegetation trends will be conducted prior to implementing any management actions. If vegetative cover remains low, no management actions may be necessary—instead, adjustments to the performance goals may be warranted based on new information which improves our understanding of salt panne habitat development. However, if it is determined that vegetation within the salt panne habitat is not on a suitable trajectory to meet the goals of the salt panne restoration, the causes of this poor performance will be investigated. These investigations should focus primarily on seasonal and annual variations in hydrology and salinity. Once the cause of poor vegetation performance is identified, appropriate management actions will be developed. If hydrology and salinity are determined to be on appropriate trajectories for salt panne development, vegetation management in the form of hand removal may be the most appropriate management action. If, however, hydrology and salinity are determined to not be on target, modifications related to these parameters may be the most appropriate management action.

If bird use of salt panne habitat does not demonstrate suitable progress toward meeting performance goals, a thorough analysis of the causes of this poor performance will be conducted prior to implementing any corrective management actions. If it is determined that salt panne hydrology, salinity, and vegetation are all within an acceptable range (e.g., within the range of the same variables in other functioning salt panne habitat), additional factors will be analyzed. Potential factors to be analyzed include those related to food sources (e.g., invertebrate populations), predation by cats and other urban predators, or competition from other birds, particularly aggressive non-native birds. Once the potential cause of poor bird performance is determined, appropriate corrective management actions will be developed.

4.7 Seasonal Wetlands

Within the context of the larger tidal wetland restoration at the BWER, the goal of including seasonal wetlands is to increase the diversity of non-tidal wetland habitat available for wildlife use. The primary ecological driver of seasonal wetland development is hydrology, and this will be the focus of monitoring and performance criteria for this habitat type. Additionally, seasonal wetlands will be monitored for the presence of invasive weeds.

4.7.1 Monitoring

Hydrology

Monitoring will be conducted to determine the presence of wetland hydrology. Hydrological monitoring can be accomplished through visual observations of inundation made on a weekly basis during the rainy season. Monitoring will be designed to capture the number of pools inundated, the approximate percentage of area inundated within each pool, and the duration of inundation. As pools dry down, the duration of soil saturation will also be documented. Hydrological monitoring will occur on an annual basis for the full 10-year monitoring period to account for natural variation in rainfall levels and other factors affecting seasonal wetland hydrology.

Vegetation and Invasive Plants

Monitoring will be conducted to determine the presence and extent of invasive weeds listed by the Cal-IPC (2013) as “High” or “Moderate”, exclusive of non-native annual grasses. This should consist of visual observations of invasive weeds and an estimate of total cover within the seasonal wetlands. Monitoring for invasive weeds will be conducted twice per year (or more frequently) during the entire 10-year monitoring period, once near the beginning of the growing season and during the annual vegetation monitoring toward the end of the growing season (or more frequently). Because it will not be possible to eliminate all propagule sources for non-native weeds which occur outside of the BWER, some level of monitoring for invasive weeds will be required for the lifespan of the restoration.

4.7.2 Performance Goals

Hydrology

Hydrology performance goals for seasonal wetlands are be based on the number of pools inundated during each rainy season and the length of inundation or soil saturation. However, because seasonal wetland hydrology will be driven by rainfall, performance goals will be linked with annual rainfall levels. Thus, the performance goals presented here will generally be applied only to years of normal or greater rainfall as determined by the use of local rainfall data and Natural Resources Conservation Service (“NRCS”) WETS tables (NRCS 1997; Sprecher and Warne 2000). Due to this variation in annual rainfall levels, it is likely that not all pools will fill every year, and the ultimate goal should be to have prolonged (i.e., two consecutive weeks or longer) inundation in a majority of all seasonal wetlands—with the remaining seasonal wetlands containing saturated soils for at least two consecutive weeks—in years with normal and greater rainfall.

Table 12. Seasonal Wetland Hydrology Performance Goals

Monitoring Year	Performance Goals
Applicable to All Years	During years of normal or greater rainfall, the majority of seasonal wetlands should be inundated for at least two consecutive weeks during the rainy season; these should generally be the same pools each year. The remaining seasonal wetlands should contain saturated soils for at least two consecutive weeks during the rainy season; these should generally be the same pools each year.

Vegetation and Invasive Plants

The performance goals presented here focus on the cover of invasive species, exclusive of non-native annual grasses, and the presence of wetland-adapted species (both native and non-native). It is expected that seasonal wetland habitats will contain a high percentage of non-native herbaceous species and, given the ample supply of weed seed sources in the surrounding areas, it is unlikely that these species will ever be fully eradicated. As such, the performance goals are be aimed at depleting the available seed bank, reducing cover of invasive weeds to a minimal level, and encouraging establishment of wetland-adapted species.

Table 13. Seasonal Wetland Vegetation and Invasive Plant Performance Goals

Monitoring Year	Performance Goals
Applicable to All Years	A. Cover of invasive species listed as “High” or “Moderate” by the Cal-IPC, exclusive of annual grasses, should remain low. B. The majority of plant cover, both native and non-native, should be composed of wetland-adapted species listed as facultative (“FAC”) or wetter on the National Wetland Plant List (Lichvar 2012).

4.7.3 Adaptive Management

The goal of seasonal wetland habitat restoration at Ballona is to increase the diversity of non-tidal wetland habitat available for wildlife use. Monitoring parameters and performance goals focus on wetland hydrology and a lack of highly invasive plant species. If it is determined that performance goals are not being met, overall trends in habitat development will be examined to determine whether corrective management actions are warranted. If trends are on track to meet long-term performance goals, no corrective management actions may be warranted and modification of the interim performance goals based on an improved understanding of seasonal wetland habitat development may be the most appropriate course of action. However, if it is determined that corrective management actions are appropriate, these may include alterations to hydrology through grading or modification of substrate characteristics (e.g., soil texture or compaction rates), more intensive weed management, or planting of appropriate native species.

4.8 Riparian Scrub and Woodland

Limited areas of riparian habitat currently exist at the BWER, and riparian habitat restoration is not a primary focus of the overall restoration effort. Some areas of existing riparian habitat will be preserved; however, a portion of existing low-quality riparian habitat may be converted to other habitat types. Riparian habitat restoration, monitoring parameters, performance goals, and management will focus primarily on sustaining high cover of riparian-associated species and low cover of highly invasive plant species. The goal of preserving the eucalyptus grove is to maintain the trees as viable roosting habitat for monarch butterfly and to prevent the spread of eucalyptus to other portions of the BWER. Long-term management of the eucalyptus grove will focus on eventually replacing the trees with native species suitable for monarch roosting.

In general, high diversity of riparian-associated plant species is the desired outcome of riparian habitat restoration; however, it is expected that establishing a diverse understory within the eucalyptus grove will be exceedingly difficult give the large amounts of litter deposited by these trees as well as allelopathic compounds potentially exuded into the soil. In addition, some native riparian species such as arroyo willow (*Salix lasiolepis*) tend to form dense, monotypic thickets, and although these areas may be low in plant diversity, they provide valuable habitat for riparian-associated wildlife species. Given the difficulty of maintaining a diverse understory in the eucalyptus grove and the tendency of riparian vegetation (i.e., willows) to form dense, monotypic stands, no specific performance goals for native plant composition, other than for invasive weeds, are included here. Instead, performance goals focus on attaining high levels of plant cover and low levels of invasive species (excluding the eucalyptus).

4.8.1 Monitoring

Monitoring of riparian habitats will focus on total canopy cover and composition, including the presence of invasive plant species listed as “High” or “Moderate” by the Cal-IPC (2013), exclusive of eucalyptus trees and non-native annual grasses. This monitoring will be quantitative in nature, with estimates of total cover by species and canopy layer. In addition, the location and extent of invasive weed populations will be documented. Monitoring for vegetation cover and composition will occur annually for the entire 10-year monitoring period. As with other habitats, it may be useful to monitor for invasive weeds twice annually (or more frequently), once near the beginning of the growing season and again during the annual vegetation monitoring to be conducted in mid- to late summer (or more frequently). In addition to the vegetation monitoring, the eucalyptus grove will be assessed for tree health by a qualified arborist every two to three years. These assessments will consist of general observations of tree health and recommendations for management actions, with the ultimate goal of replacing the trees with suitable native species. In addition, the overwintering monarch population will be quantitatively monitored on an annual basis to provide an estimate of the size of the overwintering population.

4.8.2 Performance Goals

Performance goals for riparian habitat restoration focus on maintaining the eucalyptus grove in healthy condition, providing viable roosting habitat for the overwintering monarch population, and maintaining high cover of riparian-associated species (outside of the eucalyptus grove) and low cover of invasive species listed as "High" or "Moderate" by the Cal-IPC (2013), exclusive of eucalyptus and non-native annual grasses.

Table 14. Riparian Vegetation and Invasive Plant Performance Goals

Monitoring Year	Performance Goals
1 – 3	**A.** Canopy cover of riparian-associated species (outside of areas occupied by eucalyptus trees) may be low, but vegetation should show signs of establishment and spread. Areas not occupied by eucalyptus trees should show signs of natural vegetation recruitment or should be planted with appropriate native species. **B.** Cover of invasive species listed as "High" or "Moderate" by the Cal-IPC, exclusive of the eucalyptus trees and non-native annual grasses, should remain low. Eucalyptus trees should not be allowed to expand beyond the baseline population size.
4 – 7	**A.** Canopy cover of riparian-associated species (outside of areas occupied by eucalyptus trees) should be relatively high, approaching 75% or greater by the end of Year 7 and should show signs of establishment and spread. **B.** Cover of invasive species listed as "High" or "Moderate" by the Cal-IPC, exclusive of the eucalyptus trees and non-native annual grasses, should remain low. Eucalyptus trees should not be allowed to expand beyond the baseline population size.

Table 14. Riparian Vegetation and Invasive Plant Performance Goals

Monitoring Year	Performance Goals
8 – 10	**A.** Canopy cover of riparian-associated species (outside of areas occupied by eucalyptus trees) should be nearly complete. **B.** Cover of invasive species listed as “High” or “Moderate” by the Cal-IPC, exclusive of the eucalyptus trees and non-native annual grasses, should remain low. Eucalyptus trees should not be allowed to expand beyond the baseline population size.

4.8.3 Adaptive Management

The goal of riparian habitat restoration at the BWER is to preserve existing riparian vegetation where possible, including maintaining and eventually replacing the eucalyptus grove in Area B, encouraging establishment and expansion of native riparian species, and maintaining low cover of invasive species in these areas. It is unclear at this point what restoration activities will occur in or adjacent to areas currently identified as riparian habitat; however, it is assumed that these restoration activities will be focused on planting or natural recruitment of appropriate riparian-associated native species and removal of any highly invasive species. It is expected that trends in vegetation establishment will be apparent within two to three years following the completion of initial restoration activities.

Management for riparian habitat will focus on attaining near complete cover of riparian-associated species and low levels of invasive species. In addition, the eucalyptus grove will be managed as needed to maintain the overwintering monarch population at existing or improved levels, but to prevent the spread of eucalyptus beyond its current extent and to eventually replace the eucalyptus with appropriate native species. In areas not occupied by eucalyptus trees, canopy cover will ideally consist of a combination of herbaceous plants, shrubs, and small trees. However, as noted above, some native riparian-associated species such as arroyo willow tend to form dense, monotypic stands with little to no understory vegetation—such stands provide valuable habitat for wildlife and are desirable despite having low plant diversity. In addition, it is expected that establishing understory vegetation in areas occupied by eucalyptus will be exceedingly difficult given the large amount of leaf litter, bark, and other debris dropped by these species—as such, no goals have been established for understory vegetation cover in these areas, and management should be focused on establishing native trees to replace the eucalyptus and preventing the spread of the eucalyptus and the establishment of other aggressive invaders.

Potential causes of poor vegetation establishment in areas not occupied by eucalyptus are likely to be related to water availability and physical and chemical properties of the soil. If it is determined that vegetation establishment does not demonstrate suitable progress toward meeting performance goals, studies will be conducted to determine the cause of the poor performance. Potential management actions include additional plantings, addition of temporary irrigation (if not already present), addition of slow-release fertilizers, or the addition of other soil amendments to alter soil physical or chemical properties. If it is determined that soil salinity is a cause of poor vegetation establishment, it may be necessary to modify the planting palette to include more salt-tolerant species.

As noted previously, the eucalyptus grove in Area B is being kept as roosting habitat for monarch butterflies. Although eucalyptus trees are tolerant of a wide range of soil and moisture conditions, there is potential for restoration activities to affect the growth of these trees, and it may be necessary to actively manage the trees to maintain the grove as viable roosting habitat for the monarchs. Any management will be conducted under the advisement of a certified arborist or a monarch expert, as appropriate. Large reductions in the size of the overwintering monarch population will be assessed against historical data from the site and observations of other regional (or wider-scale) trends in monarch population size to determine whether the drop in numbers is specific to the BWER or attributable to regional climate or other wide-scale factors. If the trends appear to be specific to the BWER, a monarch expert will be consulted to determine the potential causes and most appropriate management actions. Long-term management of the eucalyptus grove will focus on replacement of the trees with native trees suitable for monarch roosting.

4.9 Dune

Existing dune habitat at the BWER is composed of relict, stabilized dunes. Despite lacking many of the natural processes present in active dune systems, the dunes at the Reserve provide valuable habitat for a number of sensitive plant and wildlife species and are of great public interest. The goal of dune restoration at the BWER is to mimic conditions within the more stabilized (i.e., backdune) portions of a dune system such as the one at Ormond Beach in Ventura County. Given their removal from the active dune forming processes that occur in foredune habitat, conditions within the more stabilized portions of the dunes at Ormond Beach represent the range of conditions most likely to be achieved at the BWER. Performance goals are be based on the diversity of native dune-associated plant species present (see the potential planting palette included as Appendix A for a list of native plant species typically associated with dunes), total area of vegetation cover, and the absence of highly invasive species. Management actions will focus on maintaining the desired plant community cover and composition, reducing existing levels of invasive weeds, and preventing the establishment of new populations of invasive weeds. Currently, it is unclear whether new dune habitat will be created in addition to the existing dune habitat in the western portion of Area B and the southwestern portion of Area C. If new dune habitat is created, it may be necessary to create a revised set of monitoring protocols and performance goals to account for the different stages of development between the existing and created dune habitat.

4.9.1 Monitoring

Vegetation and Invasive Plants

The composition and cover of vegetation is the dominant characteristic feature of stabilized dune systems and will be the primary focus of monitoring. Monitoring will focus on measurements of plant species richness and cover and on the presence and extent of invasive plant species. General vegetation monitoring for dune habitat will be conducted on an annual basis during entire 10-year monitoring period. Monitoring will be conducted toward the end of the growing season after perennial plants have put on most of their annual growth. As with other habitats, it may be useful to monitor for invasive weeds twice annually (or more frequently), once near the beginning of the growing season and again during the annual vegetation monitoring to be conducted in mid- to late summer (or more frequently). Monitoring will be quantitative and will be conducted using a random sampling strategy or fixed transects. The monitoring scheme to be implemented will be similar to the vegetation monitoring conducted elsewhere in the Reserve. Monitoring will be designed to quantify (1) species richness, (2) vegetative cover, and (3) the presence and extent of invasive weeds. In conjunction with general quantitative vegetation monitoring, the entire extent of dune habitat will be qualitatively surveyed and the location and extent of invasive species rated as “High” or “Moderate” by the Cal-IPC, exclusive of annual grasses, will be documented on maps or aerial imagery. These data will be used to prioritize weed control efforts.

4.9.2 Performance Goals

Performance goals for dune habitat will be based on the diversity of native dune-associated plant species, the total area of vegetation cover, and the cover of invasive species. As noted above, if new dune habitat is to be created, it may be necessary to create a separate set of performance goals for the newly created dune habitat to account for differences in seral stages between created and existing dune habitat. Performance goals for any new dune habitat should be based on developing plant community composition and cover similar to that of the backdune habitat at Ormond Beach or another suitable reference dune system and on maintaining low cover of invasive species.

Table 15. Dune Vegetation and Invasive Plant Performance Goals

Monitoring Year	Performance Goals*
1 – 3	**A.** Total plant cover should be similar to that of other stabilized dunes in the region. Some portion of the dunes should remain unvegetated. **B.** The diversity of native dune-associated plant species should be similar to that of other stabilized dunes in the region. **C.** Existing populations of invasive species listed as “High” or “Moderate” by the Cal-IPC, exclusive of non-native annual grasses, should be significantly reduced during the early years of the restoration. Newly developed populations should not be allowed to become established.
4 – 7	**A.** Total plant cover should be similar to that of other stabilized dunes in the region. Some portion of the dunes should remain unvegetated. **B.** The diversity of native dune-associated plant species should be the same as or greater than that of other stabilized dunes in the region. **C.** Existing populations of invasive species listed as “High” or “Moderate” by the Cal-IPC, exclusive of non-native annual grasses, should be reduced to and maintained at minimal levels. Newly developed populations should not be allowed to become established.
8 – 10	**A.** Total plant cover should be similar to that of other stabilized dunes in the region. **B.** The diversity of native dune-associated plant species should exceed that of other stabilized dunes in the region. **C.** All populations of invasive species listed as “High” or “Moderate” by the Cal-IPC, exclusive of non-native annual grasses, should be reduced to and maintained at minimal levels.

* Performance goals presented here are based on restoration of existing dune habitat. If dune habitat is created, it may be necessary to create a separate set of performance goals specific to the created dune habitat.

4.9.3 Adaptive Management

The focus of dune restoration at the BWER is to provide habitat for unique plant and animal species, and given that these dune systems will lack the natural processes found in active dune systems, the focus of performance goals will be on the development of appropriate dune vegetation. Because much of the existing dune vegetation will be preserved, it is expected that restoration activities will focus on the removal of invasive species and subsequent planting of appropriate native plants. It is expected that trends in vegetation response to management activities will become apparent within two to three years following weed removal or planting.

If vegetation does not appear to be on a suitable trajectory toward meeting performance goals within two to three years following management activities, an assessment of long-term vegetation trends will be conducted to determine whether changes in management activities are warranted or whether performance goals should be modified based on an improved understanding of dune habitat development. If it is determined that trends in vegetation development are not on track to meet long-term performance goals, corrective management actions may be warranted, and an investigation into the causes of poor plant performance will be conducted. Potential corrective management actions may include the addition of slow-release fertilizer or other soil amendments, application of irrigation, more intensive weed management, or the use of sand stabilizing techniques such as installing sand fencing. Additional corrective management actions might include experimental seeding or planting techniques, trials to determine the best species for use in the dune restoration, or experimental methods of weed removal. Any such corrective management actions will be accompanied by monitoring designed to quantify and assess the outcomes.

4.10 Upland Scrub and Grassland

Within the context of the overall wetland restoration at the BWER, the goal of upland scrub and grassland habitat restoration is to create high-quality upland habitat to support tidal wetland functions. The primary support functions desired from upland habitat include (1) reducing overland flow rates, sediment loads, and contaminants for waters entering wetland habitat, (2) providing high quality nesting and high tide refuge areas for wildlife species, and (3) providing transition zones for sea level transgression. Monitoring and performance goals will focus on aspects related to the first two functions. The third function, providing transition zones for sea level transgression, will be achieved through the design process and should not require monitoring.

4.10.1 Monitoring

Monitoring of upland scrub and grassland habitats will include (1) measurements of total plant cover and plant diversity, (2) the location and cover of highly invasive species (i.e., Cal-IPC “High” or “Moderate” lists, exclusive of non-native annual grasses), and (3) use by a diversity of bird species for nesting, foraging, and other activities.

Vegetation and Invasive Plants

Vegetation monitoring will be conducted using a quantitative method (e.g., estimates of percent cover using quadrats) similar to that used to monitor vegetation elsewhere in the BWER. Monitoring will be designed to capture both the composition of vegetation and cover by individual plant species. Vegetation monitoring will commence near the end of the first full growing season following planting and will be conducted annually for the entire 10-year monitoring period. During annual vegetation monitoring, the location and extent of highly invasive weeds (i.e., plants on the Cal-IPC "High" or "Moderate" lists, exclusive of non-native annual grasses) will be documented on maps or aerial imagery. Whereas vegetation monitoring will be conducted over a limited area using a quantitative method, monitoring for invasive weeds will be conducted at a qualitative level, but will be conducted over the entire area of upland habitat. It may be useful to monitor for invasive weeds twice per year (or more frequently), once near the beginning of the growing season and again during the annual vegetation monitoring toward the end of the growing season (or more frequently). Because it will not be possible to eliminate propagule sources for non-native weeds which occur outside of the BWER, monitoring for invasive weeds will likely be required for the lifespan of the restoration.

Bird Abundance and Diversity

Monitoring for bird use of upland habitat will be conducted in conjunction with bird monitoring in other habitats at the BWER and will be consistent with the methods used elsewhere in the Reserve. Monitoring will be designed to capture (1) the abundance and species richness of birds observed using the upland habitat and (2) the activities in which the birds were engaged within the upland habitat (i.e., foraging, nesting, etc.).

Due to the large seasonal variation in bird migration and breeding patterns, monitoring for bird use of upland and transition habitats will be conducted at intervals throughout the year, with reduced monitoring during the summer breeding period to limit disturbance to breeding birds. Monitoring will be timed to occur during peak periods of bird activity. Because the ecological factors involved in bird use of upland habitat are based on a complex set of factors extending well beyond the limits of the BWER, this monitoring will be conducted every year during the 10-year monitoring period to capture the full range of variability and to compensate for stochastic events which may affect bird use in any given year.

4.10.2 Performance Goals

Performance goals for upland scrub and grassland habitats focus on (1) high cover and species richness of native plant species, (2) low cover of invasive plant species, and (3) use by a diversity of bird species.

Vegetation and Invasive Plants

Vegetation performance criteria presented here are aimed at documenting a steady increase in plant cover to meet the upland restoration objectives of providing erosion control, reducing overland flow rates and sediment and contaminant loads, and providing high quality habitat for use by wildlife species. The performance goals focus on the establishment of vegetative cover and a lack of highly invasive species. It is expected that upland habitats will contain a high percentage of non-native herbaceous species and, given the ample supply of weed seed sources in the surrounding areas, it is unlikely that these species will ever be fully controlled.

Table 16. Upland Scrub and Grassland Vegetation and Invasive Plant Performance Goals

Monitoring Year	Performance Goals
1 – 3	**A.** Canopy cover may be low, but vegetation should show signs of establishment and spread. **B.** Cover of invasive species listed as "High" or "Moderate" by the Cal-IPC, exclusive of annual grasses, should remain low.
4 – 7	**A.** Canopy cover should be relatively high, approaching 75% or greater by the end of Year 7, and should show signs of significant natural recruitment. **B.** Cover of invasive species listed as "High" or "Moderate" by the Cal-IPC, exclusive of annual grasses, should remain low.
8 – 10	**A.** Canopy cover should be nearly complete by the end of Year 10. **B.** Cover of invasive species listed as "High" or "Moderate" by the Cal-IPC, exclusive of annual grasses, should remain low.

Bird Abundance and Diversity

It is expected that many bird species will use upland scrub and grassland habitat, and although the primary wetland support function of the upland habitat is to provide high tide refuge for tidal marsh species, providing high quality habitat for non-aquatic birds is also an important function. The performance goals presented below are aimed at the presence of birds associated tidal marsh habitat as well as the presence of other birds using the habitat for foraging, roosting, and nesting—these birds may or may not be typically associated with tidal marsh habitat.

Table 17. Upland Scrub and Grassland Bird Performance Goals

Monitoring Year	Performance Goals
1 – 3	**A.** A variety of bird species should be observed foraging in the restored uplands, although the diversity and abundance of birds may be lower than observed prior to the restoration.
4 – 7	**A.** Species richness and abundance of birds should each be within pre-restoration levels and should be increasing with each successive year. **B.** Birds should be observed both foraging and demonstrating territorial behavior within the restored upland habitat.
8 – 10	**A.** Species richness and abundance of birds should each be greater than pre-restoration levels; however, annual increases may slow relative to increases observed in Years 4 – 7. **B.** Birds should be observed both foraging and demonstrating territorial behavior within the restored upland habitat.

4.10.3 Adaptive Management

The goal of upland habitat restoration at the BWER is to create high-quality habitat with support functions for tidal wetland habitat including reducing overland flow rates and sediment and contaminant loads, providing habitat for nesting and high tide refuge areas for wildlife species, and providing transition zones for sea level transgression. The primary focus of monitoring and performance goals for upland habitat is on the establishment of appropriate vegetation and use by wildlife species. It is expected that trends in the establishment of upland vegetation will be apparent within two to three years following planting or seeding. It is expected that trends in bird use may take somewhat longer to become apparent, on the order of three to five years.

If it is determined that trends in vegetation establishment or use by bird species are not on track to meet performance goals within the expected timeframe for trends to become apparent, an assessment of the overall trends in habitat development and use by wildlife will be conducted to determine whether the poor performance is specific to the BWER or occurs at a regional scale. If it is determined that the lack of progress toward meeting performance goals is specific to the BWER, the performance goals will be reevaluated in light of any improvements in our understanding of upland habitat development. If it is determined that the performance is not related to a deficiency in the performance goals, studies will be undertaken to determine the cause of the poor performance.

In terms of vegetation establishment, a lack of progress toward meeting performance goals is likely to be related to soil physical or chemical properties or moisture levels. Potential corrective management actions include additional plantings, installation of temporary irrigation (if not already present), addition of slow-release fertilizers, or addition of soil amendments to alter soil physical or chemical properties. Initial investigations indicate that salinity may be an issue in upland habitats. If it is determined that soil salinity is a cause of poor vegetation establishment, it may be necessary to modify the planting palette to include more salt-tolerant species (see the potential planting palette included as Appendix A). In terms of bird use of upland habitat, potential causes for a lack of progress toward meeting performance goals is likely to be related to vegetation composition or structure, the absence of suitable food sources, the presence of bird predators, or competition from non-native birds. Potential corrective management actions may include modifications vegetation structure or composition or management of predators or competing non-native birds.

4.11 Transition Zones

Although the habitats shown in Figure 4 are depicted with sharp boundaries between the adjacent habitats, in reality, each habitat will have a transition zone between it and the adjacent habitat. In some cases, these transition zones will be relatively narrow, such as the transition zone between tidal channels and tidal marsh habitat or the transition zone between seasonal wetland and upland grassland habitats. However, other transition zones are likely to be more broad, such as the transition zone between the high marsh and upland grassland and scrub habitats. In general, these transition zones will not be treated separately from their adjacent habitats, with one exception being the brackish marsh which represents a transition zone between saline and freshwater habitats. That said, it may be difficult to apply some performance goals to the transition zones, and in those cases, performance goals will be applied judiciously. In general, the focus of monitoring and assessments of performance in transition zones will be based on high levels of plant cover (if appropriate), low levels of invasive species, and low levels of problematic erosion or other disturbances.

4.12 Reserve-Wide Monitoring Elements

In addition to the habitat-specific monitoring parameters, a number of more general parameters will need to be monitored throughout the entire preserve. These parameters include erosion, public access, infrastructural conditions, litter, invasive species, and urban predators. Reserve-wide monitoring for these variables is discussed in the following sections. It may be most efficient to combine this monitoring with other elements of the monitoring program. Combining monitoring tasks will also help reduce disturbance to sensitive habitats or species at the BWER.

4.12.1 Erosion

Although erosion is likely to be more prevalent in certain habitats, it will be important to monitor for erosion throughout the BWER. Goals for erosion control will focus on preventing erosion and correcting any problematic erosion problems that do occur. Monitoring for erosion will occur on an annual basis, with particular emphasis during the rainy season. Monitoring will occur (1) within one month prior to the onset of seasonal rains and (2) on a monthly to bi-monthly basis following the onset of seasonal rains during the first several years of the restoration. The purpose of monitoring prior to the onset of seasonal rains is to document maintenance needs for existing erosion control measures as well as the need for any additional erosion control measures prior to the onset of the rainy season when erosion is expected to be greatest. The timing of this monitoring should be such that the land manager has sufficient time to perform maintenance or install additional controls prior to the onset of winter rains. The purpose of monthly monitoring during the rainy season is to document any areas of erosion and to identify the need for maintenance or additional control measures. Although these measures are useful for short-term erosion control during construction and the initial phases of vegetation establishment, long-term erosion control measures should be focused on the establishment of vegetative cover. Once vegetation communities have filled in sufficiently to reduce the potential for erosion, the frequency of monitoring may be reduced, but will occur no less than once per year during the entire 10-year monitoring period.

4.12.2 Public Access, Infrastructure, Litter

Public access at the BWER will be limited to roads, pedestrian trails, and designated public access areas such as picnic sites or wildlife viewing areas. Trash cans and recycling bins will be available throughout the BWER, and trash and other human debris will not be present in natural habitats. In addition, a trash boom will be installed within aquatic habitat to prevent the movement of trash to Ballona Creek. The surface of walkways and trails will be maintained in good, dry condition. Areas that flood or become muddy during the rainy season will be subject to seasonal closure or will be redesigned to prevent flooding. Trails will be free of large debris, and fencing and signage will be maintained in good condition. Social trails will not be present in any part of the Reserve. Given the relative ease of access to upland habitat relative to wetland habitat, human disturbance is likely to be a greater problem in upland habitat and will require regular monitoring and control.

Monitoring for these parameters may be qualitative in nature, but will occur over the full extent of the BWER, with particular focus in the upland areas and areas immediately adjacent to trails and other public access areas. During monitoring for human disturbance, the presence and extent of social trails, trash, and other debris will be documented on maps or aerial imagery. The condition of fencing, signage, and lighting will also be noted.

4.12.3 Invasive Species

Although monitoring for invasive plants is included in the monitoring program for individual habitats, it is included here to ensure that monitoring occurs throughout the Reserve. Monitoring for effectiveness of invasive weed control efforts will be conducted at least twice annually during the initial 10-year monitoring period, once near the beginning of the growing season and again during early to mid-summer. More frequent monitoring may desirable given sufficient funds. Thereafter, monitoring will be conducted indefinitely into the future, at intervals to be determined based on data collected during the initial 10 years of monitoring. It is likely that uplands and freshwater habitats will require greater management for invasive weeds than will tidal wetland and salt panne habitats, and monitoring should be conducted more frequently in these habitats. Monitoring may be qualitative in nature and should document the location and approximate size of populations of invasive weeds listed by the Cal-IPC as “Moderate” or “High”, exclusive of grasses and the eucalyptus grove in Area B. Although complete eradication is unlikely for many species, the goal of weed control efforts at the Reserve should be to minimize impacts from invasive species. Existing populations of highly invasive species will be controlled, to the extent feasible. New populations will be prevented from becoming established.

In addition to monitoring for invasive weeds, it may also be necessary to monitor for invasive wildlife species such as New Zealand mudsnail or American bullfrog (*Lithobates catesbeianus*). Although these species are not known to occur at the Reserve, there is potential for them to be introduced to the site. If these or other invasive wildlife species are observed at the site, a monitoring and eradication plan will be developed consistent with CDFW policies regarding such species.

4.12.4 Urban Predator Management

Given the urban setting in which the Reserve occurs, urban predators such as feral cats and raccoons are likely to pose significant threats to native wildlife in the Reserve. The presence of such urban predators may prevent the establishment of populations of wildlife species and will require control if wildlife performance goals are to be achieved. An urban predator monitoring and management plan will be developed in coordination with the CDFW. This plan will identify key areas for monitoring, trigger levels for management, and appropriate control methods. The plan will be administered by the CDFW or an appropriately licensed firm specializing in predator management.

4.12.5 Vector Control

Project proponents will work with the Los Angeles West County Vector Control District to ensure that vector concerns are addressed within the BWER. Any measures required to address vector concerns will be addressed in final plans.

4.13 Reporting

Timely reporting is a critical component of any monitoring and adaptive management program (Atkinson et al. 2004). Annual monitoring methods and results should be detailed in a report to be prepared for the SCC, the CDFW, the Corps, the Regional Water Quality Control Boards, and other interested parties. The exact content and formatting for monitoring reports will be informed by the CEQA/NEPA analysis and the regulatory permitting process. The annual monitoring report will present an analysis and discussion of the data collected over the previous year and will incorporate data and trends from previous years to create a complete picture of post-restoration habitat development. The analysis presented will be rigorous and detailed; however, the report should be written such that it can be understood by all parties involved in the restoration, whether they be technical experts or the general public.

In addition to the annual report, it may be necessary to produce brief monitoring memoranda for issues requiring rapid management decisions such as newly documented populations of invasive species, areas of severe erosion, or signs of human disturbance in sensitive habitats. The form of these brief reports will be developed in conjunction with the development of the HMMP.

4.14 Revisions to the Management Plan

Given the uncertainty involved in the development of many habitats at the Reserve, it may be necessary to modify the monitoring approach and performance goals presented here or those to be developed for the HMMP. Any modifications or additions to the monitoring approach or performance goals, or to the adaptive management program presented above will be supported by data collected at the BWER or the reference sites or from advances in our understanding of coastal habitat restoration. The triggers and process for implementing revisions to the management plan will be developed in coordination with the project design team and the CDFW and in conjunction with the development of the HMMP.

5.0 INFRASTRUCTURE PLANNING AND MANAGEMENT

The restoration and the long-term management of the BWER will require modifications to existing infrastructure and the addition of new infrastructure. The following sections outline the infrastructural requirements of both the restoration and the long-term management of the Reserve. This information is not intended to serve as a detailed analysis of the infrastructural requirements, but rather is intended to inform the development of a Property Analysis Record ("PAR") and an Operations and Maintenance Plan for the BWER. The PAR will be used to determine the funding required to conduct all of the proposed activities required for restoration, establishment, and long-term management.

5.1 Required Infrastructure for Restoration

A number of infrastructural elements may be required at the BWER in support of habitat restoration efforts. If on-site plant salvage and propagation is to occur, greenhouses and related facilities will be required. Multiple greenhouses may be required to provide space for the variety of plants needed for the restoration. Because of the infrastructural requirements for on-site plant salvage and propagation, it may be more cost-effective to outsource this work to a reputable native plant nursery or habitat restoration firm with plant propagation facilities. Temporary irrigation will be required in upland areas, transition zones, high marsh, and dune habitats where supplemental water will aid in the establishment of restoration plantings. Throughout the restoration, temporary staging areas will be required for plant and soil handling and other restoration-related tasks. In addition, temporary roads or travel ways will be required to transport restoration materials and equipment around the BWER; depending on the type of equipment to be used, these roads may require a surface treatment such as compacted gravel or geotextile fabric. It is likely that additional restoration-related infrastructural needs will be identified as the details of the restoration plan are developed.

5.2 Required Infrastructure for Long-Term Operations and Maintenance

5.2.1 Visitor Center

An interpretive visitor center is currently planned for development in Area C. The visitor center will serve as the public's main gateway to the BWER, providing educational resources on the functions and values of restored habitats and the importance of tidal wetland preservation. Plans for the visitor center are being developed by the project design team. Although the details of the visitor center have yet to be determined, it is clear that basic infrastructural elements will be necessary, including utilities, parking areas, pathways, fencing, and signage. Details on these elements will be provided in the project description for the visitor center.

5.2.2 Reserve Operations and Maintenance

The BWER will require long-term management and maintenance to ensure the success of restored habitats. Some of the major infrastructure required will likely include:

- Trails
- Gates
- Fencing
- Signage
- Interpretive panels
- Vehicles
- Maintenance workshop
- Machinery and hand tools

Other infrastructure, including a greenhouse to propagate plant material, may be required for successful operations and maintenance of the BWER and should be identified in the development of a long-term Operations and Maintenance Plan. The Operations and Maintenance Plan should provide detailed information on the planning, timing, and execution of yearly and periodic Reserve management tasks. The Plan should identify both up-front and on-going management tasks and the estimated costs of all tasks.

Following the preparation of a long-term Operations and Management Plan, a PAR will be performed to determine the financial requirements for managing and maintaining the BWER. All of the required management and maintenance needs of the Reserve identified in the Operations and Maintenance Plan will be analyzed in the PAR to determine the full cost of implementation.

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APPENDIX A

POTENTIAL PLANT PALETTE

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Appendix A. Potential plant palette for wetland and upland restoration areas in BWER. Plant nomenclature follows Baldwin et al. (2012).

Scientific Name	Common Name	Life form	Conservation Status*	Salt Marsh	Mud flat	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Low Transition	High Transition	Upland	Grass	Scrub	Dune	Seasonal Wetland	Freshwater / Brackish	Salt Tolerant	Landscape Suitable	Historically at BWER
Abronia latifolia	Sand verbena	Perennial forb										x			x					
Abronia maritima	Red sand verbena	Perennial forb	Rank 4								x	x			x			x		x
Abronia umbellata	Pink sand verbena	Perennial forb									x	x			x			x		x
Abronia villosa	Villose abronia	Annual herb										x			x			x		x
Acer macrophyllum	Big leaf maple	Tree										x	x						x	
Acer negundo	Boxelder	Tree										x					x		x	
Achillea millefolium	Common yarrow	Perennial forb									x	x	x	x					x	
Acmispon americanus	Spanish clover	Annual herb																		x
Acmispon argophyllus	Silver birds foot trefoil	Perennial herb										x	x	x						
Acmispon argyraeus	Canyon birdsfoot trefoil	Perennial herb										x	x	x						
Acmispon brachycarpus	Short podded lotus	Annual herb										x	x	x	x					
Acmispon dendroideus	Island broom	Shrub										x	x	x						
Acmispon glaber	Deerweed	Perennial shrub									x	x	x	x	x			x		x
Acmispon maritimus	Coastal lotus	Annual herb										x		x						
Acmispon strigosus	Strigose lotus	Annual herb										x	x	x	x					x
Adenostoma fasciculatum	Chamise	Perennial shrub										x								x
Agrostis exarata	Spike redtop	Perennial herb															x			
Alnus rhombifolia	White alder	Tree															x		x	
Amaranthus californicus	California amaranth	Annual herb															x			x
Amblyopappus pusillus	Dwarf coastweed	Annual herb																x		

Scientific Name	Common Name	Life form	Conservation Status*	Salt Marsh	Mud flat	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Low Transition	High Transition	Upland	Grass	Scrub	Dune	Seasonal Wetland	Freshwater / Brackish	Salt Tolerant	Landscape Suitable	Historically at BWER
Ambrosia acanthicarpa	Annual bursage	Annual herb										x	x	x						x
Ambrosia chamissonis	Beach bur-sage	Perennial herb										x			x					x
Ambrosia psilostachya	Western ragweed	Perennial forb										x	x		x		x			x
Ammannia robusta	Grand redstem	Annual herb															x			
Amsinckia spectabilis	Seaside fiddleneck	Annual herb													x			x		
Anemopsis californica	Yerba mansa	Perennial herb																	x	x
Arenaria paludicola	Marsh sandwort	Perennial herb	FE, SE, Rank 1B	x		x	x	x									x	x	x	
Artemisia californica	California sage brush	Evergreen shrub										x		x	x			x	x	x
Artemisia douglasiana	Douglas' mugwort	Perennial forb									x									x
Artemisia dracunculus	Wild tarragon	Perennial forb									x	x		x					x	x
Artemisia palmeri	San Diego sage	Shrub	Rank 4									x	x	x				x		
Arthrocnemum subterminale	Parish's pickleweed	Perennial forb x		x			x											x		x
Asclepias fascicularis	Narrow leaf milkweed	Perennial forb										x	x				x		x	
Astragalus pycnostachyus	Marsh milk vetch	Perennial herb		x														x		
Astragalus pycnostachyus var. lanosissimus	Ventura marsh milk vetch	Perennial forb	FE, SE, Rank 1B	x				x	x	x							x	x		
Astragalus tener	Alkali milk vetch	Annual herb									x	x	x		x	x	x	x		
Astragalus tener var. titi	Coastal dunes milk vetch	Annual forb	FE, SE, Rank 1B						x	x	x			x	x		x	x		
Astragalus trichopodus	Milk vetch	Perennial forb											x					x		x
Atriplex californica	California saltbush	Perennial								x	x							x		x

Scientific Name	Common Name	Life form	Conservation Status*	Salt Marsh	Mud flat	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Low Transition	High Transition	Upland	Grass	Scrub	Dune	Seasonal Wetland	Freshwater / Brackish	Salt Tolerant	Landscape Suitable	Historically at BWER
		forb																		
Atriplex canescens	Fourwing saltbush	Perennial shrub												x				x		
Atriplex lentiformis	Large saltbush	Evergreen shrub									x	x	x	x				x		x
Atriplex pacifica	Pacific saltbush	Annual forb	Rank 1B											x	x					
Atriplex parryi	Parry'ss saltbush	Shrub										x		x		x	x	x	x	
Atriplex patula	Spear saltbush	Annual forb						x		x								x		x
Atriplex watsonii	Watson's saltbush	Perennial forb					x	x		x								x		
Baccharis glutinosa	Saltmarsh baccharis	Perennial forb								x								x		
Baccharis pilularis	Coyote brush	Evergreen shrub									x	x		x	x					x
Baccharis salicifolia	Mule fat	Evergreen shrub												x		x		x		x
Baccharis sarothroides	Broom baccharis	Perennial shrub												x				x		
Batis maritima	Saltwort	Evergreen shrub		x			x	x	x	x								x		
Bistorta bistortoides	American bistort	Perennial forb														x	x			
Bolboschoenus maritimus	Alkali bulrush	Perennial graminoid		x	x	x										x	x			x
Bolboschoenus maritimus subsp. paludosus	Saltmarsh bulrush	Perennial graminoid														x	x	x		
Bolboschoenus robustus	Robust bulrush	Perennial graminoid		x				x			x						x	x		x
Brickellia californica	California brickelbush	Perennial forb									x			x				x		x
Bromus arizonicus	Arizona brome	Annual graminoid										x	x							
Bromus carinatus	California brome	Annual graminoid																x		x
Bromus grandis	Tall brome	Perennial herb										x	x	x						
Bromus maritimus	Maritime brome	Perennial herb										x	x		x					

Scientific Name	Common Name	Life form	Conservation Status*	Salt Marsh	Mud flat	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Low Transition	High Transition	Upland	Grass	Scrub	Dune	Seasonal Wetland	Freshwater / Brackish	Salt Tolerant	Landscape Suitable	Historically at BWER
Calystegia macrostegia	Southern California morning glory	Perennial vine									x	x		x						x
Calystegia sepium	Hedge bindweed	Perennial herb		x												x	x	x		
Calystegia soldanella	Beach morning glory	Perennial herb									x	x		x						
Camissoniopsis bistorta	California sun cup	Annual herb									x	x		x						x
Camissoniopsis cheiranthifolia	Beach evening primrose	Perennial forb										x	x	x	x			x		x
Camissoniopsis cheiranthifolia subsp. suffruticosa	Shrubby beach primrose	Perennial herb										x	x		x				x	x
Camissoniopsis lewisii	Lewis' evening primrose	Annual forb	Rank 3									x			x					x
Camissoniopsis micrantha	Spencer primrose	Annual herb										x	x		x				x	x
Carex barbarae	Santa Barbara sedge	Perennial graminoid									x	x	x	x		x		x	x	
Carex praegracilis	Clustered field sedge	Perennial graminoid														x	X		x	
Carex spissa	San Diego sedge	Perennial graminoid															X		x	
Caulanthus lasiophyllus	California mustard	Annual herb										x	x	x						x
Centromadia parryi ssp. australis	Southern tarplant	Annual forb	Rank 1B									x	x	x		x		x	x	x
Chaenactis glabriuscula	Common yellow pincushion	Annual forb										x	x	x	x					x
Chaenactis glabriuscula var. glabriuscula	Common yellow pincushion	Annual forb										x	x	x	x					x
Chaenactis glabriuscula var. orcuttiana	Orcutt's yellow pincushion	Annual forb	Rank 1B									x	x	x	x					x
Chamerion angustifolium	Fireweed	Perennial forb										x		x			x			
Chenopodium berlandieri	Pitseed goosefoot	Annual forb										x							x	x
Chloropyron maritimum	Salt-marsh bird's beak	Annual herb		x								x			x			x		x
Chloropyron	Salt-marsh bird's beak	Annual	FE,	x								x			x			x		

Scientific Name	Common Name	Life form	Conservation Status*	Salt Marsh	Mud flat	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Low Transition	High Transition	Upland	Grass	Scrub	Dune	Seasonal Wetland	Freshwater / Brackish	Salt Tolerant	Landscape Suitable	Historically at BWER
maritimum ssp. maritimum		herb	SE, Rank 1B																	
Clarkia purpurea	Winecup Clarkia	Annual herb										x	x	x						
Clematis ligusticifolia	Western white clematis	Vine / perennial forb										x					x			x
Corethrogyne filaginifolia	Common sandaster	Perennial forb									x	x		x						x
Cornus glabrata	Brown twig dogwood	Tree/ shrub										x	x				x			
Cornus sericea	American dogwood	Shrub															x		x	
Cornus sericea ssp. sericea	Creek dogwood	Shrub															x		x	
Crassula aquatica	Aquatic pygmyweed	Annual forb										x	x				x			
Crassula connata	Sand pygmyweed	Annual forb										x	x	x	x		x			x
Cressa truxillensis	Spreading alkali weed	Perennial forb x		x			x						x			x		x		x
Croton californicus	California croton	Perennial forb									x	x	x	x	x			x		x
Croton setiger	Dove weed	Annual forb										x	x	x						
Cryptantha intermedia	Clearwater cryptantha	Annual forb										x		x						x
Cucurbita foetidissima	Missouri gourd	Vine / perennial forb										x	x	x	x					x
Cuscuta californica	California dodder	Parasitic vine										x	x	x						x
Cuscuta campestris	Field dodder	Parasitic vine										x	x	x	x					x
Cuscuta indecora	Large-seeded dodder	Parasitic vine										x	x			x	x			x
Cuscuta salina	Saltmarsh dodder	Parasitic vine		x			x	x		x										x
Cylindropuntia prolifera	Coastal cholla cactus	Succulent shrub										x		x						
Cyperus eragrostis	Tall flatsedge	Perennial forb										x					x			x
Cyperus erythrorhizos	Red rooted cyperus	Annual forb															x			

Scientific Name	Common Name	Life form	Conservation Status*	Salt Marsh	Mud flat	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Low Transition	High Transition	Upland	Grass	Scrub	Dune	Seasonal Wetland	Freshwater / Brackish	Salt Tolerant	Landscape Suitable	Historically at BWER
Cyperus esculentus	Yellow nutgrass	Perennial forb										x					x			x
Cyperus laevigatus	Smooth cyperus	Perennial forb										x		x			x			
Cyperus niger	Black cyperus	Perennial forb										x		x			x			
Cyperus parishii	Parish's flatsedge	Perennial forb										x		x			x			
Cyperus squarrosus	Awned cyperus	Annual forb															x			
Datura wrightii	Jimsonweed	Perennial forb										x	x	x						x
Deinandra fasciculata	Clustered tarweed	Annual forb										x	x	x						x
Deinandra kelloggii	Kellog's tarweed	Annual forb										x	x							
Deinandra paniculata	Paniculate tarplant	Annual forb	Rank 4									x	x	x					x	x
Dichondra occidentalis	Western dichondra	Perennial forb	Rank 4									x	x	x						x
Distichlis littoralis	Shore grass x	Perennial graminoid		x				x										x		
Distichlis spicata	Spiked saltgrass	Perennial graminoid		x			x	x		x								x		x
Dudleya caespitosa	Sand lettuce	Perennial succulent										x	x	x	x				x	
Dudleya lanceolata	Southern California dudleya	Perennial succulent										x		x						
Dudleya palmeri	Palmer's dudleya	Perennial succulent										x		x						
Dudleya pulverulenta	Chalk dudleya	Perennial succulent										x		x					x	
Dudleya virens	Bright green dudleya	Perennial succulent										x		x						
Eleocharis coloradoensis	Rush	Perennial graminoid		x			x	x		x	x					x	x	x	x	
Eleocharis macrostachya	Longstem spike-rush	Perennial graminoid		x			x	x		x	x						x	x		x
Eleocharis montevidensis	Montevideo spike-rush	Perennial graminoid															x			x
Elymus condensatus	Giant rye grass	Perennial graminoid										x	x	x					x	x
Elymus triticoides	Creeping wild rye	Perennial									x	x	x			x		x		

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		graminoid																		
Encelia californica	California brittlebush	Shrub										x	x	x	x				x	x
Encelia farinosa	Brittlebush	Shrub										x		x						
Epilobium brachycarpum	Annual fireweed	Annual forb										x	x							
Epilobium campestre	Smooth boisduvalia	Annual forb										x	x	x			x			
Epilobium canum	California fuschia	Perennial forb										x		x						
Epilobium ciliatum	Fringed willow herb	Perennial forb										x	x	x			x			x
Epilobium densiflorum	Dense flowered spike primrose	Annual forb										x	x	x						
Epipactis gigantea	Stream orchid	Perennial forb															x			
Equisetum telmateia ssp. braunii	Giant horsetail	Fern															x			
Ericameria arborescens	Golden fleece	Shrub										x		x					x	
Ericameria ericoides	California goldenbush	Shrub										x		x	x			x		x
Ericameria palmeri	Palmer's goldenweed	Shrub										x		x						
Ericameria pinifolia	Pine bush	Shrub										x		x						x
Erigeron canadensis	Canadian horseweed	Annual herb										x								x
Eriodictyon trichocalyx	Yerba santa	Shrub										x		x					x	
Eriogonum cinereum	Coast ashyleaf buckwheat	Shrub									x	x		x					x	
Eriogonum elongatum	Longstem buckwheat	Perennial forb										x		x						
Eriogonum fasciculatum	California buckwheat	Shrub												x	x					x
Eriogonum giganteum	St. Catherine's lace	Shrub										x		x						
Eriogonum gracile	Slender buckwheat	Annual graminoid										x	x	x						x
Eriogonum gracillimum	Rose and white buckwheat	Annual forb										x	x	x						
Eriogonum grande	Island buckwheat	Perennial forb										x		x						

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Eriogonum nudum	Nude buckwheat	Shrub										x	x	x						
Eriogonum parvifolium	Dune buckwheat	Shrub										x		x	x				x	x
Eriogonum viridescens	Bright green buckwheat	Annual forb										x	x	x						
Eriophyllum confertiflorum	Golden yarrow	Shrub										x		x					x	
Eryngium aristulatum	California eryngo	Perennial herb														x				
Erysimum capitatum var. capitatum	Sand dune wallflower	Perennial herb									x	x		x						
Erysimum suffrutescens	Suffrutescent wallflower	Perennial forb	Rank 4									x			x					x
Eschscholzia californica	California poppy	Annual/perennial herb										x			x			x	x	x
Euphorbia albomarginata	Rattlesnake weed	Perennial forb										x	x	x						x
Euphorbia crenulata	Chinese caps	Annual/perennial herb										x	x	x						
Euphorbia melanadenia	Spurge	Perennial forb										x								
Euphorbia polycarpa	Small-seeded spurge	Perennial forb										x		x						x
Euphorbia serpens	Creeping spurge	Annual forb															x			
Euthamia occidentalis	Western goldenrod	Perennial forb		x				x		x								x		
Festuca californica	California fescue	Perennial herb										x	x							
Festuca microstachys	Small fescue	Annual herb										x	x	x				x		
Festuca octoflora	Sixweeks grass	Perennial graminoid										x	x							
Festuca rubra	Red fescue	Perennial graminoid										x	x							
Frangula californica	California coffeeberry	Shrub										x								
Frankenia salina	Alkali heath	Perennial forb		x			x	x	x	x	x							x		x
Fraxinus velutina	Velvet Arizona ash	Tree										x								x
Galium angustifolium	Narrow-leaved bedstraw	Perennial herb																		x

Scientific Name	Common Name	Life form	Conservation Status*	Salt Marsh	Mud flat	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Low Transition	High Transition	Upland	Grass	Scrub	Dune	Seasonal Wetland	Freshwater / Brackish	Salt Tolerant	Landscape Suitable	Historically at BWER
Gambelia speciosa	Island snapdragon	Shrub										x		x					x	
Gnaphalium palustre	Western marsh cudweed	Annual herb										x	x			x	x			x
Grindelia camporum	Common gum plant	Perennial herb											x							x
Grindelia hirsutula	Gumweed	Perennial herb												x						
Grindelia stricta	Coastal gumweed	Perennial herb		x																
Hazardia squarrosa	Saw-toothed hazardia	Perennial shrub											x	x				x		
Helianthus annuus	Common annual sunflower	Annual herb										x	x	x					x	x
Heliotropium curassavicum	Seaside heliotrope	Perennial forb		x				x	x	x								x		x
Hesperoyucca whipplei	Whipple's yucca	Shrub										x		x						
Heteromeles arbutifolia	Toyon	Evergreen shrub											x	x						x
Heterotheca grandiflora	Telegraph weed	Annual/perennial forb										x		x						x
Heterotheca sessiliflora	Golden aster	Annual/perennial forb										x	x	x						
Heterotheca villosa	Villous golden-aste	Perennial forb										x		x			x			x
Hoffmannseggia glauca	Waxy hoffmannseggia	Perennial forb														x		x		x
Hordeum brachyantherum	Meadow barley	Perennial graminoid									x	x	x			x	x	x		
Hordeum brachyantherum ssp. californicum	California barley	Perennial graminoid										x	x	x		x	x			
Hordeum depressum	Alkali barley	Annual graminoid								x	x	x	x			x		x		x
Hordeum intercedens	Bobtail barley	Annual graminoid	Rank 3									x	x			x	x			
Hordeum jubatum	Fox tail barley	Perennial graminoid										x				x	x			
Hypericum anagalloides	Tinker's penny	Annual/perennial herb														x	x	x		
Isocoma menziesii	White flowered	Shrub										x			x					x

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	goldenbush																			
Isocoma menziesii var. vernonioides	Coastal goldenbush	Shrub									x	x	x	x	x	x	x	x		
Isolepis cernua	Low bulrush	Annual graminoid					x									x		x		
Isomeris arborea	Bladder pod	Perennial shrub										x		x				x		
Iva axillaris	Poverty weed	Perennial forb		x					x		x	x	x					x		
Jaumea carnosa	Fleshy jaumea	Perennial forb		x	x	x	x										x	x		x
Juglans californica	California black walnut	Tree	Rank 4									x								
Juncus acutus	Spiny rush	Perennial graminoid		x	x	x	x									x	x	x		x
Juncus acutus ssp. leopoldii	Spiny rush	Perennial graminoid	Rank 4							x						x	x	x		x
Juncus ambiguus	Saline toad rush	Perennial graminoid														x	x			
Juncus balticus	Baltic rush	Perennial graminoid		x	x	x	x			x						x	x	x		x
Juncus bufonius	Common toad-rush	Annual graminoid						x	x	x						x	x	x		x
Juncus bufonius var. *occidentalis*	Western toad rush	Perennial graminoid														x	x			x
Juncus effusus	Common bog rush	Perennial graminoid		x		x	x	x		x	x					x	x	x		
Juncus macrophyllus	Longleaf rush	Perennial graminoid														x	x			
Juncus mexicanus	Mexican rush	Perennial graminoid		x	x	x	x	x		x						x	x	x	x	x
Juncus patens	Common rush	Perennial graminoid														x	x	x	x	
Juncus textilis	Basket rush	Perennial graminoid										x		x					x	
Juncus xiphioides	Iris leaved rush	Perennial graminoid														x	x		x	
Laennecia coulteri	Coulter's horseweed	Annual herb														x	x	x		x
Lasthenia glabrata	Yellow ray goldfields	Annual herb									x	x			x	x		x		

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Scientific Name	Common Name	Life form	Conservation Status*	Salt Marsh	Mud flat	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Low Transition	High Transition	Upland	Grass	Scrub	Dune	Seasonal Wetland	Freshwater / Brackish	Salt Tolerant	Landscape Suitable	Historically at BWER
Lasthenia glabrata var. coulteri	Coulter's goldfields	Annual forb							x							x				
Layia platyglossa	Common tidy tips	Annual forb										x	x	x		x			x	
Lepidium virginicum ssp. menziesii	Robinson's pepper grass	Annual forb										x	x	x						x
Leptochloa fusca ssp. uninervia	Mexican sprangle top											x	x	x		x				x
Leptosyne gigantea	Giant coreopsis	Shrub										x		x						
Lilium humboldtii	Humboldt's lily	Perennial herb										x		x					x	
Limonium californicum	Sea lavender	Perennial forb		x			x	x		x	x	x				x	x	x		x
Lupinus arboreus	Coastal bush lupine	Shrub										x		x	x				x	
Lupinus bicolor	Bicolored lupine	Annual/perennial herb																x	x	x
Lupinus chamissonis	Coastal bush lupine	Evergreen shrub									x	x		x					x	x
Lupinus excubitus var. hallii	Hall's bush lupine	Shrub										x		x					x	x
Lupinus latifolius	Broadleaf lupine	Perennial herb															x		x	
Lupinus longifolius	Longleaf bush lupine	Shrub										x		x					x	x
Lupinus succulentus	Arroyo lupine	Annual herb										x	x						x	x
Lupinus truncatus	Truncate-leaved lupine	Annual herb										x	x	x					x	x
Lycium californicum	California boxthorn	Shrub								x	x	x		x				x		
Malacothamnus fasciculatus	Bushmallow	Shrub										x		x				x		x
Malacothrix saxatilis	Cliff aster	Perennial forb									x	x		x						x
Malosma laurina	Laurel sumac	Tree / shrub										x		x						x
Malvella leprosa	Alkali mallow	Perennial forb										x	x	x		x	x			x
Melica imperfecta	Small-flowered melic grass	Perennial graminoid										x	x	x						x
Mimulus aurantiacus	Sticky monkeyflower	Shrub										x	x	x					x	

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Mimulus cardinalis	Scarlet monkeyflower	Perennial herb														x	x		x	
Mimulus guttatus	Common yellow monkeyflower	Annual/perennial herb														x	x		x	
Mimulus latidens	Broad toothed monkeyflower	Annual herb										x	x			x	x		x	
Mimulus moschatus	Musk monkeyflower	Perennial herb														x	x		x	
Mimulus pilosus	Downy monkeyflower	Annual herb										x					x		x	
Muhlenbergia rigens	Deergrass	Perennial herb										x	x						x	
Nemophila maculata	Five spot	Annual forb										x	x							
Nemophila menziesii	Baby blue eyes	Seasonal wildflower										x	x	x					x	
Nemophila pedunculata	Meadowfoot nemophilia	Annual forb										x	x			x	x			
Oenothera elata	Hooker's evening primrose	Perennial forb										x	x		x	x	x	x		
Oenothera elata ssp. hirsutissima	Hairy evening primrose	Perennial forb														x	x			x
Oenothera elata ssp. hookeri	Common evening primrose	Perennial forb										x		x	x	x	x			x
Opuntia basilaris	Beavertail cactus	Succulent shrub										x		x					x	
Opuntia littoralis	Coastal prickly pear	Succulent shrub										x		x					x	x
Paspalum distichum	Knot grass	Perennial herb					x	x		x		x	x			x	x	x		
Penstemon centranthifolius	Scarlet bugler	Perennial forb										x								
Penstemon heterophyllus	Foothill penstemon	Perennial forb										x								
Penstemon spectabilis	Showy penstemon	Perennial forb										x							x	
Persicaria hydropiperoides	Water pepper	Perennial forb														x	x			
Persicaria lapathifolia	Willow weed	Annual forb										x	x	x		x	x			x
Persicaria punctata	Dotted smartweed	Perennial forb														x	x			

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Petunia parviflora	Wild petunia	Annual forb										x	x			x	x			x
Phacelia brachyloba	Short lobed phacelia	Annual forb										x		x						
Phacelia cicutaria	Caterpillar phacelia	Annual forb										x	x	x						
Phacelia distans	Common phacelia	Annual forb										x	x							
Phacelia douglasii	Douglas' phacelia	Annual forb										x	x	x						
Phacelia fremontii	Fremont's phacelia	Annual forb										x	x	x						
Phacelia minor	California bluebell	Annual forb										x		x						
Phacelia ramosissima	Branching phacelia	Perennial forb									x	x	x	x	x			x		x
Phacelia stellaris	Star phacelia	Annual forb	Rank 1B								x	x		x						
Phyla lanceolata	Lance leaf lippia	Perennial forb									x	x	x			x	x			
Phyla nodiflora	Common lippia	Perennial forb														x	x		x	
Plantago erecta	Foothill plantain	Annual forb										x	x	x						
Plantago subnuda	Tall coastal plantain	Perennial herb														x	x			
Platanus racemosa	Western sycamore	Deciduous tree										x		x		x				
Pluchea odorata	Marsh fleabane	Perennial forb						x		x								x		
Poa secunda	Pine bluegrass	Perennial herb										x	x							
Populus fremontii	Fremont cottonwood	Deciduous tree												x		x				x
Potentilla anserina subsp. pacifica	Silverweed	Perennial forb					x	x		x								x		
Prunus ilicifolia ssp. ilicifolia	Holly-leaf cherry	Tree/ shrub										x		x					x	
Pseudognaphalium beneolens	Cudweed	Perennial forb										x	x	x	x					x
Pseudognaphalium biolettii	Two-color rabbit-tobacco	Perennial herb										x	x	x	x					
Pseudognaphalium californicum	Ladies' tobacco	Annual/perennial herb										x	x	x						x
Pseudognaphalium	Wright's cudweed	Perennial										x			x					x

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microcephalum		herb																		
Pseudognaphalium ramosissimum	Pink cudweed	Biennial herb										x	x	x	x					x
Pseudognaphalium stramineum	Cottonbatting plant	Perennial herb										x	x	x	x					x
Quercus agrifolia	Coast live oak	Tree										x								x
Quercus berberidifolia	Scrub oak	Tree										x		x						
Rhamnus ilicifolia	Hollyleaf redberry	Shrub										x		x					x	
Rhus aromatica	Skunkbush	Shrub										x								
Rhus integrifolia	Lemonade berry	Shrub										x		x					x	
Rhus ovata	Sugar bush	Shrub																		x
Ribes aureum	Golden currant	Shrub										x							x	
Ribes californicum	California gooseberry	Shrub										x							x	
Ribes malvaceum	Chaparral currant	Shrub										x		x					x	x
Ribes speciosum	Fuchsia flowering gooseberry	Shrub										x							x	
Rosa californica	California wild rose	Shrub									x	x	x	x				x	x	x
Rubus ursinus	California blackberry	Vine										x								
Rumex californicus	California dock	Perennial herb														x	x	x		
Rumex crassus	Willow leaved dock	Perennial herb										x			x		x			
Rumex fueginus	Golden dock	Annual/perennial herb														x	x	x		x
Rumex persicarioides	Dock	Annual/perennial herb						x				x			x			x		
Rumex salicifolius	Willow dock	Perennial herb								x		x	x			x		x		x
Ruppia cirrhosa	Spiral ditch grass	Perennial herb			x												x	x		
Ruppia maritima	Ditch grass	Perennial herb			x												x	x		x
Sagittaria montevidensis	Giant arrowhead	Perennial herb															x			
Sagittaria	Montevideo	Perennial															x			x

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montevidensis subsp. calycina	arrowhead	herb																		
Salicornia bigelovii	Annual pickleweed	Annual forb		x			x	x	x									x		
Salicornia depressa	Virginia glasswort	Annual herb		x												x		x		
Salicornia pacifica	Common pickleweed	Perennial forb x		x			x											x		x
Salix exigua	Narrow-leaved willow	Deciduous shrub										x				x				
Salix gooddingii	Black willow	Tree															x			x
Salix laevigata	Red willow	Tree															x	x		x
Salix lasiolepis	Arroyo willow	Deciduous shrub														x				x
Salix melanopsis	Dusky willow	Tree / shrub															x			
Salvia apiana	White sage	Perennial shrub										x		x				x	x	
Salvia leucophylla	Purple sage	Shrub										x		x					x	
Salvia mellifera	Black sage	Perennial shrub										x		x				x	x	
Salvia spathacea	Hummingbird sage	Perennial herb										x					x	x	x	
Sambucus nigra	Black elderberry	Deciduous shrub												x		x			x	
Sambucus nigra subsp. caerulea	Blue elderberry	Shrub										x							x	
Sambucus nigra subsp. canadensis	Blue elderberry	Shrub										x							x	
Schoenoplectus acutus	Hard stem bulrush	Perennial herb		x	x	x										x	x			
Schoenoplectus americanus	Chairmaker's bulrush	Perennial herb														x	x			x
Schoenoplectus californicus	California tule	Perennial graminoid		x	x	x										x	x	x		x
Scirpus californicus	California bulrush	Perennial herb		x							x						x	x		
Sesuvium verrucosum	Western sea-purslane	Perennial herb										x	x	x		x	x			x
Setaria parviflora	Bristlegrass	Perennial										x	x	x						x

Scientific Name	Common Name	Life form	Conservation Status*	Salt Marsh	Mud flat	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Low Transition	High Transition	Upland	Grass	Scrub	Dune	Seasonal Wetland	Freshwater / Brackish	Salt Tolerant	Landscape Suitable	Historically at BWER
		graminoid																		
Silene laciniata	Mexican silene	Perennial forb										x		x						
Sisyrinchium bellum	Western blue-eyed grass	Perennial graminoid										x	x						x	
Solanum americanum	American black nightshade	Annual/perennial forb															x			x
Solanum douglasii	Douglas's nightshade	Perennial forb										x		x	x	x	x			x
Solanum umbelliferum	Blue witch	Shrub										x	x	x						
Solanum xanti	Nightshade	Shrub / perennial forb										x		x						x
Solidago velutina subsp. californica	California goldenrod	Perennial herb									x	x	x	x						x
Spartina foliosa	Cordgrass	Perennial graminoid		x	x	x												x		
Spergularia macrotheca	Sticky sand spurry	Perennial herb		x				x		x		x		x			x			x
Spergularia marina	Salt marsh sand spurry	Perennial herb		x				x		x					x		x			x
Stephanomeria exigua	Small wire lettuce	Annual forb										x		x						x
Stephanomeria virgata	Tall stephanomeria	Annual forb										x	x	x						x
Stipa cernua	Nodding needlegrass	Perennial graminoid										x	x	x						x
Stipa coronata	Crested needlegrass	Perennial graminoid										x	x	x						
Stipa lepida	Foothill needle grass	Perennial graminoid										x	x	x						
Stipa pulchra	Purple needle grass	Perennial graminoid										x	x	x					x	
Suaeda calceoliformis	Horned sea blite	Annual herb														x		x		x
Suaeda californica	California sea blite	Shrub		x													x	x		
Suaeda esteroa	Estuary sea-blite	Perennial x forb		x			x											x		x
Suaeda nigra	Seepweed	Perennial forb								x	x					x		x		

Scientific Name	Common Name	Life form	Conservation Status*	Salt Marsh	Mud flat	Low Marsh	Mid Marsh	High Marsh	Salt Pan	Low Transition	High Transition	Upland	Grass	Scrub	Dune	Seasonal Wetland	Freshwater / Brackish	Salt Tolerant	Landscape Suitable	Historically at BWER
Suaeda taxifolia	Woolly seablite	Evergreen shrub		x				x	x	x		x	x		x	x		x		x
Symphoricarpos albus	Common snowberry	Shrub										x							x	
Symphoricarpos mollis	Trailing snowberry	Shrub										x							x	
Symphyotrichum subulatum	Annual saltmarsh aster	Annual herb		x				x										x		
Thalictrum fendleri var. polycarpum	Fendler's meadow rue	Perennial forb										x							x	
Trichostema lanatum	Woolly bluecurls	Shrub										x		x					x	
Triglochin concinna	Arrow grass	Perennial herb		x	x	x	x	x									x	x		
Triglochin maritima	Seaside arrow grass	Perennial forb		x	x	x	x	x									x	x		
Typha domingensis	Southern cattail	Perennial herb		x	x	x											x			x
Typha latifolia	Common cattail	Perennial forb															x			x
Urtica dioica ssp. holosericea	Hoary nettle	Perennial forb										x	x	x		x	x			x
Verbena bracteata	Bigbract verbena	Annual/perennial forb										x	x			x	x			
Verbena lasiostachys	Common verbena	Perennial forb										x	x			x	x			x
Verbena lasiostachys subsp. lasiostachys	Western vervain	Perennial forb														x	x			
Verbena lasiostachys subsp. scabrida	Robust vervain	Perennial forb										x				x	x			
Verbena scabra	Rough vervain	Perennial forb										x	x	x		x	x			
Woodwardia fimbriata	Giant chain fern	Fern											x			x	x			
Xanthium spinosum	Spiny cocklebur	Annual forb														x	x			x
Xanthium strumarium	Rough cocklebur	Annual forb														x	x			x

*Key to Conservation Status:

FE Federal endangered

SE State endangered

Rank 1B California Rare Plant Rank 1B: Plants rare, threatened, or endangered in California and elsewhere

Rank 3 California Rare Plant Rank 3: Plants about which we need more information—a review list

Rank 4 California Rare Plant Rank 4: Plants of limited distribution—a watch list

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APPENDIX B

RESULTS OF INITIAL SOIL ANALYSES

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APPENDIX C

INVASIVE PLANT CONTROL METHODS

Appendix C. Control methods for selected invasive plant species at the Reserve (adapted from DiTomaso and Healy 2007a, b).

Acacia (*Acacia cyclops*, *A. longifolia*, *A. retinodes*). Acacia is a woody shrub or tree that is resistant to many herbicides. The most effective method of control for acacia is manual removal of aboveground vegetation; sprouts from the cut stump must be removed until the root system dies. Seedlings must be pulled until the seed bank is exhausted, at least three years.

Giant reed (*Arundo donax*). Manual removal of giant reed is ineffective. Systemic herbicide, such as glyphosate, should be applied to mature plants in late summer to early fall. It is also possible to use the 'cut stump' method on giant reed canes during the spring and summer. Giant reed can resprout through both vegetative and root material; if plants are controlled using the 'cut stump' method, all plant material should be collected and disposed of offsite.

Black mustard (*Brassica nigra*). Black mustard is an annual species that spreads exclusively by seed. Repeated mowing before the plant forms mature seeds can be an effective control method. This species makes a great deal of seed which can survive up to 11 years; continued monitoring and maintenance is recommended for at least 11 years after initial treatment.

Sea-fig (*Carpobrotus chilensis*). Sea-fig is a succulent perennial. The species is shallow-rooted, making hand weeding an effective control method. The species will resprout from vegetative fragments left in contact with the ground, so all material should be collected and disposed of offsite. This species produces viable seed, and vegetative fragments can remain unseen in the soil; continued monitoring and maintenance is recommended for at least three years.

Poison hemlock (*Conium maculatum*). Poison hemlock is an annual species with a deep taproot. Repeated mowing before the plant sets seed (late summer to early fall) can be an effective method of control. This species thrives in recently disturbed soil; caution should be taken to minimize soil disturbances. The seed can remain viable for up to three years; monitoring and maintenance is recommended for at least three years.

Pampas grass (*Cortaderia selloana*). Pampas grass can be killed by cutting the plant below the crown. This is most easily done with a chainsaw or ax. This species thrives in recently disturbed soil, and caution should be taken to minimize soil disturbances.

Red gum (*Eucalyptus camaldulensis*). Red gum is a long-lived tree that can easily resprout after cutting. Mature trees should be cut down or girdled and treated with glyphosate or similar systemic herbicide. Herbicide should be applied to the exposed sapwood to reduce the number of sprouts from the root network. Young trees can be removed by hand. The root network and seeds can remain viable for up to three years; monitoring and maintenance is recommended for at least three years.

Terracina spurge (*Euphorbia terracina*). Terracina spurge is a perennial species that is very difficult to control. It is resistant to most chemical herbicides and is not affected by mowing (underground parts can persist in the soil for up to eight years). A combination of chemical and manual control methods should be used over the course of at least eight years to ensure all the remaining plants and below ground parts are eliminated.

Sweet fennel (*Foeniculum vulgare*). Sweet fennel is a perennial species with a deep taproot. Because it is perennial mowing is not an effective means of control. Fall burning followed by herbicide treatment of new foliage has been shown to control larger stands, although the process can take up to two years. This species thrives in recently disturbed soil, and caution should be taken to minimize soil disturbances. The seed can remain viable for up to three years; monitoring and maintenance is recommended for at least three years.

Crown daisy (*Glebionis coronaria* [*Chrysanthemum coronarium*]). This species is an annual plant which spreads exclusively by seed. Repeated mowing before the plant forms mature seeds can be an effective control method.

Canary ivy (*Hedera canariensis*). Canary ivy is shallow rooted, making hand weeding an effective control method. The species will resprout from vegetative fragments left in contact with the ground, so all material should be collected and disposed of offsite. This species produces viable seed, and vegetative fragments can remain unseen in the soil; continued monitoring and maintenance is recommended for at least three years.

Summer mustard (*Hirschfeldia incana*). Summer mustard is an annual species that spreads exclusively by seed. Repeated mowing before the plant forms mature seeds can be an effective control method. This species makes a great deal of seed which can live up to 11 years; continued monitoring and maintenance is recommended for at least 11 years after initial treatment.

Ngaio tree (*Myoporum laetum*). Ngaio tree is a large shrub or small tree that readily resprouts after cutting. Mature trees should be cut down or girdled and treated with glyphosate or similar systemic herbicide. Herbicides should be applied to the exposed sapwood to reduce the number of sprouts from the root network. Young trees can be removed by hand. The root network and seeds can remain viable for up to three years; monitoring and maintenance is recommended for at least three years.

Tree tobacco (*Nicotiana glauca*). Tree tobacco is a short-lived shrub or small tree. Manual removal of mature plants and seedlings is an effective control method.

Phoenix date palm (*Phoenix canariensis*). Phoenix date palm is a long-lived tree. Manual removal of mature plants and seedlings is an effective control method. This species thrives in recently disturbed soil; caution should be taken to minimize soil disturbances.

Aleppo pine (*Pinus halepensis*). Aleppo pine is a long-lived conifer. Manual removal of mature plants and seedlings is an effective control method for this species.

Castor bean (*Ricinus communis*). Castor bean is a perennial species that can occur as an herbaceous plant or small woody shrub. Manual removal or systemic herbicide application can be effective means of control of this plant. The removal of a larger plant often encourages increased seed germination; care should be taken to maintain the area where any larger tree was removed.

Tumbleweed (*Salsola tragus*). Tumbleweed is an annual herb that spreads by seed. One of the most effective methods of control for tumbleweed is to cut the young plants immediately above the cotyledons. Treatment it must be timed to ensure plants are not able to produce viable seed. Seeds remain viable for up to two years; maintenance and monitoring should be continued for up to two years.

Brazilian peppertree (*Schinus terebinthifolius*). Brazilian peppertree is a woody shrub. Roots of the Brazilian peppertree will readily resprout. Mature trees should be cut down or girdled and treated with glyphosate or similar systemic herbicide. Herbicides should be applied to the exposed sapwood to reduce the number of sprouts from the root network. Young trees can be removed by hand. The root network and seeds can remain viable for up to three years; monitoring and maintenance is recommended for at least three years.

Saltcedar (*Tamarix ramosissima*). Saltcedar is a woody shrub to small tree. Cut stumps will readily resprout; mature trees should be cut down or girdled and treated with glyphosate or similar systemic herbicide. Herbicides should be applied to the exposed sapwood to reduce the number of sprouts from the root network. Young trees can be removed by hand. Seeds remain viable for only five weeks, but mature plants produce many seeds. Seedlings should be pulled as soon as they are found to prevent further infestation.

APPENDIX D

INVENTORY OF BASIC BEST MANAGEMENT PRACTICES

Appendix D. Inventory of Basic Best Management Practices.

The following Best Management Practices are recommended for implementation during the restoration at the BWER. The list presented below primarily addresses measures designed to protect water quality. The list is intended to serve as a guide only and is not intended to be an exhaustive list of all best management practices to be implemented. Additional best management practices may be appropriate and/or may be required by the regulatory agencies. For additional best management practices see Cal-IPC (2012a, b), Environmental Protection Agency (2000), and Caltrans (2003), among others.

- The construction, staging, and access areas should be clearly marked with orange plastic, or similar, fencing and no work should be conducted outside of this area.

- A qualified biologist should train all project staff regarding habitat sensitivity, identification of listed species, and required best management practices before the start of construction. The training should cover the general measures being implemented to conserve the species as they relate to the project, penalties for noncompliance, and species ecology with key identifying features. A factsheet or other supporting materials containing this information should be prepared and distributed to all project staff. Upon completion of training, employees should sign a form stating that they attended the training and understand all of the conservation and protection measures. The training should be conducted in languages other than English, as appropriate, for workers who do not speak or understand English.

- A Spill Prevention and Control Plan should be developed for work within and adjacent to the aquatic habitats. The Spill Prevention and Control Plan should contain measures to prevent and control potential spills of hazardous materials associated with mechanical equipment (e.g., oil, gas, hydraulics, etc.), as well as measures to minimize contact with the stream bed, such as the use of work pads. The plan and materials necessary to implement it should be accessible on-site.

- All fueling, maintenance, and staging of equipment and vehicles should occur away from wetlands and outside of active stream channels, above the top of the bank.

- Heavy equipment should be checked daily for leaks. Equipment with leaks should not be used until leaks are fixed.

- Any leaks, drips, or spills should be immediately controlled to prevent entry into waterways, ditches, or other tributaries to waterways.

- At a pre-construction meeting, all workers should be informed of the importance of preventing accidental spills and the procedure, protocol, and required measures to be followed if an accidental spill or construction site discharge enters waterways, ditches, or other tributaries to waterways.

- All workers should ensure that food scraps, paper wrappers, food containers, cans, bottles, and other trash from the project area are deposited in covered or closed trash containers. The trash containers should not be left open and unattended overnight.

- If water is present in streams or channels during construction, water diversion should be implemented following procedures approved by the USFWS and the RWQCB and should be constructed using clean and contained material such as sandbags filled with gravel and wrapped in plastic, an inflatable coffer dam system, or similar materials.

- Tightly woven fiber netting, straw, or similar material should be used for erosion control after completion of construction activities and/or before the onset of a rain event. The material used should be designed to avoid trapping of wildlife species which might be present in the project area during or after construction. Plastic monofilament matting should not be used for erosion control.

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APPENDIX B4
Construction Equipment and Sequencing

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Overview

The purpose of this workbook is to identify assumptions for construction of the Ballona Wetlands Project. The assumptions will be used to support the air quality, greenhouse gas, and transportation analyses. The workbook includes three primary tabs, which are denoted in dark blue. The light blue tabs summarize the construction sequences for Alternatives 1a through 6.

Instructions for Review

The first five tables were used to provide the construction assumptions. Below is a brief description of each table.

1) Construction Master (Alt 1): This table summarizes the construction sequence for Alternative 1 (columns A through D) and identifies the requested construction data (columns E through O).
2) Equipment Ref: Since many of the actions are similar (e.g., "remove trash"), it is anticipated that the same (or similar) equipment and personnel assumptions can be used for multiple actions. The Equipment
3) Soil Export: This table summarizes the options for exporting excess soil offsite.

The first table identify the construction sequences for Alternative 1. Differences relative to Alternative 1 are identified in the last three tables. Construction assumptions developed for Alternative 1 will be used to evaluate sequences that are the same as Alternative 1 (unless otherwise instructed).

Construction Master (Alt 1)

Sequence	Area	Title	Actions	Start Date	Working Days	Overlap	Equipment Reference	Notes/ Assumptions
		PHASE 1						
1	B	Area "B" Southeast Gas Lines	1a. Remove and relocate existing gas line	1/2/2017	20	A	4	Assumed start date. Schedule shift as required after EIR certification and governmental approvals..
2	B	Area "B" South Enhancement	2a. Create swale (10,000 CY wet cut)	1/2/2017	40	A	1	Independent Seqence which may occur any time during the project schedule .
3	A	Area "A' Gas Line Removal	3a. Remove existing inactive gas line	1/2/2017	10	A	4	
			3b. Cut and cap gas line at Fiji Way	1/2/2017	1	A	4	
4	A & B	Pedestrian/Bike Bridge	4a. Construct temporary & portion of final re-routed trail to existing trail	4/17/2017	40	A, B, C	7	2nd step, start after rainy season
			4b. Construct new pedestrian/bike bridge over Ballona Creek	1/2/2017	130	A, B, C	8	1st step, start on south side
			4c. Reroute Ballona Creek Bike Trail under Culver Blvd Bridge	7/4/2017	5	A, B, C	7	Final step weekend after the 4th of July
5	A & C	Lincoln Bridge	5a. Build Lincoln Bridge next to Culver Bridge to connect Area A to Area C North	7/4/2017	65	A, B, C	9	Note, if assuming new bridge NOT using existing foundations, Use Equip 8 and 130 days duration
6	A	Clear, Grub, and Stockpile Area "A"	6a. Remove vegetation from Area A (54,400 CY dry cut)	7/4/2017	10	C	10	
			6b. Remove trash	7/4/2017	20	C	10	
			6c. Stockpile	7/4/2017	20	C	10	
7	A	Excavate Area "A"	7a. Remove 36" concrete pipe near center of Area A	7/4/2017	5	C	4	
			7b. Excavate old fill from Area A (1,134,200 CY wet cut and 54,400 dry cut, see note)	7/4/2017	555	C	11	This cut is the 2.05M CY, less cuts accounted for in other sequences. Assume dry max move is 10k cy/day; wet max move is 4k cy/day; wet soil spread over 4 of 20 acre for 5 days is limiting issue.
			7c. Dig below (over excavate) future levees (25,200 CY dry cut)	7/4/2017	5	C	11	Within Seq 7b
8	A	Area "A' Construct North Levee	8a. Grade and construct new levee around Area A (125,300 CY fill)	7/4/2017	35	C	12	Within Seq 7b
			8b. Protect Del Ray 13, 14, 15, 17, and 19	1/2/2017	n/a	n/a	n/a	
9	B & Property 1	Area "B" North Gas Line Relocation & Well Abandonment	9a. Drill new well at SoCal Gas Plant to replace Del Ray 12	1/2/2017	50	D	5	
			9b. Abandon and plug Del Ray 12	4/3/2017	90	D	6	
			9c. Remove/relocate existing pipelines	7/4/2017	10	D	4	
10	B	Area "B" North Clear & Grub	10a. Remove vegetation from Area B North and interim levee (25,000 CY wet cut)	7/4/2017	10	E	10	
			10b. Remove trash	7/4/2017	50	E	10	
11	B	Area "B" North Over-Excavate and Stockpile	11a. Excavate Area B North (56,700 CY wet cut)	7/4/2017	25	E	11	
			11b. Dig below (over excavate) future levees (11,400k CY wet cut)	7/4/2017	5	E	11	
12	B	Construct Area "B" Levee	12a. Construct Area B levees (437,000 CY fill = total import from Area A = 546,000 CY)	8/14/2017	165	E	12	Uses dry or dried out dirt from Area A, imported over new Ballona bridge. Area A exported dirt placed here first. Time is within 555 days from Seq 7, but extra equipment added during this time.
13	B	Clear, Grub, and Stockpile Area "B" East	13a. Remove vegetation in Area B East (4,600 CY wet cut)	2/5/2018	5	E	1	
			13b. Stockpile and prepare for fill	2/5/2018	5	E	10	
14	B	Area "B" East Stockpile Grading	14a. Grade Area B east and import from Area A (80,000 CY import from Area A)	2/12/2018	25	E	11	Uses dry or dried out dirt from Area A, imported over new Ballona bridge. Area A exported dirt placed here second. Time is within 555 days from Seq 7, but extra equipment added during this time.
15	C	Clear & Grub Area "C" North & South	15a. Protect baseball fields and structures.	1/2/2017	n/a	n/a	n/a	
			15b. Clear vegetation from Area C North (56,000 CY dry cut) & South (15,000 CY dry cut)	4/2/2018	10	C, E	10	
			15c. Re-align and replace Marina ditch (45,000 CY wet cut)	4/23/2018	15	C, E	11	
16	A & C	Area "A" Grading and Export to Area "C" North & South	16a. Excavate Area A and export to C South (300,000 CY total)	5/21/2018	75	C, E	11	Uses dry or dried out dirt from Area A, imported over new Lincoln bridge and across Culver Blvd. Area A exported dirt placed here third. Time is within 555 days from Seq 7, but extra equipment added during this time.
			16b. Excavate Area A and export to C North (720,000 CY ultimate total; 420,000 CY to C North)	9/3/2018	110	C, E	11	Uses dry or dried out dirt from Area A, imported over new Lincoln bridge. Area A exported dirt placed here fourth. Time is within 555 days from Seq 7, but extra equipment added during this time.
17	C	Finish Grading for Uplands Area "C" South	17a. Finish grading Area C South	6/3/2019	15	C, E	13	
			17b. Re-establish upland vegetation	6/24/2019	5	C, E	14	
18	B	Area "B" New and Reconstructed Culverts	18a. Install culverts under Culver/Jefferson Blvd, Gas Co Rd, and FWM berm; modify existing culvert under west end of Culver Blvd.	1/7/2019	130	F	1	
			18b. Remove existing FWM pipes and outlets	7/8/2019	15	F	1	
			18c. Construct new FWM outlet and spillway	7/29/2019	40	F	1	

Color	Description
	Could start sooner if desired, not later
	Work must start and finish in non-rainy season
	Cannot start until habitat establishment period complete. Work in Non-rainy season
	Independent effort, can start any time after this start date.

Sequence	Area	Title	Actions	Start Date	Working Days	Overlap	Equipment Reference	Notes/ Assumptions
19	A & B	Area "A" and Area "B" North Excavate and Breach Existing Levees	19a. Excavate Ballona Creek Channel in Areas A and B North (277,800 CY cut)	4/15/2019	130	G	11	Total time allowed during non-rainy season - 4/15 to 10/15
20	A & B	Area "A" and Area "B" North Block and Fill Existing Channels	20a. Install temporary pipe	4/15/2019	10	G	4	Time assumed within Seq 19
			20b. Temporary block then fill existing Ballona Creek (258,500 CY fill from Seq 19)	4/15/2019	60	G	11	Time assumed within Seq 19
21	A & B	Area "A" and Area "B" North Remove Existing Levees	21a. Lower and breach existing Ballona Creek levee (383,400 CY) - Export to Area C North, quantities included in Sequence 16, ultimate.	7/8/2019	120	G	11	Time assumed within Seq 19
22	B	Area "B" West Fire Access Road	22a. Construct maintenance and fire road in Area B West	10/14/2019	20	H	7	
			22b. Reconstruct Area B parking lot	10/14/2019	20	I	7	
23	A & B	Bike Path, Pedestrian Walkway and Amenities	23a. Construct bike and ped trails on levees	10/14/2019	65	J	7	
			23b. Construct County Parking Structure Foundation	10/14/2019	60	K	2	Independent sequence anytime after Seq 8a. Is complete
			23c. Construct County Parking Structure	10/14/2019	120	K	3	Independent sequence anytime after Seq 8a. Is complete
24	A	Export	24a. Export final excess dirt quantity (Assume up to 110,000 CY)	10/14/2019	35	C, E	15	See separate tab for export
		PHASE 2						
		Area A Gas Well Removal and Restoration						
25	A & Property 1	Gas Well Abandonment	25a. Drill new well at SoCal Gas Plant to replace Del Ray 19	1/2/2017	50	L	5	Assumes one crew working sequencially. Multiple crews could cut time down.
			25b. Abandon and plug Del Ray 13, 14, 15, 17, 18, and 19	3/13/2017	225	L	6	Assumes one crew working sequencially. Multiple crews could cut time down.
			25c. Remove existing gas lines serving removed wells	1/22/2018	10	L	4	
26	A	Area A around Wells Clear & Grub	26a. Remove vegetation around wells (2,000 CY)	1/22/2018	5	M	1	
27	A	Area A around Wells Grading and Export to West Area B	27a. Excavate Area A and Export to West Area B (208,000 CY)	1/22/2018	5	M	11	
28	A	Finish Grading For Uplands	28a. Finish grading around wells	2/12/2018	10	M	1	
			28b. Re-establish upland vegetation	2/26/2018	5	M	14	
		Area B wells						
29	B	Area B Abandon Wells	29a. Drill new well at SoCal Gas Plant to replace Del Rey 9 and Vidor 18	1/2/2017	50	N	5	Assumes one crew working sequencially. Multiple crews could cut time down.
			29b. Abandon and plug Vidor 1, 2, 3, 5, 14, 18 and Del Rey 4, 5, 9, 11	3/13/2017	225	N	6	Assumes one crew working sequencially. Multiple crews could cut time down.
			29c. Remove existing pipelines	11/13/2017	10	N	4	
30	B	Area B around Wells Clear & Grub	30a. Remove vegetation around wells (2,000 CY)	11/27/2017	5	O	1	
31	B	Finish Grading For Uplands	31a. Finish grading around wells	12/4/2017	10	O	1	
			31b. Re-establish upland vegetation	12/18/2017	5	O	14	
		Area B West						
32	B	Area "B" West Clear & Grub	32a. Remove vegetation in Area B West (76,000 CY)	4/17/2023	10	P	10	
33	B	Area "B" West Grading and Levee Extention	33a. Install temporary flexible storm drain	5/1/2023	10	P	1	
			33b. Dig below (over excavate) levees (10,800k CY wet cut)	5/1/2023	10	P	12	
			33c. Grade Area B West channels, construct salt pan berm, and construct levee with import from stockpile from Area B North and East at 248,000 CY (31,200 + 216,800 CY (291,800 less 49,000 and 26,000))	5/15/2023	75	P	12	
34	B	Area "B" West Excavate and Breach Existing Levees	34a. Breach existing levee in Area B West and place in Stability berms (75,000 CY wet = 26,000 + 49,000)	4/15/2023	130	P	11	Time allowed during non-rainy season = 130 Days, Time expected = 30
35	B	Finish Bike Path, Pedestrian Walkway and Amenities	35a. Construct maintenance and fire access road and bike path on new levee.	8/14/2023	20	Q	7	
36	B	Finish Grading For Uplands	36a. Finish grading Area B East	9/4/2023	10	Q	13	
			36b. Re-establish upland vegetation	9/18/2023	5	Q	14	

Equipment Reference

Reference #	Action(s)	Equipment Type	Number per day	Hours per day	Employees per day
1	2a, 13a, 18a, 18b, 18c, 26a, 28a, 30a, 31a, 33a	Grader	2	8	26
		Truck	12	8	
		Loader	4	8	
		Backhoe	2	8	
		Generator Set	1	8	
2	23b	Grader	4	8	24
		Truck	10	8	
		Loader	4	8	
		Backhoe	1	8	
		Drill Rig	1	8	
		Generator Set	2	8	
3	23c	Truck	12	8	40
		Backhoe	1	8	
		Crane	1	8	
		Loader	4	8	
		Generator Set	2	8	
4	1a, 3a, 3b, 7a, 9c, 20a, 25c, 29c	Backhoe	1	8	8
		Truck	4	8	
		Loader	1	8	
		Grader	1	8	
5	9a, 25a, 29a	Drill Rig	1	24	70
		Generator Set	6	24	
		Truck	20	24	
		Forklift	1	24	
		Backhoe	1	24	
		Crane	2	24	
6	9b, 25b, 29b	Drill Rig	1	12	17
		Truck	17	12	
		Generator Set	1	12	
7	4a, 4c, 22a, 22b, 23a, 35a	Backhoe	2	8	15
		Truck	10	8	
		Loader	4	8	
		Grader	1	8	
8	4b (5a?)	Drill Rig	1	8	50
		Crane	2	8	
		Generator Set	4	8	
		Truck	30	8	
		Forklift	2	8	
		Backhoe	2	8	
		Grader	1	8	
9	5a	Drill Rig	1	8	30
		Crane	2	8	
		Generator Set	3	8	
		Truck	16	8	
		Forklift	2	8	
10	6a, 6b, 6c, 10a, 10b, 13b, 15b, 32a	Grader	4	8	35
		Truck	20	8	
		Loader	8	8	
		Backhoe	2	8	
		Generator Set	1	8	
11	7b, 7c, 11a, 11b, 14a, 15c, 16a, 16b, 19a, 20b, 21a, 27a, 34a	Grader	6	8	80
		Truck	50	8	
		Loader	6	8	
		Backhoe	6	8	
12	8a, 12a, 33b, 33c	Grader	6	8	90
		Truck	60	8	
		Loader	6	8	
		Backhoe	6	8	
		Drill Rig	1	8	
		Generator Set	2	8	
13	17a, 36a	Grader	4	8	10
		Truck	240	8	
14	17b, 28b, 31b,	Truck	10	8	16
15	24a	Loader	2	8	122
		Truck	120	8	

Soil Export, Alternative 1

After grading operations are complete, there may be up to 110,000 c.y. of excess soil that might be exported outside the project boundary for disposal. Export will occur during **Sequence 24.**

Option	Description	Haul Trucks			Crane			Tugs (to pull barges)			
		Trips/day	Miles/trip	Total Trips	Number	Hours	Days	Number	Miles/trip	Hours/trip	Trips/tug
Off-Shore Disposal	Soil transported to temporary local staging areas along Ballona Creek (truck)	670	1	7,330	0	0	0	0	0	0	0
	Soil loaded on barge (crane)	0	0	0	1	8	31	0	0	0	0
	Soil barged up to 55 miles to the US EPA Los Angeles ocean disposal site off San Pedro (LA-2, 30 miles) or the Newport Bay ocean disposal site off Newport Beach (LA 3, 55 miles) (30 barge trips)	0	0	0	0	0	0	1	110	12	31
Port of Los Angeles (barge)	Soil transported to temporary local staging areas along Ballona Creek (truck)	670	1	7,330	0	0	0	0	0	0	0
	Soil loaded on barge (crane)	0	0	0	1	8	31	0	0	0	0
	Soil barged 30 miles from the shoreline of Port (30 barge trips)	0	0	0	0	0	0	1	30	8	31
Port of Los Angeles (truck)	Soil transported to temporary local staging areas along Ballona Creek (truck)	670	1	7,330	0	0	0	0	0	0	0
	Soil loaded on barge (crane)	0	0	0	1	8	31	0	0	0	0
	Soil barged 33 miles from the shoreline of Port (30 barge trips)	0	0	0	0	0	0	1	30	8	31
	Soil trucked to facilities in Los Angeles County, Orange County, Riverside County, and Ventura County	240	30.7-245	7,330	0	0	0	0	0	0	0
Landfill	Soil trucked to facilities in Los Angeles County, Orange County, Riverside County, and Ventura County	240	30-79.3	7,330	0	0	0	0	0	0	0

Soil Export, Alternative 2

After grading operations are complete, there may be up to 10,000 c.y. of excess soil that might be exported outside the project boundary for disposal. Export will occur during **Sequence 24.**

Option	Description	Haul Trucks			Crane			Tugs (to pull barges)			
		Trips/day	Miles/trip	Total Trips	Number	Hours	Days	Number	Miles/trip	Hours/trip	Trips/tug
Off-Shore Disposal	Soil transported to temporary local staging areas along Ballona Creek (truck)	670	1	670	0	0	0	0	0	0	0
	Soil loaded on barge (crane)	0	0	0	1	8	1	0	0	0	0
	Soil barged up to 55 miles to the US EPA Los Angeles ocean disposal site off San Pedro (LA-2, 30 miles) or the Newport Bay ocean disposal site off Newport Beach (LA 3, 55 miles) (150 barge trips)	0	0	0	0	0	0	1	110	12	1
Port of Los Angeles (barge)	Soil transported to temporary local staging areas along Ballona Creek (truck)	670	1	670	0	0	0	0	0	0	0
	Soil loaded on barge (crane)	0	0	0	1	8	1	0	0	0	0
	Soil barged 30 miles from the shoreline of Port (150 barge trips)	0	0	0	0	0	0	1	30	8	1
Port of Los Angeles (truck)	Soil transported to temporary local staging areas along Ballona Creek (truck)	670	1	670	0	0	0	0	0	0	0
	Soil loaded on barge (crane)	0	0	0	1	8	1	0	0	0	0
	Soil barged 33 miles from the shoreline of Port (150 barge trips)	0	0	0	0	0	0	1	30	8	1
	Soil trucked to facilities in Los Angeles County, Orange County, Riverside County, and Ventura County	240	30.7-245	670	0	0	0	0	0	0	0
Landfill	Soil trucked to facilities in Los Angeles County, Orange County, Riverside County, and Ventura County	240	30-79.3	670	0	0	0	0	0	0	0

Soil Export, Alternative 3

After grading operations are complete, there may be up to 1,226,000 c.y. of excess soil that might be exported outside the project boundary for disposal. Export will occur during **Sequence 24.**

NOTE: MATCHES FULL EXPORT

Option	Description	Haul Trucks			Crane			Tugs (to pull barges)			
		Trips/day	Miles/trip	Total Trips	Number	Hours	Days	Number	Miles/trip	Hours/trip	Trips/tug
Off-Shore Disposal	Soil transported to temporary local staging areas along Ballona Creek (truck)	670	1	81,730	0	0	0	0	0	0	0
	Soil loaded on barge (crane)	0	0	0	3	8	110	0	0	0	0
	Soil barged up to 55 miles to the US EPA Los Angeles ocean disposal site off San Pedro (LA-2, 30 miles) or the Newport Bay ocean disposal site off Newport Beach (LA 3, 55 miles) (330 barge trips)	0	0	0	0	0	0	3	110	12	110
Port of Los Angeles (barge)	Soil transported to temporary local staging areas along Ballona Creek (truck)	670	1	81,730	0	0	0	0	0	0	0
	Soil loaded on barge (crane)	0	0	0	3	8	110	0	0	0	0
	Soil barged 30 miles from the shoreline of Port (330 barge trips)	0	0	0	0	0	0	3	30	8	110
Port of Los Angeles (truck)	Soil transported to temporary local staging areas along Ballona Creek (truck)	670	1	81,730	0	0	0	0	0	0	0
	Soil loaded on barge (crane)	0	0	0	3	8	110	0	0	0	0
	Soil barged 33 miles from the shoreline of Port (330 barge trips)	0	0	0	0	0	0	3	30	8	110
	Soil trucked to facilities in Los Angeles County, Orange County, Riverside County, and Ventura County	240	30.7-245	81,730	0	0	0	0	0	0	0
Landfill	Soil trucked to facilities in Los Angeles County, Orange County, Riverside County, and Ventura County	240	30-79.3	81,730	0	0	0	0	0	0	0

Construction, Alternative 2

Sequence	Area	Title	Actions	Same as Alt 1?	Schedule Adjustment ?	Equipment Adjustment ?
		PHASE 1				
1	B	Area "B" Southeast Gas Lines	1a. Remove and relocate existing gas line	Y		
2	B	Area "B" South Enhancement	2a. Create swale (10,000 CY wet cut)	Y		
3	A	Area "A' Gas Line Removal	3a. Remove existing inactive gas line	Y		
			3b. Cut and cap gas line at Fiji Way	Y		
25	A & Property 1	Gas Well Abandonment	25a. Drill new well at SoCal Gas Plant to replace Del Ray 19	Y		
			25b. Abandon and plug Del Ray 13, 14, 15, 17, 18, and 19	Y		
			25c. Remove existing gas lines serving removed wells	Y		
26	A	Area A around Wells Clear & Grub	26a. Remove vegetation around wells (2,000 CY)	Y		
27	A	Area A around Wells Grading and Export to West Area B	27a. Excavate Area A and Export to West Area B (208,000 CY)	Y		
28	A	Finish Grading For Uplands	28a. Finish grading around wells	Y		
			28b. Re-establish upland vegetation	Y		
29	B	Area B Abandon Wells	29a. Drill new well at SoCal Gas Plant to replace Del Rey 9 and Vidor 18	Y		
			29b. Abandon and plug Vidor 1, 2, 3, 5, 14, 18 and Del Rey 4, 5, 9, 11	Y		
			29c. Remove existing pipelines	Y		
30	B	Area B around Wells Clear & Grub	30a. Remove vegetation around wells (2,000 CY)	Y		
31	B	Finish Grading For Uplands	31a. Finish grading around wells	Y		
			31b. Re-establish upland vegetation	Y		
4	A & B	Pedestrian/Bike Bridge	4a. Construct temporary & portion of final re-routed trail to existing trail	Y		
			4b. Construct new pedestrian/bike bridge over Ballona Creek	Y		
			4c. Reroute Ballona Creek Bike Trail under Culver Blvd Bridge	Y		
5	A & C	Lincoln Bridge	5a. Build Lincoln Bridge next to Culver Bridge to connect Area A to Area C North	Y		
6	A	Clear, Grub, and Stockpile Area "A"	6a. Remove vegetation from Area A (54,400 CY dry cut)	Y		
			6b. Remove trash	Y		
			6c. Stockpile	Y		
7	A	Excavate Area "A"	7a. Remove 36" concrete pipe near center of Area A	Y		
			7b. Excavate old fill from Area A (1,384,000 CY wet cut, see note)	Y		
			7c. Dig below (over excavate) future levees (30,000 CY dry cut)	Y		
8	A	Area "A' Construct North Levee	8a. Grade and construct new levee around Area A (125,300 CY fill)	Y		
9	B & Property 1	Area "B" North Gas Line Relocation & Well Abandonment	9a. Drill new well at SoCal Gas Plant to replace Del Ray 12	Y		
			9b. Abandon and plug Del Rey 12	Y		
			9c. Remove/relocate existing pipelines	Y		
10	B	Area "B" North Clear & Grub	10a. Remove vegetation from Area B North and Area B West (25,000 CY wet cut)	Y		
			10b. Remove trash	Y		
11	B	Area "B" North Over-Excavate and Stockpile	11a. Excavate Area B North (56,700 CY wet cut)	Y		
			11b. Dig below (over excavate) future levees (3,000 CY wet cut)	N		
12	B	Construct Area "B" Levee	12a. Construct Area B levees (266,200 CY = total import from Area A = 332,800 CY)	Y		
13	B	Clear, Grub, and Stockpile Area "B" East	13a. Remove vegetation in Area B East stockpile area (4,600 CY wet cut)	Y		
			13b. Stockpile and prepare for fill	Y		
14	B	Area "B" East Grading	14a. Grade Area B east and import from Area A (324,000 CY import from Area A)	N	Increase from 20 to 85 days	
15	C	Clear & Grub Area "C" North & South	15a. **Demo** baseball fields and structures.	N	Add 15 Days	
			15b. Clear vegetation from Area C North (56,000 CY dry cut) & South (**51,000** CY dry cut)	N	Increase from 15 to 25 days	
			15c. Re-align and replace Marina ditch (45,000 CY wet cut)	Y		
16	A & C	Area "A" Grading and Export to Area "C" North & South	16a. Excavate Area A and export to C South (**540,000** CY total)	N	Increase from 75 to 135 days	
			16b. Excavate Area A and export to C North (**500,000** CY ultimate total; **183,000** CY at this sequence until levee is breached)	N	Decrease from 110 to 50 days	
17	C	Finish Grading for Uplands Area "C" South	17a. **Reconstruct ballfields and structures and detailed grading in** Area C South	N	Increase from 15 to 65 days	Use 7
			17b. Re-establish upland vegetation	Y		
18	B	Area "B" New and Reconstructed Culverts	18a. Install culverts under Culver/Jefferson Blvd, Gas Co Rd., and FWM berm; modify existing culvert under west end of Culver Blvd.	Y		
			18b. Remove existing FWM pipes and outlets	Y		
			18c. Construct new FWM outlet and spillway	Y		
19	A & B	Area "A" and Area "B" North Excavate and Breach Existing Levees	19a. Excavate Ballona Creek Channel in Areas A and B North (277,800 CY cut)	Y		
20	A & B	Area "A" and Area "B" North Block and Fill Existing Levees	20a. Install temporary pipe	Y		
			20b. Temporary block then fill existing Ballona Creek (269,100 CY fill from Seq 19)	Y		
21	A & B	Area "A" and Area "B" North Remove Existing Levees	21a. Lower and breach existing Ballona Creek levee (383,400 CY) - Export to Area C North, quantities included in Sequence 16, ultimate.	Y		
22	B	Area "B" West Fire Access Road	22a. Construct maintenance and fire road in Area B West	Y		
			22b. Reconstruct Area B parking lot	Y		

Sequence	Area	Title	Actions	Same as Alt 1?	Schedule Adjustment ?	Equipment Adjustment ?
23	A & B	Bike Path, Pedestrian Walkway and Amenities	23a. Construct bike and ped trails on levees	Y		
			23b. Construct County Parking Structure Foundation	Y		
			23c. Construct County Parking Structure	Y		
24	A	Export	24a. Export final excess dirt quantity (Assume 10,000 CY)	N	Decrease from 35 to 3 days	

Construction, Alternative 3

Sequence	Area	Title	Actions	Same as Alt 1?	Schedule Adjustment ?	Schedule Adjustment ?
1	B	Area "B" Southeast Gas Lines	1a. Remove and relocate existing gas line	Y		
2	B	Area "B" South Enhancement	2a. Create stormwater detention/treatment swale/wetland (10,000 CY wet cut)	Y		
3	A	Area "A' Gas Line Removal	3a. Remove existing inactive gas line	Y		
			3b. Cut and cap gas line at Fiji Way	Y		
25	A & Property 1	Gas Well Abandonment	32a. Drill new well at SoCal Gas Plant to replace Del Rey 17 and 19	Y		
			32b. Abandon and plug Del Rey 13, 14, 15, 17, 18 and 19	Y		
			32c. Remove existing gas lines serving removed wells	Y		
			31a. Finish grading around wells	N		
9	B & Property 1	Area "B" North Gas Line Relocation & Well Abandonment	31b. Re-establish upland vegetation	N		
			9c. Remove existing pipelines	Y		
29	B	Area B Abandon Wells	29b. Abandon and plug Vidor 1, 2, 3, 5, 14, 18 and Del Rey 4, 5, 9, 11	Y		
			29b. Remove existing pipelines	Y		
30	B	Area B around Wells Clear & Grub	30a. Remove vegetation around wells (2,000 CY)	Y		
31	B	Finish Grading and Habitat Establishment	31a. Finish grading around wells	Y		
			31b. Establish vegetation	Y		
6	A	Clear, Grub, and Stockpile Area "A"	6a. Remove vegetation from Area A (54,400 CY dry cut)	Y		
			6b. Remove trash	Y		
			6c. Stockpile	Y		
7	A	Excavate Area "A"	7a. Remove 36" concrete pipe near center of Area A	Y		
			7b. Excavate old fill from Area A (999,700CY wet cut, see note)	Y	Decrease from 555 to 400 days	
			7c. Dig below (over excavate) future levees (30,000 CY dry cut)	Y		
8	A	Area "A' Construct North Levee	8. Grade and construct new levee around Area A (125,300 CY fill)	Y		
19	A	Area "A" Excavate New Channel	19a. Excavate Ballona Creek Channel in Area A (190,900 CY cut)	N	Decrease from 130 to 55 days	
16	A & C	Area "A" Grading and Export **Off-Site**	16a. Excavate Area A and export **Off-Site (1,230,000 CY Total; Split into Seq 's 16 (859k), 19/20 (195k), 21 (166k), and 24 (10k))**	N	Increase from 75 to 340 days	
				N	Deleted	
17	C	**Remove invasives** for Uplands Area "C" **North &** South	17a. **Remove invasives** Area C **North &** South	N	Increase from 15 to 45 days	Use 14
			17b. Re-establish upland vegetation	Y		
23	A & B	Bike Path, Pedestrian Walkway and Amenities	23a. Construct bike and ped trails on levees	Y		
			23b. Construct County Parking Structure Foundation	Y		
			23c. Construct County Parking Structure	Y		
xx	**A**	**Area "A" Excavate New Channel**	**Install culverts in existing north Ballona Creek levee**	**N**	**ADDED LINE, 20 days**	**Use 1**
24	A	Export	24a. Export final excess dirt quantity (Assume 1,230,000 CY, per line 16a.)	N	See 16a	

Construction, Alternative 4

Sequence	Area	Title	Actions
NEW	A, B, C	Restoration	Invasive species removal and volunteer-based restoration

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APPENDIX B5
Preliminary Operation and Maintenance Plan

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Ballona Wetlands Ecological Reserve

Preliminary Operations and Maintenance Plan

January 2017

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BALLONA WETLANDS RESTORATION PROJECT

PRELIMINARY OPERATIONS AND MAINTENANCE PLAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

BMPs	Best Management Practices
Ballona Reserve	Ballona Wetlands Ecological Reserve
Cal-IPC	California Invasive Plant Council
CCC	California Conservation Corps
CDFG	California Department of Fish and Game (now California Department of Fish and Wildlife)
CDFW	California Department of Fish and Wildlife (formerly California Department of Fish and Game)
CESA	California Endangered Species Act
CEQA	California Environmental Quality Act
CHRAMP	Ballona Wetlands Ecological Reserve Conceptual Habitat Restoration and Adaptive Management Plan
CNPS	California Native Plant Society
Corps	U.S. Army Corps of Engineers
GIS	Geographic Information System
HMMP	Habitat Mitigation and Monitoring Plan
LA County	Los Angeles County
LACFCD	Los Angeles County Department of Public Works-Flood Control District
MSL	Mean sea level
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
O&M Plan	Operations and Maintenance Plan
PAR	Property Analysis Record
PMT	Project Management Team
PWA	Phillip Williams and Associates
Reserve	Ballona Wetlands Ecological Reserve
SCC	California State Coastal Conservancy
SLC	California State Lands Commission
SMBRC	Santa Monica Bay Restoration Commission
SRT Gate	Self-Regulating Tide Gate
USFWS	U.S. Fish and Wildlife Service

1.0 OPERATIONS AND MAINTENANCE PLAN

1.1 Introduction and Purpose

The intent of the Ballona Wetlands Restoration Project is to restore, enhance, and establish native coastal wetland and upland habitats within the Ballona Reserve, while maintaining a flood protection system that is sustained by natural processes and requires minimal operations and maintenance activities. The restored Ballona Creek channel has been designed to minimize maintenance; however, significant maintenance may be required for the channel. The purpose of this document is to describe the activities required for the ongoing operation and maintenance of the Ballona Wetlands Ecological Reserve (Ballona Reserve), which would include, but would not necessarily be limited to, site monitoring and management (e.g., trash and debris removal; channel, levee, and water control structure maintenance; habitat and vegetation maintenance; vector control; maintenance of public trails, lookouts, and points of entry; access to public parking lots; maintenance of the ballfields), other ongoing or routine maintenance (e.g., safety patrols, maintenance of emergency access routes), and staffing and personnel needs. This Preliminary Operations and Maintenance Plan (Preliminary O&M Plan) has been developed to describe the anticipated short- and long-term management and maintenance activities that would be required to achieve the following key objectives:

1. Maintain the same or greater flow-carrying capacity as the original Ballona Creek channel design approved in accordance with existing U.S. Army Corps of Engineers (Corps) requirements as determined through Section 14 of the Rivers and Harbors Act of 1899 and codified in 33 U.S.C. §408 (commonly referred to as "Section 408");
2. Maintain a diversity of functional restored wetland and upland habitats; and
3. Provide public access and safety.

This Preliminary O&M Plan has been developed to ensure that anticipated O&M activities that could result in physical environmental impacts are included as part of the restoration project and are evaluated in the Ballona Wetlands Restoration Project Environmental Impact Statement (EIS)/Environmental Impact Report (EIR). A summary of this Plan is provided in Chapter 2, *Description of Alternatives*, of the EIS/EIR. This Preliminary O&M Plan should not be interpreted as any sort of regulatory approval by the California Department of Fish and Wildlife (CDFW), or otherwise binding on CDFW related to the issuance of a regulatory approval in the future.

As part of the Section 408 permit process, which will occur following conclusion of the environmental review process, a Final O&M Plan will be jointly developed by the Los Angeles County Department of Public Works-Flood Control District (LACFCD), CDFW, and any other responsible parties (e.g., Los Angeles County Department of Beaches and Harbors, Los Angeles County Sheriff's Department, City of Los Angeles Fire Department, and Ballona Wetlands Conservancy). The Final O&M Plan will identify all operations and maintenance responsibilities, providing more detail than contained in this Preliminary O&M Plan; however, it is anticipated that this Preliminary O&M Plan will form the basis of the Final O&M Plan.

1.2 Operation and Maintenance Responsibilities

CDFW manages and maintains primary ownership of the Ballona Reserve (with a smaller interest owned by the California State Lands Commission [CSLC]). The Corps, in cooperation with the LACFCD, constructed the Ballona Creek channel and levees within the Ballona Reserve as part of the Los Angeles County Drainage Area (LACDA) project. On behalf of the LACFCD, the LACDPW operates and maintains LACDA project features for the section of the Ballona Creek channel upstream of Lincoln Boulevard to the Ballona Creek outlet, including LACDA project features within the Ballona Reserve. While the primary responsibilities for the management and maintenance of the Ballona Reserve fall under the responsibility of CDFW and LACFCD, other responsible parties may be involved, including, but not necessarily limited to, Los Angeles County Department of Beaches and Harbors, Los Angeles County Sheriff's Department, City of Los Angeles Fire Department, and Ballona Wetlands Conservancy. This document identifies an agency responsible for completion of specific O&M activities, but that agency may choose a qualified contractor to complete the activity under its supervision.

The main responsibilities of the Preliminary O&M Plan for the Ballona Reserve fall into three general categories: flood and stormwater facility inspection and maintenance; habitat restoration monitoring and maintenance; and public access, public services, and general maintenance.

Flood and stormwater management will primarily be the responsibility of the LACFCD and Ballona Reserve staff. LACFCD is responsible for maintaining and inspecting the LACDA project facilities within the Ballona Reserve, including the Ballona Creek channel and related infrastructure, which includes, but is not limited to, trash booms, flood risk management levees, levee access roads and fencing, channels, self-regulating tide flap gates, and culverts. Drainage structures and other flood management or stormwater related infrastructure that is needed only for habitat purposes will be the responsibility of Ballona Reserve staff. Drainage structures needed to maintain the integrity of roads and associated infrastructure would be the responsibility of the owner of the road.

Habitat restoration monitoring and maintenance activities will be the responsibility of CDFW or a qualified contractor working under the direction of CDFW. In addition, CDFW will coordinate at its discretion with NGOs to conduct restoration and maintenance activities.

Operation and maintenance of public access, public services, and general maintenance primarily will be the responsibility of LACDPW and Ballona Reserve staff. The LACDPW is responsible for maintaining the bike paths on the flood risk management levees. Both LACDPW and Ballona Reserve staff will be responsible for maintaining and inspecting the bike paths located on the flood risk management levees and portions of the pedestrians paths. Ballona Reserve staff will be responsible for the remaining pedestrian paths, public provided services, and the overall general maintenance of the areas that are accessible to the public, which includes, but is not limited to, pedestrian paths and boardwalks, sitting and viewing areas, interpretative signage, and entrances and exits to the Ballona Reserve.

This Preliminary O&M Plan is adaptive and the responsibilities and activities included in this document are subject to change, as needed, and as further described in Section 2.0, *Future Revisions to Preliminary Operations and Maintenance Plan*, and after agreement from the entities involved.

1.3 Operations and Maintenance Tasks/Activities

Existing and future O&M tasks are discussed below for: flood and stormwater facility inspection and maintenance; habitat restoration monitoring and maintenance; and public access, public services, and general maintenance. Future O&M tasks are described for Alternative 1 – Full Tidal Restoration/Proposed Action first, followed by descriptions for Alternative 2 – Restored Partial Sinuous Creek and Alternative 3 – Levee Culverts and Oxbow. Future O&M tasks for Alternative 4 – No Project would be the same as under existing conditions.

Flood and Stormwater Facility Inspection and Maintenance

Flood risk and stormwater management may include modifications to LACDA project structures within the Ballona Reserve by removing all or portions of the existing levees and the concrete-lined channel in favor of constructing new flood risk management levees, restoring the wetland floodplain, constructing new water-control structures (such as culverts, weirs, and tide gates, and associated access roads) and/or erosion protection features, and modifications to existing operations and maintenance requirements.

The existing LACDA project structures and facilities are continuously maintained in such a manner and operated at such times and for such periods as necessary to obtain the maximum flood protection benefits (33 CFR §208.10). The LACFCD currently operates and maintains these structures and facilities within the Ballona Reserve consistent with the Corps' Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual for the Los Angeles County Drainage Area (the "OMRR&R") (Corps 1999). Table 1 lists current LACFCD maintenance activities (P. Holland, Los Angeles County Department of Public Works, pers. comm.) and identifies which activities are anticipated to be continued as part of the Ballona Wetlands Restoration Project.

Ballona Creek Channel and Levees

Existing

The Ballona Creek flood risk management channel and levees were constructed in 1939 by the Corps (Corps 1999).

LACDPW, on behalf of LACFCD, currently performs maintenance of the existing flood risk management channel. The channels and levees have not been modified since 1976. The anticipated design life for these levees is approximately 50 years. The existing levee slopes are armored with a mix of rock, rubble, and concrete. As the levees continue to age and show signs of deterioration and weed infestation, it is the responsibility of LACFCD to perform repairs to the hardscape surfaces, as well as manage vegetation. In addition to monitoring for erosion along the levees, changes in channel bathymetry are monitored and repaired, as needed, to provide proper hydraulic performance.

Future – Alternative 1

Ballona Creek Channel - Flood Conveyance Capacity

LACFCD would continue to perform existing maintenance activities for Ballona Creek channel following restoration. While the restored Ballona Creek channel will be designed to minimize maintenance requirements, a monitoring and as-needed maintenance program would be developed for the channel.

The level of channel erosion and deposition during storm flow events is anticipated to be acceptable for the restoration and flood management. The levee heights are designed to meet flood criteria with a reduced channel cross-section (i.e., reduction in the design channel cross-section due to deposition). Due to the existing limited amount of sediment coming from the watershed, the channel is not expected to reach this reduced cross-section. However, this reduced channel cross-section will define a minimum allowable cross-section and maintenance limits for the channel. The channel cross-section will be monitored on a prescribed schedule (e.g., every five years) and after significant storm events and compared to the minimum allowable channel cross-section to confirm that the cross-section and flood performance is within the predetermined maintenance limit. Only if the channel cross-section were to reach the minimum cross-section (the smallest cross-section that still maintains flood protection, see EIS/EIR Appendix F10) through unforeseen circumstances would channel maintenance (e.g., dredging) be required. Any major debris or blockage of the channel that may negatively affect flood risk protection or restoration performance would need to be removed; however, this is not anticipated.

Table 1. Existing and Future LACFCD O&M Activities

Current LA County O&M Activities	Anticipated Continuation of Existing O&M Activities	Note
1. Clean channel invert	Yes	See Below
2. Clean trash net	Yes	No change anticipated
3. Inspect and lock gates	Yes	Some new access gate locations will be operated by on-site Ballona Reserve staff
4. Inspect and service flap gates	Yes	Existing West Area B flap gates to remain in Phase 1 of Alternative 1, Alternative 2, and Alternative 3; new structures and gates in North Area B in Alternative 1 and 2 and in West Area B in Alternative 1.
5. Inspect and service sub-drains	Yes	For existing sub-drains to remain within Project Area
6. Maintenance and repair of fence and gates	Yes	Some new fence and gate locations
7. Maintenance and repair of weep holes	Yes	Four existing levees and weep holes to remain
8. Midge control	TBD	If needed, midge control responsibilities may be shared between LACFCD and Ballona Reserve management due to the potential increased populations of midges in wetlands versus flood channels.
9. Operation and maintenance of tidal gates	Yes	Existing West Area B SRT gates to remain in Phase 1 of Alternative 1, Alternative 2, and Alternative 3; new structures and gates.
10. Pre-emergent nuisance plant control	Yes	The responsibility of nuisance plant control will depend on the location of the nuisance plants. Nuisance plants in the flood risk management infrastructure (e.g., walkways, bike paths, culverts, etc.) will be managed by LACFCD, with prior approval of the Land Manager; nuisance plants in the Ballona Reserve restoration areas will be managed by the Ballona Reserve.
11. Spill response	Yes	Spill response will be the responsibility of the location where the spill occurred and spreads. If a spill affects the Ballona Reserve restored habitats, it will be the responsibility of Ballona Reserve on-site staff and management. Spills that affect the channels will be the responsibility of LACFCD. Responsibilities for spills that overlap in both areas will be shared between Ballona Reserve management/ on-site staff and LACFCD.
12. Nuisance plant removal	Yes	The responsibility of nuisance plant control will depend on the location of the nuisance plants. Nuisance plants in the flood risk management infrastructure (e.g., walkways, bike paths, culverts, etc.) will be managed by LACFCD, with the prior approval of the Land Manager; nuisance plants in the Ballona Reserve restoration areas will be managed by the Ballona Reserve.

Table 1. Existing and Future LACFCD O&M Activities (continued)

Current LA County O&M Activities	Anticipated Continuation of Existing O&M Activities	Note
13. Trash/debris	Yes	The responsibility of trash/debris control will depend on the location of the trash and debris. Trash/debris in the creek and associated flood risk management infrastructure (i.e. walkways, bike paths, culverts, etc.) will be managed by LACFCD, with prior approval of the Land Manager; trash/debris in the Ballona Reserve restoration areas will be managed by the Ballona Reserve.
14. Existing bike path repair and management	Yes	Maintenance of the bike path following existing LACFCD channels will be the responsibility of the LACFCD.
15. Vegetation Management	TBD	The responsibility of vegetation management would depend on the location. Vegetation management on the levees, if required, will be the responsibility of LACFCD, with prior approval of the Land Manager; vegetation management in the Ballona Reserve restoration areas (i.e. fuel management etc.) will be managed by the Ballona Reserve.

TBD = to be determined in coordination with Los Angeles County

For purposes of estimating potential maintenance requirements related to sedimentation, up to 4 feet of uniform deposition along the new channel alignment would be allowed before channel maintenance would be required. This amount of sedimentation is estimated to take at least 50 years to accumulate in the channel and would require removal of approximately 125,000 CY of material. If this channel maintenance threshold were reached, LACFCD would perform the required maintenance using floating mechanical or hydraulic dredge equipment. Dredge equipment would be transported to the site by truck or barge via Marina del Rey Harbor or the Ballona Creek channel to the Pacific Avenue Bridge. Dredge equipment would be assembled in the channel. The channel would be dredged to the design dimensions of the channel. Dredged material either would be beneficially used within the wetlands (e.g., to raise sub-tidal and intertidal mudflat areas and create additional vegetated wetland habitat) or would be disposed of off-site. Land and marine-based off-haul options would be similar to options described for Project construction. However, soil excavation and disposal volumes for maintenance activities would be less than Project construction volumes. Any off-haul activities for maintenance therefore would have a shorter duration than for construction activities. Sediment testing would be performed prior to channel maintenance and any soil requiring special management measures would be handled and disposed of according to regulations. Table 2 below summarizes details related to maintenance of the channel capacity.

Table 2. Ballona Creek Conveyance Capacity Summary

Quantity	Area Affected	Dredging Equipment	On-site Reuse Equipment	Off-site Disposal Equipment	Frequency
125,000 CY	21 acres dredging and 6 acres access along channel	Hydraulic dredge, floating barge with long-reach excavator	Low ground pressure track truck and track long reach excavator, mats for access	Low ground pressure track truck, haul and dump truck	50 years

Ballona Creek Channel - Bank Protection

In locations where armoring would be installed along the banks of the Ballona Creek channel to limit erosion, scour protection would be inspected and maintained as needed. Level 1 armoring (consisting of buried rock revetment) and Level 3 armoring (consisting of vegetated channel banks) are proposed within the realigned reach of Ballona Creek. The Level 1 buried rock revetment would be designed to withstand velocities and shear stresses as if it were exposed and thus scour or erosion at the revetment that would expose bedding or cause undercutting is not anticipated. In the event that the buried armoring was exposed after a storm, natural processes would be allowed to rebury/revegetate those areas (e.g., vegetation recruitment in remaining soils, encouraging deposition) and no maintenance would be required. Level 3 vegetated channel banks are located in areas of the channel where the consequences of erosion would not impact infrastructure and thus the impacts are low. Erosion of Level 3 vegetated armoring would be considered a manifestation of natural processes in the restoration area and would be allowed to evolve/revegetate with no maintenance required.

Perimeter Levees - General

The levees themselves will be maintained following Corps policy and guidance letter on the periodic inspection procedures for the Levee Safety Program (Corps 2008) maintenance requirements. The levees are expected to require limited maintenance, and they would be inspected annually and after significant storm events. Maintenance would include, but not be limited to: periodic repaving of the bike path and walking trail; replacement or repair of fencing that may be installed; replacement or repair of any overlook or educational equipment placed along the walking trail; trash collection and graffiti removal; and habitat care, including removal of invasive species from the levees. These activities may include public education and involvement programs. Minor erosion best management practices (BMPs) may be necessary periodically.

CDFW would be responsible for replacement or repair of any overlook or educational equipment placed along the walking trail, and for any graffiti removal required for these elements.

Perimeter Levees -Vegetation

Planting along levee alignments implements tiered approach to applying the Corps' Guidelines for Landscape Planting and Vegetation at Levees (ETL 1110-2-583, April 2014). The proposed planting plans strike a balance between use of upland grasses in a vegetation free zone along the levee core and a vegetation management zone with grasses and small, shallow rooted shrubs between the vegetation free zone and the areas dedicated to upland and transitional habitat.

- Vegetation Free Zone – This zone follows Corps guidance providing a zone of perennial upland grasses along the levee core that would be mowed to facilitate inspection of the levee core. The Vegetation Free Zone would extend 15 feet beyond the toe of the levee core along the steeper land side of the levee. Along the creek side of the levee, where existing grades would be raised to create broad, flat transitional slopes ranging from 10H:1V to 20H:1V and flatter to support the habitat objectives of the project, the Vegetation Free Zone would extend 15 feet beyond the levee core.
- Vegetation Maintenance Zone – This zone provides an area of upland grasses and small shallow rooted shrubs that may be mowed as needed to facilitate inspections or selective removal of shrubs that could impact the integrity of the levee core. The Vegetation Management Zone would extend to 15 feet beyond the toe of the buried levee core on the water side of the levee. In this zone, the levee core would be buried by 8 to 10 feet of soil to support the habitat objectives of the Project. The intent would be that mowing or select vegetation removal would not be regularly needed, but would be included in Project permits to facilitate any maintenance and inspections should issues arise. The planting list within the Vegetation Management Zone would add low

shrubs with small root balls that are limited to 2-3 feet in depth to the perennial grasses included in the Vegetation Free Zone. A root-free zone of at least 3 feet would be maintained above the levee core.

- Habitat Zone – The Habitat Zone is located 15 feet from the levee core toe. In areas of higher levee fill (i.e., West Area B) this zone would incorporate 6 to 10 feet of soil above the levee toe at slopes of 10-20H:1V. This zone would support the full range of habitat plantings included in the upland and transitional habitat mix. Within the Habitat Zone, regular inspection is not anticipated.

Perimeter Levees – Scour Protection

In locations where armoring would be installed to limit erosion, the scour protection would be inspected and maintained as-needed. Three levels of armoring are proposed along the perimeter levees: Level 1 and Level 2 would consist of buried rock revetment; Level 4 would consist of vegetation only. A short reach of Level 1 armoring between the Culver and Lincoln Boulevard bridges would consist of surface rock revetment/concrete. Inspection and maintenance of this section of channel bank protection would continue as under existing conditions. The Level 1 and Level 2 buried rock revetment would be designed to withstand velocities and shear stresses as if it were exposed and thus scour or erosion at the revetment that would expose bedding or cause undercutting is not anticipated. In the event that the buried armoring becomes exposed after a storm, natural processes would be allowed to rebury/revegetate those areas (e.g., vegetation recruitment in remaining soils, encouraging deposition) and no maintenance would be required. Inspection and maintenance of Level 4 armoring is as described under Perimeter Levees –Vegetation.

Ballona Creek - Water Level Monitoring

Water levels will be monitored in the restored Ballona Creek channel and in the Area B managed marsh as they currently are in the existing channel and West Area B wetlands. In addition, Ballona Creek channel flows will be monitored at the Lincoln Boulevard bridge (or upstream), as they are being monitored for project baseline conditions data collection.

Future – Alternatives 2 and 3

Maintenance of Ballona Creek Channel and Levees under Alternative 2 would be the same as described under Alternative 1.

Maintenance of Ballona Creek Channel and Levees under Alternative 3 would be the same as the existing conditions.

Water Control Structures

Existing

The existing West Area B self-regulating tide gates (SRT gates) were installed in 2003 as a Corps 1135 project,[1] and are operated and maintained by LACFCD. LACFCD inspects and maintains the tide gates, including removal of debris/obstructions from the gates. The gates are checked on a weekly basis, and obstruction removal typically occurs twice per year. The gates are inspected and serviced annually. O&M

[1] Section 1135 of the Water Resources Development Act of 1986, as amended, provides the authority to modify existing Corps projects to restore the environment and construct new projects to restore areas degraded by Corps projects. A project is accepted for construction after a detailed investigation shows it is technically feasible, environmentally acceptable, and provides cost effective environmental benefits. Each project must be complete within itself, not a part of a larger project. The maximum federal expenditure per project is $5 million, which includes both planning and construction costs.

of the existing tide gates would continue until the structure is removed and the levee is breached (e.g., in Phase 2 of Alternative 1).

Future – Alternative 1

A number of new slide or tide gates will be installed to connect South and Southeast Area B to West and North Area B (and in turn the Ballona Creek channel), to maintain operation of the Freshwater Marsh, and to connect South and Southeast Area B. Inspection of the new water control structures will be the same as described for the existing gates. The gates will be checked on a weekly basis with obstruction removal occurring as needed. The gates will be inspected and serviced annually. Gates may be adjusted seasonally for habitat management purposes at the discretion of the Ballona Reserve Manager.

Due to the exposure conditions at the Project site, the new gates (like the existing ones) are likely to require replacement every 10 years. Replacement of the gates would be done using a crane and gates would be delivered to the Project site using a flatbed truck. Access to each water control structure would be along the paths/access routes along the perimeter levee. Connector channels between the water control structures and Ballona Creek may require sediment removal during the first 10 years post-construction. For purposes of estimating potential maintenance requirements related to sedimentation in the connector channels, up to 6 inches of sedimentation was assumed to deposit in the channels per maintenance event. Sediment removal would be accomplished using a low ground pressure (LGP) excavator and material would be removed from the Project site using a LGP track truck. A temporary access route, 35-feet wide, would be created using mats along one side of channel to provide equipment access. Access into the Project site would be from the perimeter levees. Table 3 below provides a summary of activities related to maintenance of water control structures and connecting channels.

Future – Alternatives 2 and 3

Maintenance of water control structures under Alternative 2 would be similar to description under Alternative 1, but with the following exceptions. Under Alternative 2, West Area B would not be improved. The existing West Area B gates connecting West Area B to Ballona Creek would remain and would continue to be maintained as under the existing conditions.

Maintenance of water control structures under Alternative 3 would be similar to the existing conditions, but also would include the addition of two new banks of culverts and gates connecting Area A to Ballona Creek. The existing West Area B gates connecting West Area B to Ballona Creek would remain and would continue to be maintained as under the existing conditions. Twelve new gates would be installed between Area A and Ballona Creek. Maintenance and replacement of these gates would be completed at the same frequency and using the same equipment and approach as described under Alternative 1.

South and Southeast Area B Flood Risk Management Berms

Existing

The berm features do not exist in the baseline (pre-Project) condition.

Future – Alternative 1

Berms would be constructed along lower perimeter elevations of South and Southeast Area B and tied into areas of high ground to maintain the existing level of flood risk protection (e.g., around the SoCalGas facility and along Culver Boulevard and Jefferson Boulevard). Maintenance of the berms would be focused on erosion protection.

Table 3. Alternative 1 Water Control Structure Summary

Location	Activity	Frequency	Equipment	Quantity	Area Affected
Wetland to West Area B	Replace gate	Once every 10 years for life of project	Crane	1 gate	N/A
South Area B to West Area B	Replace gates	Once every 10 years for life of project	Crane	5 gates	N/A
	Connector channel to Ballona Creek sediment removal	Years 1-5: 2 times per year Years 6-10: 1 time per year	LGP excavator, LGP track trucks, mats to provide access along channel	Years 1-5: 560 CY per year Years 6-10: 280 CY per year	2.3 acres within channel 1 acre adjacent to channel for access
Southeast Area B to North Area B	Replace gates	Once every 10 years for life of project	Crane	5 gates	N/A
	Connector channel to Ballona Creek sediment removal	Years 1-5: 2 times per year Years 6-10: 1 time per year	LGP excavator, LGP track trucks, mats to provide access along channel	Years 1-5: 130 CY per year Years 6-10: 65 CY per year	0.5 acres within channel 0.2 acre adjacent to channel for access
Freshwater Marsh to North Area B	Connector channel to Ballona Creek sediment removal	Years 1-5: 2 times per year Years 6-10: 1 time per year	LGP excavator, LGP track trucks, mats to provide access along channel	Years 1-5: 240 CY per year Years 6-10: 120 CY per year	1 acre within channel 1 acre adjacent to channel for access
Gas Company Road	Replace gates	Once every 10 years for life of project	Crane	5 gates	N/A

Monitoring for erosion will occur during the rainy season. Monitoring will occur approximately one month prior to the expected onset of seasonal rains on a monthly to bi-monthly basis following the onset of seasonal rains during the first several years of the restoration. The timing of monitoring will allow the Ballona Reserve Manager sufficient time to perform maintenance or install additional controls prior to the onset of winter rains. The purpose of monthly monitoring during the rainy season is to document any areas of erosion and to identify the need for maintenance or additional control measures. Although these measures are useful for short-term erosion control during construction and the initial phases of vegetation establishment, long-term erosion control measures will be focused on the establishment of vegetative cover. Once vegetation communities have become sufficiently established to reduce the potential for erosion, the frequency of monitoring may be reduced, but will occur no less than once per year during the entire 10-year monitoring period. If significant erosion is observed, measures may be taken to correct the erosion issue such as re-grading or installation of more durable surface scour protection measures.

Future – Alternatives 2 and 3

Maintenance of flood risk management berms under Alternative 2 will be the same as described under Alternative 1.

Alternative 3 does not include flood risk management berms and, thus, no additional maintenance will be needed.

Freshwater Marsh and Associated Drainage Structures

Existing

The Freshwater Marsh was completed in 2009 and is operated and maintained by the Ballona Wetlands Conservancy, a non-profit State of California established agency funded by the Playa Vista development. Operations for the Freshwater Marsh consist primarily of controlling the water surface elevation to provide detention of smaller storm events balanced with adequate freshwater availability for health of the ecosystem. Maintenance includes trash, weed, and vector control, as well as structural maintenance for the drainage and access structures and features. Monitoring of the health of the Freshwater Marsh is accomplished through regular testing and inspection of inflows and outflows as prescribed by permits issued by the Corps and the Regional Water Quality Control Board and annual reporting. The Ballona Wetlands Conservancy has a separate operation and maintenance manual, and a stipulated documentation and reporting process that allows the Freshwater Marsh to be operated and maintained in perpetuity with minimal maintenance costs.

The Freshwater Marsh is outside the Project area, but has multiple inlet and outlet structures that connect to the Ballona Reserve. All of these structures are under the primary jurisdiction of the LACFCD, but are operated, inspected, and maintained by the Ballona Wetlands Conservancy.

Future – Alternative 1

Three outlet structures will be modified by the Project. The greatest modification will be due to the removal and relocation of the Ballona Creek levee. When the south levee is relocated along Culver Boulevard, an existing outlet structure and set of three flap gates will be relocated to the new levee location. The second modification is the completion of a relatively small outlet pipe (24-inch diameter) extending from an existing valve structure, which will allow direct freshwater release into Area B-South irrespective of storm events. The third modification, the existing overflow weir structure, may be modified to adjust a variable overflow elevation control system. After construction, the relocated structure, flap gates, pipes, and weir will continue to be operated and maintained by the Ballona Wetlands Conservancy. Replacement of the gates would be accomplished using the same approaches as summarized under the Water Control Structures section above. Details are provided in the table below.

Table 4. Alternative 1 Freshwater Marsh Summary

Location	Activity	Frequency	Equipment	Quantity	Area Affected
Freshwater Marsh to North Area B	Replace gates	Once every 10 years for life of Project	Crane	3 gates	N/A

Future – Alternatives 2 and 3

Maintenance of the Freshwater Marsh and associated drainage structures under Alternative 2 will be the same as described under Alternative 1.

Maintenance of the Freshwater Marsh and associated drainage structures under Alternative 2 will be the same as described under the existing condition.

Stormwater Management Features

Existing

The stormwater bio-swales and pre-treatment basins do not exist in the baseline (pre-Project) condition.

Future – Alternative 1

Stormwater management features requiring maintenance include bio-swales and pre-treatment basins. Information in this section is based on descriptions provided in a technical memorandum by Psomas (Psomas 2016)

Bio-swales

Maintenance of bio-swales is expected to be limited to non-native vegetation removal. Non-native plant removal would include work with hand tools such as shovels, rakes, hatchets, wheel barrows, and small trucks for hauling of equipment and spoils. The trucks would remain at the nearest access path or road with removal of spoils conveyed to them.

It is expected that these efforts would occur once a year for the lifespan of the Project. Two to four people could be expected to provide this annual maintenance in two to five days. The expected volumes of non-native plant species to be removed would vary but should be minor. The area impacted also would be minor, limited to within the bioswales, the footprint of which will be finalized during design.

Pre-Treatment Basins

Maintenance of pre-treatment basins will include non-native vegetation removal, minor structural repair, and sediment removal.

Non-native vegetation removal in the pre-treatment basins would utilize the same equipment and methods as described above under bio-swales and would occur at the same frequency. Impact areas for removal and access for each basin would be the same as described in under sediment removal in Table 5 below.

Minor structural repair would include repair of storm drain pipes, headwalls, and berms associated with the stormwater management features. Minor chipping or cracking of the concrete structures (storm drain pipe and headwalls) would be repaired with small batches of concrete or mortar that is hauled in with either a portable mixer or in a five gallon bucket and applied to the local repair area. Minor berm distress (rills and other erosion level distress) would be repaired with shovels and hand tamps. Trucks for hauling hand tools and personnel would remain at the nearest access path or road. It is expected that these efforts would occur once a year for the lifespan of the Project.

The pre-treatment retention/detention basins are designed to capture stormwater runoff from upstream tributary areas and allow the silts and other debris carried by the runoff to settle within the basins prior to infiltration and/or discharge into the Ballona wetlands. This “storage” must be maintained for proper functioning. The basins have been sized to intercept the 5-year storm event while the minimum storm event to provide appropriate pre-treatment is a 2-year storm. The basin sizing for a 5-year storm will allow room for sediment and debris build up without initially impacting functionality. Therefore, the pre-treatment basins can be allowed to fill approximately 40% before major maintenance is necessary. Sediment removal quantities for each basin based on this design criterion are included in Table 5 below.

A formal inspection related to storage volume and accumulation volume will be conducted annually. Permanent markers and volume indicators (concrete posts or similar) will be placed in the basin for ease of the visual inspection estimate. Removal of sediment is estimated to be required once every 50 years for the life of the Project. When removal sediment is required, the maintenance effort will consist of excavating the accumulated silts and debris with a lightweight backhoe, dump truck, and assorted hand tools from the basin to return it to the original design size and depth. This effort is estimated to require four to six people and be completed in one to three weeks. The excavated material can either be used elsewhere where erosion may have occurred (if testing indicates the material deems it suitable for re-use), or can be trucked to an acceptable disposal site. Because the backhoe and trucks must directly access each basin to be excavated, a defined ingress/egress route will be established to limit the vehicular impact. Repair of the ingress/egress path and replanting of stripped areas in the basin will be required after the effort is completed. Details related to basin area and access are summarized in Table 5.

Table 5. Stormwater Pre-Treatment Basins Sediment Removal Summary

Basin	Activity	Frequency	Equipment	Quantity (cubic yards)	Area Affected (square feet)
Southeast Area B					
3A	Sediment Removal	Once every 50 years for the life of Project	Backhoe, flatbed truck, dump truck, grading roller	190 CY	Basin: 11,171 SF Access: 535 SF
11D	Same as above			50 CY	Basin: 7,750 SF Access : 3,990 SF
13E	Same as above			80 CY	Basin: 6,945 SF Access : 3,170 SF
15D	Same as above			130 CY	Basin: 5,427 SF Access: 1,545 SF
West Area B					
14B-Pershing Drain	Same as above			1,030 CY	Basin: 30,900 SF Access: 482 SF
South Area B					
15C	Same as above			1,190 CY	Basin: 18,060 SF Access : 1,205 SF
18C	Same as above			1,820 CY	Basin: 29,810 SF Access: 485 SF
Area A					
Parking Structure	Same as above			860 CY	Basin: 14,810 SF Access: 1,512 SF
North Area C					
Fiji Ditch	Same as above			TBD	Basin: 1,700 SF Access: NA

Future – Alternatives 2 and 3

Maintenance of stormwater management features under Alternative 2 would be similar to description under Alternative 1, but with the following exceptions. Under Alternative 2, West Area B would not be improved and thus, the sediment removal activities associated with Basin 14B-Pershing Drive would not be needed.

Maintenance of stormwater management features under Alternative 3 would be similar to description under Alternative 1, but with the following exceptions. Under Alternative 3, only Area A would be improved and thus, only the sediment removal activities associate with the Parking Structure Basin would be included.

Trash Boom

Existing

LACFCD operates and maintains an existing trash boom system (or trash net) between the Culver Boulevard and Lincoln Boulevard bridges, which catches trash and debris carried downstream by Ballona Creek flows, primarily during storm events. LACFCD provided the following information on existing trash boom O&M. LACFCD inspects the trash net weekly and removes trash from the net as necessary.

Description

- Three booms – 75 feet connected to 50 feet connected to 75 feet all have 10-inch diameter booms and 18-inch skirts.

Maintenance Routines

- The trash boom is inspected weekly for debris, and the net is cleaned if necessary.
- After every rain event, the net is monitored and repairs are made, as needed.
- Debris is collected during daylight hours only, on an outgoing tide, and only during the week unless there is a storm that has recently passed, and trash was present on the last working day of the week.
- If necessary, a supervisor checks the net on weekends and calls a crew to clean the net.

Amount of Trash Collected

Year	Tons	Trash Removal Days
2006	38	43
2007	44	43
2008	46	24
2009	27	12
2010	21	18
2011	23	20
2012	22	13 (through November 28)

The Project allows for continued O&M of the existing trash net; no changes to trash net O&M are anticipated.

Vector Control Protocols

Existing

Vector control activities have not occurred within the Project area over the last several years due to drought conditions. In previous years, the Los Angeles County West Vector Control District (LACWVCD) has applied larvicides in South Area B, and likely other wet areas of the Ballona Reserve. LACFCD currently controls insect vectors, including midges and mosquitos, along existing flood risk management channels within Los Angeles County, including Ballona Creek. For example, the LACDPW sought and thereafter received State Water Resources Control Board continuous coverage (effective July 1, 2014) under General Permit Water Quality Order No. 2011-0002-DWQ, Statewide General National Pollutant Discharge Elimination System (NPDES) for Aquatic Vector Control Applications, to apply an insecticide called Bactimos PT to Ballona Creek channel sections outside the Project area between the months of April and October each year to keep midge populations below nuisance levels. The active ingredient in the insecticide applied for is *Bacillus thuringiensis, israelis* (BTI), a microbial larvicide that targets mosquitos, aquatic midge larvae, and closely-related insects such as black flies.

Future

Wetlands are known to increase populations of insect vectors, such as midges and mosquitos, to levels much higher than those seen in flood risk management channels, but not necessarily in saltwater wetlands. Therefore, vector control methods within the restored wetland complexes may or may not need to increase in frequency and/or amount to augment the existing vector control methods already in place by the LACFCD. Also, the restored and enhanced tidal wetlands would be designed to provide daily tidal flushing to support tidal wetland functions, which would also discourage vector breeding; however, it is possible that vector control within certain areas of the restored wetland complexes may need to increase in frequency and/or amount. Future vector control activities within the Ballona Reserve would be coordinated between LACFCD, LACWVCD, and CDFW. If pesticide application is determined to be necessary, the least toxic available control will be used. Based on best available information, it is anticipated that Bactimos PT or another insecticide that has BTI as an active ingredient will be used in strict accordance with a pesticide application plan that is substantially similar to the Pesticide Application Plan (PAP) for Ballona Creek and Centinela Creek Vector Control Program prepared by LACDPW, dated July 3, 2014, and submitted in support of its 2014 NPDES General Permit for Vector Control Application pursuant to Water Quality Order No. 2011-0002-DWQ.

If vector control is determined necessary to control mosquitoes and/or midges, Bactimos PT will be applied uniformly over the entire surface area of the waterbody. If complete surface coverage is not possible, then applications will be concentrated at least within 2 meters of the perimeter in <1 meter deep water. Bactimos PT will be applied using conventional ground application equipment such as hand or motorized spreaders or backpack blowers. Although actual use may vary depending on vector abundance and compliance with application directions, the expected application rate is 25 pounds per acre. Applications will be timed carefully to coincide with periods in the lifecycle when larvae are actively feeding, i.e., in the warmer periods of April and October each year.

LACFCD

<u>Habitat Restoration, Monitoring, and Maintenance</u>

All habitat restoration activities will be coordinated by the CDFW and conducted by local NGOs or contracted staff in the Ballona Reserve.

Existing

Existing O&M activities related to habitat management include, but are not necessarily limited to, the following:

- Restore native habitats through hand planting and hydrological improvements
- At the discretion and approval of the CDFW, control and limit the spread of exotic non-native and/or invasive species (floral and faunal) that threaten to dominate the landscape and outcompete native species, which serves to restore the integrity of intact, native communities
- Conduct ongoing floral and faunal surveys
- Identify and remove or circumvent any barriers to wildlife movement
- Maintain and restore habitat continuity between upland and wetland habitats

- Restore ecological function to disturbed areas adjacent to continuous habitat
- Install wildlife housing and nesting platforms

Future

Revegetation

Portions of the restored site will be planted (e.g., upland, transition zone, high marsh, and low marsh), while other marsh areas may rely on natural recruitment of salt marsh vegetation (e.g., mid marsh). The Ballona Reserve Conceptual Habitat Restoration and Adaptive Management Plan (CHRAMP) (Appendix A) includes a revegetation plan, including monitoring and maintenance, as well as a plant palette. Vegetation maintenance, irrigation, and weeding may be required for certain habitats (e.g., for transition and upland habitat plantings).

Establishment of vegetation in the restored habitats will be based on a combination of natural revegetation and planting or seeding with native plant species appropriate to the hydrologic, soil, and climatic conditions at Ballona Reserve. Due to the extensive area involved in the restoration and the potential cost involved in the use of potted plants and plugs, natural revegetation and/or seeding will be used whenever possible. Areas receiving regular tidal inundation are ideal for natural revegetation as tidal waters can contain large numbers of propagules for plants suited to tidally influenced habitats—these include low and mid-marsh habitats, as well as brackish marsh habitats. Limited installation of potted plant material or plugs may be used in these areas to speed recolonization of the marsh plain, especially in Area A where input of dispersing seed will likely be low due to the low cover of tidal wetland plants currently present in this portion of the Ballona Reserve. Subsoils and soils excavated from existing marsh or salt pan habitat may lack a suitable seed bank for natural revegetation in uplands; however, if this is the case, these soils will have the advantage of lacking an upland weed seed bank as well. These areas will require seeding with an appropriate mix of native herbaceous plants with supplemental planting of native shrubs. Alternatively, shrubs may be seeded; however, establishment of shrubs from seed is a slow process and better results are likely to be achieved with potted plants. Given the need for sand stabilization in the created dunes, the use of potted plants and plugs is preferred over natural revegetation in this habitat.

Plantings will require careful phasing to ensure that plants are installed at the correct time of year (ideally at the onset of winter rains) and that plantings occur as soon as possible after final grading. This will help ensure successful establishment with minimal need for irrigation, reduce the potential for erosion, and minimize colonization by weedy non-native species. Plantings in high marsh, transition, and upland habitats (including dunes) are likely to require supplemental irrigation during the first two to three years after planting. Depending on rainfall and soil moisture levels, temporary above-ground irrigation may be used in the high marsh or transition areas. If rainfall is below average or is considered inadequate to establish high marsh and transition zone vegetation, or to improve plant survival or establishment, an irrigation system consisting of a pressurized main line with hose bibs for manual watering or an automated overhead spray system would be used. The irrigation system would be located above the tidal zone to allow for plant establishment in this environment and would be connected to existing domestic and recycled water mains.

As previously mentioned, a potential plant palette is provided in the CHRAMP, which is included as Appendix A of this Plan. This list was developed based on the suite of native species documented in the existing conditions and baseline studies reports (PWA et al. 2006; Johnston et al. 2011, 2012), as well as on historical references and plant lists from other coastal wetlands in southern California (Schreiber 1981; Mattoni and Longcore 1997; Sullivan and Noe 2001; Dark et al. 2011; Sawyer et al. 2009). The species included in the list are all native to southern California. Efforts have been made to limit the species on this list to those historically present in the greater Los Angeles region; however, some species have been included based on their ease of propagation, adaptability to a wide range of environmental conditions, and ability to host special-status or other desired species.

There is potential to salvage some existing vegetation for use in the restored habitats; however, use of salvaged plant material will require careful timing to ensure that plants are removed from existing habitats and replanted during appropriate phenological stages and during appropriate times of year, both of which are species-specific. Salvaging existing vegetation would require an extensive area of land, on-site or off-site, devoted to propagation and staging. Because the plants being salvaged or propagated would be adapted to the local climate, heated greenhouse facilities may not be necessary; however, other infrastructure would be necessary. Such infrastructure might include shading structures, raised beds, propagation benches, irrigation, fencing, etc. Although the cost of salvaging plant material from the site could be reduced with volunteers, dedicated staff experienced in large-scale plant propagation would be necessary. Alternatively, the stockpiling and maintenance of salvaged plant material can be contracted out to a reputable nursery or a firm specializing in habitat restoration. It is unlikely that all of the plant material needed for the restoration can come from salvaged plant material, and propagation of additional plant material will be necessary. Plant propagation should be accomplished through collection of seeds and cuttings from healthy populations within the Santa Monica Bay watershed. If suitable donor populations cannot be located within this watershed, plant propagules may be sourced from adjacent watersheds; however, efforts should be made to collect plant material from as close to the Ballona Reserve as possible to maintain the genetic integrity of the regional flora and to ensure that the plants are adapted to the local climate. A large amount of plant material will be required over the lifespan of the restoration and it will be important to have ample material available during the initial planting and for supplementary planting in subsequent years as habitats develop. Initial plantings should focus on the dominant species desired in each habitat, with supplementary plantings to increase diversity in later stages of the restoration.

A Detailed Planting Plan will be developed for the restoration efforts and will outline specific protocols for plant sourcing and propagation, necessary infrastructure and staffing for on-site salvage and propagation, requirements for contracted plant salvage and propagation, specifications for soil amendments and irrigation, specifications and a schedule for planting and subsequent management actions, and a weed control plan to ensure successful establishment and long-term maintenance of plant communities at the Ballona Reserve. The Plan will be prepared and administered by the CDFW or a qualified contractor working under the direction of CDFW.

Urban Predator Management

Given the urban setting surrounding the Ballona Reserve, urban predators such as feral cats and raccoons are likely to pose significant threats to native wildlife within the Ballona Reserve. The presence of such urban predators may prevent the establishment of populations of wildlife species and may require control to achieve wildlife performance goals. An Urban Predator Monitoring and Management Plan will be developed in coordination with the CDFW. This plan will identify key areas for monitoring, trigger levels for management, and appropriate control methods. The Plan will be prepared and administered by the CDFW or a qualified contractor working under the direction of CDFW.

Erosion Protection

Erosion protection of manufactured slopes will be necessary in certain areas or conditions, primarily upland habitat restoration areas such as the upland fill in Area C North and Area B (between Culver, Lincoln, and Jefferson Boulevards). During and immediately after construction, erosion protection measures will be used to reduce escape of sediment from the Project site related to construction activities. The potential for maintenance related to long-term erosion (not related to the Ballona Creek or a drainage structure) is increased as the slope of the land increases. Slopes with a horizontal to vertical ratio steeper than 5:1 will be regularly inspected. Preventive measures may include revegetation or installation of localized short-term protection, such as biodegradable netting. If significant erosion is observed, measures may be taken to correct the erosion issue such as re-grading or installation of more durable surface scour protection measures.

Monitoring for erosion will occur during the rainy season. Monitoring will occur approximately one month prior to the expected onset of seasonal rains on a monthly to bi-monthly basis following the onset of seasonal rains during the first several years of the restoration. The timing of monitoring will allow the Ballona Reserve Manager sufficient time to perform maintenance or install additional controls prior to the onset of winter rains. The purpose of monthly monitoring during the rainy season is to document any areas of erosion and to identify the need for maintenance or additional control measures. Although these measures are useful for short-term erosion control during construction and the initial phases of vegetation establishment, long-term erosion control measures will be focused on the establishment of vegetative cover. Once vegetation communities have become sufficiently established to reduce the potential for erosion, the frequency of monitoring may be reduced, but will occur no less than once per year during the entire 10-year monitoring period.

Post-Restoration Monitoring

Habitat Monitoring. A wide variety of monitoring activities will occur in the Ballona Reserve following habitat restoration, which will vary based on habitat type. The habitats that will be monitored include tidal marsh, subtidal and intertidal channels, mudflat habitat, brackish marsh, salt pan, seasonal wetlands, riparian scrub and woodland, dune, upland scrub and grassland, and transition zones. Monitoring for some habitats will be more general and encompass the entire Ballona Reserve (ex: transition zones), while other habitats may require a greater level of detail in monitoring due to the complexity of the habitat and the wide variety of species it supports, such as salt pan and subtidal and intertidal channels. Habitat monitoring activities will be the responsibility of the CDFW or a qualified contractor working under the direction of CDFW. O&M activities/monitoring efforts are presented in in Table 6.

Invasive Species Management. Vegetation monitoring will be conducted to determine the presence and extent of invasive weeds and the establishment of native species in the restored areas. Plantings will be monitored for general health and vigor and evidence of any disease or wildlife browsing. Dead plants will be replaced, as needed, to establish the target plant communities. Mulch will be replenished in the planting basins, as required, and foliage protection cages will be maintained during the establishment period. Temporary irrigation systems also will be maintained and repaired as required.

Invasive weeds of concern are those listed by the California Invasive Plant Council (Cal-IPC; Cal-IPC 2013) as “High” or “Moderate,” exclusive of non-native annual grasses and the eucalyptus grove in Area B. On-site removal of invasive species would occur, and other non-native species also shall be removed if they are inhibiting the establishment and development of native plant species. Monitoring will consist of visual observations of invasive weeds and an estimate of total cover within the seasonal wetlands. Monitoring for invasive weeds will be conducted twice per year (or more frequently) during the entire 10-year monitoring period, once near the beginning of the growing season and during the annual vegetation monitoring toward the end of the growing season (or more frequently). Because it will not be possible to eliminate all propagule sources for non-native weeds that occur outside of the Ballona Reserve, some level of monitoring for invasive weeds will be required for the lifespan of the restoration.

Upland and freshwater habitats will require greater management for invasive weeds than will tidal wetland and salt pan habitats. Although complete eradication is unlikely for many species, the goal of weed control efforts at the Ballona Reserve is to minimize impacts from invasive species. Existing populations of highly invasive species will be controlled, to the extent feasible, and every effort will be made to prevent new populations from becoming established. Some of the existing non-native, invasive

Table 6. O&M Activities/Monitoring Efforts

O&M Activities/ Monitoring Efforts	Tidal Marsh	Subtidal and Intertidal Channels	Mudflat Habitat	Brackish Marsh	Salt Pan	Seasonal Wetlands	Riparian Scrub and Woodland	Dune	Upland Scrub and Grassland	Transition Zones	Reserve-wide Monitoring Elements
Bird Abundance and Diversity Monitoring	X		X		X				X		
Channel Morphology Monitoring		X									
Erosion Monitoring	X	X	X	X	X	X	X	X	X	X	X
Fish Abundance and Diversity Monitoring		X									
Hydrology and/or Salinity Monitoring					X	X					
Macroinvertebrate Abundance and Diversity			X								
Monitoring Canopy Cover and Determining Habitat Suitability for Monarch Butterfly							X				
Public Access, Infrastructure, Litter	X	X	X	X	X	X	X	X	X	X	X
Urban Predator Management	X	X	X	X	X	X	X	X	X	X	X
Vector Control	X	X	X	X	X	X	X	X	X	X	X
Vegetation and Invasive Plants	X	X	X	X	X	X	X	X	X	X	X
Water Quality		X									

plant species classified as “High” or “Moderate” by the Cal-IPC within the Ballona Reserve include black mustard (*Brassica nigra*), short podded mustard (*Hirschfeldia incana*), crown daisy (*Glebionis coronaria*), sea fig (*Carpobrotus* spp.), and pampas grass (*Cortaderia selloana*).

Weed removal methods contained in the Cal-IPC Weed Workers Manual[2] and website and at the U.S. Department of Agriculture website (http://plants.usda.gov/java/noxiousDriver) will be followed. Hand removal is the preferred method of removing weed species; accordingly, weed removal will occur using manual methods to the maximum extent possible. Hand removal or the use of small handheld equipment (such as a Weed Wrench or a chainsaw) will be used in areas where the associated ground disturbance will not adversely affect sensitive wildlife species. For some species, particularly woody species or large-biomass species (e.g., pampasgrass [*Cortaderia jubata*]), mowers, chainsaws, or other handheld equipment may be used.

Weeds will be removed before the species sets seed. When this is not feasible, seed heads will be removed from plants prior to removing the stems and roots. Seed heads of invasive species will be placed in plastic trash bags and removed from the project site for proper disposal. Plant materials will be removed entirely and disposed of carefully, including stems and all root fragments, to prevent regeneration or spread. In general, removal will be performed during the late winter or early spring when soils are moist enough to remove entire plants without breaking the roots.

If hand removal methods are found to be ineffective or the problem is too widespread for hand removal to be practical, chemical controls may be implemented, as described below. Herbicides may be used in conjunction with physical removal methods for species that are known to be difficult to control. An Herbicide Treatment Plan will be prepared for each treated weed species, including such information as the type of herbicide to be used, application rates, and timing of treatment. The Herbicide Treatment Plan will be prepared by the CDFW or a qualified contract prior to herbicide application. In all cases, herbicides would be used only to the extent necessary to support native plant establishment and limit adverse effects to sensitive species and habitats. For sites within 100 feet of a wetland or stream, the project will use herbicides approved by the Environmental Protection Agency (EPA) for use near wetlands and streams. Herbicides will not be used when rain is predicted within 24 hours after application, and herbicide application shall not resume again until 72 hours after rain. During nesting season, appropriate measures will be taken to avoid disruption of nests.

In addition to monitoring for invasive weeds, it may also be necessary to monitor for invasive wildlife species, such as New Zealand mudsnail (*Potamopyrgus antipodarum*) or American bullfrog (*Lithobates catesbeianus*). Although these species are not known to occur at the Ballona Reserve, there is potential for them to be introduced to the site. If these or other invasive wildlife species are observed at the site, a Monitoring and Eradication Plan will be developed consistent with CDFW policies regarding such species. The Plan will be prepared and administered by the CDFW or a qualified contractor working under the direction of CDFW.

2 The Watershed Project and California Invasive Plant Council, 2004. Weed Workers’ Handbook, A Guide to Techniques for Removing Bay Area Invasive Plants. [http://www.cal-ipc.org/ip/management/wwh/pdf/18601.pdf].

Public Access, Public Services, and General Maintenance

Existing

Existing O&M activities related to public access, public services, and general maintenance include, but are not necessarily limited to, the following:

- Develop interpretive trails within the Ballona Reserve within West Area B, for use by the general public and schools, working with local schools, teachers, students and volunteers;
- Design and install interpretive signs and other displays within the Ballona Reserve;
- Close or re-route existing trails for adaptive management/resource protection, at the discretion of the Ballona Reserve manager, using natural barriers such as boulders and logs, and restore native habitat;
- Conduct periodic reviews of public uses in the Ballona Reserve and assess the need for modifications to the public use program, the need for additional trails, and/or closure of some trails;
- Maintain trails as necessary for passage, public safety and resource protection by trimming vegetation, controlling erosion, and removing weeds;
- Vegetation mowing, or other forms of removal, to provide for fuel modification or a buffer between the open space and nearby existing facilities;
- Patrol the Ballona Reserve to enforce regulations that prohibit unauthorized uses;
- Use signage and written notifications to foster cooperation. Issue citations and/or pursue legal action when voluntary cooperation cannot be obtained;
- Reduce impacts from maintenance of utility easements where they disrupt ecological functions by minimizing size and/or frequency of impact, and/or other methods;
- Remove any potentially hazardous materials;
- Fence repair and installation as needed, at the discretion of the Ballona Reserve Manager;
- Notify, evict, and cleanup trespasser debris as needed, at the discretion of the Ballona Reserve Manager;
- Prune vegetation and/or take other corrective measures where needed to discourage illegal camping and other uses of the Ballona Reserve;
- Minor grading to restore topography after misuse and illegal trespasser activity (e.g., camp establishment, BMX track construction); and
- Stage equipment container(s) and management trailer within the Ballona Reserve for ongoing reserve management and maintenance.

Table 7, Other Current and Ongoing Routine Operation and Maintenance Activities, lists other routine current and ongoing O&M activities that would continue with implementation of the Project.

Table 7. Other Current and Ongoing Routine Operation and Maintenance Activities

Ongoing O&M Activities	O&M Activity Frequency	Notes
Inspect and lock gates	Daily	To be performed by the County at existing and new gate locations.
Maintenance and repair of fence and gates	Monthly or as needed	To be performed as needed for existing and new fence and gate locations by on-site Ballona Reserve staff except for levee-related fences and gates, which would be the responsibility of the LACFCD.
Trail maintenance	Weekly or as needed	To be performed by CDFW as needed for existing and new trails except for levee access roads and related accessways, the maintenance of which would be the County's responsibility.
Bicycle path maintenance	Weekly or as needed	Sweeping and maintenance of path surface to be conducted as needed by the County.
Access road maintenance	Approximately every 5 years or as needed	Pavement management and resurfacing to be conducted as needed by the LACFCD or the County.

SOURCES: P. Holland, Los Angeles County Department of Public Works. Personal Communication; R. Brody, California Department of Fish and Wildlife, 2014. Personal Communication.

Future

Public Access

Public access at the Ballona Reserve will be limited to roads, pedestrian trails, and designated public access areas such as picnic sites or wildlife viewing areas. The surface of walkways and trails will be maintained in good, dry condition. Areas that flood during the rainy season will be subject to seasonal closure or will be redesigned to prevent flooding. Trails will be free of large debris, and fencing and signage will be maintained in good condition.

Public access areas will include split-rail fencing, decomposed granite trails, and padlocks for fenced areas. Gravel or another ADA compliant material will be needed over the entire trail to ensure the trails are ADA compliant. Additionally, in the design phase of the public access areas, elevated walkways and piers will be considered to account for potential changes in sea level rise. This will prevent permanent or periodic flooding and wave action that could periodically cause damage and restrict access to the public access areas.

Social trails[3] and/or other non-official routes will not be allowed in any part of the Ballona Reserve. Given the relative ease of access to upland habitat relative to wetland habitat, human disturbance is likely to be a greater problem in upland habitat and will require regular monitoring and control. During monitoring for human disturbance, the presence and extent of social trails, trash, and other debris will be documented on maps or aerial imagery. Monitoring will occur over the full extent of the Ballona Reserve, with particular focus in the upland areas and areas immediately adjacent to trails and other public access areas. The condition of fencing, signage, and lighting also will be noted.

Hours of operation for public use of the West Culver Parking Lot and the existing parking lot and new parking structure in Area A would be from dawn to dusk. Parking would be locked after hours. The West Culver Parking Lot currently is unlocked, and CDFW and the City of Los Angeles Police Department

[3] A "social trail" is a path developed by erosion caused by animal or human footfall. The path usually represents the shortest or most easily navigated route between the origin and destination.

periodically check for vehicles that are parked overnight. This lot would be locked after dusk as part of future operations, during which the Los Angeles County Department of Beaches and Harbors would assume the responsibilities currently exercised by CDFW.

All maintenance activities for the ballfields would continue to be undertaken in conformance with the use agreement between the Culver-Marina Little League and CDFW.

Public Services - Trash

Trash and other human debris will not be allowed in natural habitats. Trashcans and recycling bins will be available throughout the publicly accessible areas of the Ballona Reserve and will be regularly emptied by a trash-collection agency contracted by the CDFW. Volunteers also will continue to clean up trash. Trash removal would occur as needed within the restored wetlands for some trash that is not caught upstream at the existing trash net either by LACFCD or CDFW. LACFCD would remove trash along the levees and CDFW would remove trash within the restored wetlands.

In addition, all workers should ensure that food scraps, paper wrappers, food containers, cans, bottles, and other trash from the project area are deposited in covered or closed trash containers. The trash containers should not be left open and unattended overnight.

Public Services – Public Safety

To ensure public safety, a public safety officer may be hired by CDFW to monitor the site for trails or other public access features that should be closed or re-routed due to the presence of hazardous conditions; to ensure that emergency access routes are unrestricted and available for use; to coordinate with the Los Angeles County Sherriff’s Department if illegal or dangerous activities are witnessed or suspected; and to enforce regulations that prohibit unauthorized uses.

Summary of Preliminary Operations and Maintenance Activities

The intent of the Ballona Wetlands Restoration Project is to restore a wetland and creek habitat and flood protection system that is sustained by natural processes and requires minimal operations and maintenance activities. The restored Ballona Creek channel is intended to have no substantial maintenance requirements. The levees are intended to have no substantial maintenance requirements, with only periodic repaving of bike paths and walking trails, fence repair, trash collection, and similar upkeep necessary. In locations where armoring is installed to limit erosion, the scour protection would be inspected and maintained as needed maintenance; however, maintenance is not anticipated to be needed. Flap gates will need regular inspection and maintenance to ensure proper operation. Gates eventually may need to be replaced when they are significantly damaged or reach the end of their useful life. Inspection of other water control structures will also occur periodically, but problems are unlikely except in the very long term. Gates may be adjusted seasonally for habitat management. Portions of the restored site will be planted, while other marsh areas may rely on natural recruitment of vegetation. The revegetation plan will include monitoring and maintenance. Vegetation maintenance, irrigation, and weeding may be required for certain habitats. A long-term Final O&M Plan will be established among the CDFW, the LACFCD, and other responsible parties to identify all operations and maintenance responsibilities for the new channel and levees, water control structures, habitat and vegetation, flood risk management, and other components of the project as part of the Section 408 permit process.

Tables 8a, 8b, and 8c and summarize the specific O&M tasks and activities discussed in this document. Potential environmental impacts of the tasks and activities identified in this Preliminary Operation and Maintenance Plan are evaluated in the EIS/EIR for the Project.

Table 8a. Summary of Operation and Maintenance Activities – Flood and Stormwater Monitoring and Management

Category	Ballona Reserve Location/Element	Task	Documentation or Reporting Requirement and Permit Acquisition	Frequency and Timing	Duration	Estimated Hours Required	Estimated Annual Cost
Flood and Stormwater Facility Management - Inspection	**Channel Inspection**	Levee elevation survey	TBD	As-needed if determined to be necessary	As-needed if determined to be necessary	TBD	TBD
		Levee inspection	TBD	Annual and after significant storm events	Life of project	TBD	TBD
		Scour protection inspection	TBD	Annual and after significant storm events	Life of project	TBD	TBD
		Channel cross-section survey	TBD	Once a year every five years and after significant storm events	Life of project	TBD	TBD
		Channel inspection	TBD	Annual and after significant storm events	Life of project	TBD	TBD
	Culver Levee water control structures	Structure inspection	TBD	Monthly	Life of project	TBD	TBD
	Road and perimeter drainage structures	Structure and pavement surface inspection, erosion inspection	TBD	Monthly	Life of project	TBD	TBD
	Water level monitoring	Channel and Area B managed wetland water level monitoring	TBD	Continuous	Life of project	TBD	TBD
	Flow monitoring	Creek discharge monitoring at Culver Blvd. bridge / upstream	TBD	Continuous during storm season	Life of project	TBD	TBD
	Data Analysis and Reporting	Analyze data, compare to established maintenance thresholds, authorize established maintenance measures	TBD	Annual	Life of project	TBD	TBD
Flood and Stormwater Facility Management - Operations	**Existing West Area B SRT gate operations**	Continue ongoing inspection, gate service, and maintenance (e.g., debris removal)	TBD	As-needed	Interim Phase	TBD	TBD
	New Culver Levee water control structures operations	Perform any established seasonal adjustments to water control structures; perform any annual adjustments identified through data analysis and reporting	TBD	Seasonal and annual or as-needed	Life of project	TBD	TBD
	Trash boom	Continue ongoing O&M	TBD	Weekly	Life of project	TBD	TBD
Flood and Stormwater Facility Management - As-needed Maintenance	**Channel Inspection**	Perform levee repairs as-needed / identified through inspection and monitoring data analysis and reporting	TBD	As-needed	Life of project	TBD	TBD
		Repair scour protection structures as-needed / identified through inspection and monitoring data analysis and reporting	TBD	As-needed	Life of project	TBD	TBD
		Perform channel excavation / dredging as-needed / identified through inspection and monitoring data analysis and reporting	TBD	Once every 50 years	Life of project	TBD	TBD
	Culver Levee water control structures	Repair Culver Levee water control structures as-needed / identified through inspection and monitoring data analysis and reporting/ Replace every 10 years	TBD	Repair as-needed Replacement every 10 years	Life of project	TBD	TBD
	Road and perimeter drainage structures	Repair/replace structures, remove silt, repair erosion protection, roadway resurfacing as needed / identified through inspection and monitoring data analysis and reporting	TBD	As-needed, and regular pavement resurfacing program	Life of project	TBD	TBD

Table 8b. Summary of Operation and Maintenance Activities – Habitat Restoration, Monitoring, and Maintenance

Category	Ballona Reserve Location/Element	Task	Documentation or Reporting Requirement and Permit Acquisition	Frequency and Timing	Duration	Estimated Hours Required	Estimated Annual Cost
Habitat Restoration, Monitoring, and Maintenance - Restoration Implementation	**N/A**	Implement restoration according to restoration design, CHRAMP, HMMP, CEQA documents, regulatory permits, etc.	HMMP	Ongoing (year round)	Duration of restoration and monitoring period	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Post-Restoration Reserve Management	**N/A**	Oversee management of Ballona Reserve post-restoration to ensure it corresponds with the restoration goals laid out in the CHRAMP.	HMMP	Annually (year round)	Continue indefinitely	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Habitat Monitoring	**All Habitats**	Collect high-resolution, orthorectified aerial imagery of site	HMMP	Annually (late summer at low tide)	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
		Monitor known populations of special-status plants. Populations will be monitored for density, cover, size, and number of individuals present.	HMMP; CEQA	Annually (timing depends on phenology of species in question)	Monitoring will occur for at least 10 years.	TBD	TBD
		Monitor for invasive weed establishment throughout the Ballona Reserve, with specific focus on the restoration areas.	HMMP	Annually or more frequently based on the species phenology; generally will occur in late spring, but may vary.	Continue indefinitely	TBD	TBD
		Assess effectiveness of weed control activities following the weed monitoring activities.	HMMP; HMP	Annually; timing varies based on timing of control efforts and phenology of species in question.	Continue indefinitely	TBD	TBD
		Monitor BMPs and excessive or problematic habitat erosion. This will be conducted via a walk through survey and will photographically document eroded areas.	HMMP	Semi-annually in spring and fall; additional monitoring should be conducted after heavy storms.	Continue indefinitely	TBD	TBD
		Monitor for litter, social trails, and other signs of human disturbance in natural habitats and restoration areas. A walk-through survey will be conducted as part of routine monitoring.	HMMP	Annually	Continue indefinitely	TBD	TBD
		Monitor for non-native urban predators (e.g., domestic cats).	HMMP	Annually; year-round.	Continue indefinitely	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Habitat Monitoring	**Tidal Marsh**	Monitor vegetation establishment, composition, and cover.	HMMP	Annually, at end of growing season and at low tide.	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
		Monitor bird abundance, diversity, and activities (e.g., foraging, resting, breeding).	CEQA	Annually; timing will vary based on phenology (e.g., migration, breeding, overwintering).	Monitoring will occur for at least 10 years.	TBD	TBD
		Monitor Belding's Savannah sparrow.	CESA; CEQA	Annually; during annual state-wide census	Monitoring will occur for at least 10 years or as long as state-wide census is in effect.	TBD	TBD

Table 8b. Summary of Operation and Maintenance Activities – Habitat Restoration, Monitoring, and Maintenance (continued)

Category	Ballona Reserve Location/Element	Task	Documentation or Reporting Requirement and Permit Acquisition	Frequency and Timing	Duration	Estimated Hours Required	Estimated Annual Cost
Habitat Restoration, Monitoring, and Maintenance - Habitat Monitoring	**Subtidal and Intertidal Channels**	Monitor channel location and extent.	HMMP	Annually; assessment can occur anytime and is based on aerial imagery collected in late summer.	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
		Ground-based monitoring of in-channel geomorphology including measurements of channel depth, width, and the location of banks at a variety of locations near and far from the channel openings.	HMMP	Annually after the rainy season; additional monitoring may occur immediately following large storm events.	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
		Ground based monitoring of sedimentation rates (esp. inboard of tide gates, culverts, etc.).	HMMP	Semi-annually in spring and fall; additional monitoring may be conducted after heavy storms.	Continue indefinitely	TBD	TBD
		Monitor sedimentation levels at openings to Ballona Creek and inboard of tide gates, culverts, etc.	HMMP	Semi-annually in spring and fall; additional monitoring may be conducted after heavy storms.	Continue indefinitely	TBD	TBD
		Monitor fish abundance, species richness, and diversity each major in tidal channel.	CEQA	Annually during summer when fish abundance and diversity is at its peak. Monitoring will occur at high tide.	Monitoring will occur for at least 10 years.	TBD	TBD
		Monitor water quality.	401	Annually (continuous if using data loggers or at intervals; TBD if assessing manually)	Monitoring will occur for at least 10 years.	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Habitat Monitoring	**Mudflats**	Monitor macroinvertebrate abundance and diversity of benthic invertebrates.		Annually (summer?), ad determined by project biologist	Monitoring will begin following one full year after the reestablishment of tidal activity and will be conducted annually for the duration of the 10-year monitoring period.	TBD	TBD
		Monitor bird abundance, diversity, and activities (e.g., foraging, resting, breeding).		Annually; timing will vary based on phenology (e.g., migration, breeding, overwintering), but always at low tide.	Duration of 10-year monitoring period.	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Habitat Monitoring	**Brackish Marsh**	Qualitative assessment of vegetation establishment and a lack of highly invasive weeds.		Annually in late summer.	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Habitat Monitoring	**Salt Pan**	Monitor hydrologic changes including fluctuations in water height throughout the year.		Annually, if needed; continuous if using data loggers or monthly (or more frequently) if using staff gauges or other manual methods.	A minimum of ten years, beginning of tidal year following construction activities.	TBD	TBD
		Monitor soil salinity.		Annually at the end of dry season/before onset of winter rains.	A minimum of ten years, beginning of tidal year following construction activities.	TBD	TBD
		Monitor vegetation establishment, composition, and cover.		Annually from years 1 to 5, then once in year 7 and year 10, assuming vegetation is approaching the expected performance standards. Monitoring should occur in mid to late summer.	A minimum of ten years, beginning of tidal year following construction activities.	TBD	TBD

Table 8b. Summary of Operation and Maintenance Activities – Habitat Restoration, Monitoring, and Maintenance (continued)

Category	Ballona Reserve Location/Element	Task	Documentation or Reporting Requirement and Permit Acquisition	Frequency and Timing	Duration	Estimated Hours Required	Estimated Annual Cost
		Monitor bird abundance, diversity, and activities (e.g., foraging, resting, breeding).		Annually; timing will vary based on phenology (e.g., migration, breeding, overwintering); always at low tide.	A minimum of ten years, beginning of tidal year following construction activities.	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Habitat Monitoring	**Seasonal Wetlands**	Monitor hydrology.		Annually; weekly basis during the rainy season.	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
		Monitor vegetation establishment, composition, and cover.		Annually; near end of growing season.	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Habitat Monitoring	**Riparian Scrub and Woodland**	Monitor vegetation establishment, composition, and cover.		Annually; mid- to late summer.	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
		Monitor eucalyptus tree health and success of efforts to replace with native tree species.		Every 2 to 3 years in mid- to late summer.	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
		Qualitative assessment of overwintering monarch population on eucalyptus and changes associated with replacement of eucalyptus with native species.		Annually; winter.	Continue indefinitely or as long as the species is listed by CDFW.	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Habitat Monitoring	**Dunes**	Quantitative monitoring of vegetation establishment, composition, and cover.		Annually in late summer.	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Habitat Monitoring	**Upland Scrub and Grassland**	Quantitative monitoring of vegetation establishment, composition, and cover.		Annually in mid- to late-summer.	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
		Monitor bird abundance, diversity, and activities (e.g., foraging, resting, breeding).		Annually; timing will vary based on phenology (e.g., migration, breeding, overwintering)	A minimum of ten years, beginning at the end of the first growing season following the completion of construction activities.	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Habitat Maintenance	**All Habitats**	Remove invasive plants.		Annually or more frequently based on the phenology of the species targeted for control.	Continue indefinitely	TBD	TBD
		Install additional plantings according to CHRAMP and HMMP.		Annually, as needed based on vegetation monitoring results. Vegetation should be installed at onset of winter rains.	Until plantings are on a clear trajectory to achieve restoration goals.	TBD	TBD
		Operate irrigation system		As needed during growing season.	As needed during initial 2 to 3 years of plant establishment	TBD	TBD

Table 8b. Summary of Operation and Maintenance Activities – Habitat Restoration, Monitoring, and Maintenance (continued)

Category	Ballona Reserve Location/Element	Task	Documentation or Reporting Requirement and Permit Acquisition	Frequency and Timing	Duration	Estimated Hours Required	Estimated Annual Cost
		Inspect irrigation system		Annually, prior to onset of growing season.	For the lifespan of the irrigation system.	TBD	TBD
		Implement predator control program.		Annually; year-round.	Continue indefinitely	TBD	TBD
		Implement adaptive management actions		Annually (varies)	Continue indefinitely	TBD	TBD
		Remove trash and other debris		Annually to semi-annually.	Continue indefinitely	TBD	TBD
Habitat Restoration, Monitoring, and Maintenance - Data Analysis and Habitat Restoration, Monitoring, and Maintenance – Reporting	**All Habitats**	Compile and input data into database		Annually (TBD)	Continue indefinitely	TBD	TBD
		Analyze data and prepare annual monitoring and maintenance report		Annually (TBD)	Continue indefinitely	TBD	TBD
		Prepare annual work plan		Annually (TBD)	Continue indefinitely	TBD	TBD

Table 8c. Summary of Operation and Maintenance Activities – Public Access, Public Services, and General Maintenance

Category	Ballona Reserve Location/Element	Task	Documentation or Reporting Requirement and Permit Acquisition	Frequency and Timing	Duration	Estimated Hours Required	Estimated Annual Cost
Public Access, Public Services, and General Maintenance - Public Access	**Roads, Sidewalks, Trails**	Inspect roads, sidewalks, and trails for damage or maintenance issues	TBD	Annually or more frequently	Continue indefinitely	TBD	TBD
Public Access, Public Services, and General Maintenance - Public Access	**Signage**	Inspect signs (including kiosks and interpretive panels) for damage, theft, or other maintenance issues	TBD	Annually or more frequently	Continue indefinitely	TBD	TBD
Public Access, Public Services, and General Maintenance - Public Access		Inspect public areas daily (e.g., lobby, restrooms, interpretive areas, outdoor meeting areas, etc.)	TBD	Annually; daily	Continue indefinitely	TBD	TBD
Public Access, Public Services, and General Maintenance - General Maintenance	**Greenhouse Facilities**	Inspect greenhouse facilities (e.g., heating, ventilation, irrigation, benches, other equipment)	TBD	Annually or more frequently, in conjunction with irrigation inspection (?)	TBD	TBD	TBD
Public Access, Public Services, and General Maintenance - Public Access	**Bike Paths**	TBD	TBD	TBD	TBD	TBD	TBD
Public Access, Public Services, and General Maintenance - Public Access		Conduct repairs to bike paths	TBD	Annually (as needed)	Continue indefinitely	TBD	TBD
Public Access, Public Services, and General Maintenance - Public Access	**Roads, Sidewalks, Trails**	Conduct repairs to roads, sidewalks, and trails	TBD	Annually (as needed)	Continue indefinitely	TBD	TBD
Public Access, Public Services, and General Maintenance - Public Access	**Signage**	Replace or repair signage (including kiosks and interpretive panels)	TBD	Annually (as needed)	Continue indefinitely	TBD	TBD
Public Access, Public Services, and General Maintenance - Public Access		Maintain public areas (e.g., lobby, restrooms, interpretive areas, outdoor meeting areas, etc.)	TBD	Annually, Daily	Continue indefinitely	TBD	TBD
Public Access, Public Services, and General Maintenance - General Maintenance	**Greenhouse Facilities**	Conduct repairs to greenhouse facilities (e.g., heating, ventilation, irrigation, benches, other equipment)	TBD	Annually (as needed)	TBD	TBD	TBD
Public Access, Public Services, and General Maintenance – Public Services	**Entire Ballona Reserve**	Enforce all applicable rules/laws, ensure public safety	TBD	Annually (as needed)	Continue indefinitely	TBD	TBD

1.4 Estimated Operations and Maintenance Costs and Funding Sources

Estimated Costs

The preliminary estimated costs provided in Section 2.1.1 of the Draft EIS/EIR will be refined before this Preliminary Operation and Maintenance Plan is finalized. High cost, long life, capital equipment (e.g., bridges, levees, tide gates, culverts, and roads) have life spans of 50 to 100 years or longer, barring damage from disasters, unlawful acts, or faulty materials. They require very little major maintenance activities, but their continued viability requires routine inspection and preventative maintenance and they may ultimately be replaced or reinforced. The ultimate replacement/reinforcement will have a high cost and will likely create localized disturbance to the ecosystem. A separate permitting process may be required for these items. These items are likely maintained by the County for public safety. Smaller cost items (e.g., parking lots, walkways, lighting, and fencing) have varying costs, but will likely be maintained by CDFW. Different groups may also be responsible for maintenance and activities will be categorized depending on the urgency for maintenance and replacement. Daily maintenance (e.g., changing light bulbs, cleaning toilets, replacing hand tools, weeding of some areas) may have public involvement, but will require staffing appropriate to the need.

<u>Assets and Capital Equipment</u>

- Tide gates
- Culverts
- Roads (pavement, gutters, culverts, shoulders)
- Bridges
- Parking areas
- Sidewalks
- Trails (decomposed granite trails, including drainage crossings)
- Trash containers, liners, and a large dumpster
- Modular pre-fabricated trailer office space with a septic tank
- Split-rail fencing and padlocks
- Fence repair equipment (e.g. bolt cutters and splicers)
- Cage traps
- Provisions for kiosks, signage, benches, and Trex trails
- Staging areas
- Lighting
- Boardwalks
- Greenhouse facilities
- Workshop/garage for tractor and other machinery
- Tractor (or other equipment for levee maintenance or other)
- Other large machinery (e.g., tractor attachments, shop tools)
- Infrastructure/Habitat maintenance tools (e.g., drills, saws, post drivers, shovels, etc.)
- Restrooms
- Monitoring equipment (binoculars, cameras, spotting scope, tripod, and cell phones).
- Vehicles
- Gator All-Terrain Vehicle outfitted with a 150 gallon Intellispray
- Mower
- Backpack sprayers
- Office equipment (e.g. computers, copiers, file cabinets, etc.)
- Irrigation system (temporary for habitat restoration)

Operations and Maintenance

- Administration (restoration oversight, Ballona Reserve management, monitoring/maintenance coordination, report coordination, permit/agency coordination, etc.)
- Permitting and approvals (including mitigation)
- Habitat monitoring (conducted by project team or design team/professionals)
- Habitat maintenance
- Data analysis and reporting
- Infrastructure monitoring
- Infrastructure operations (e.g., tide gate adjustments)
- Infrastructure maintenance
- Law enforcement

Funding Sources

- CDFW
- SCC
- LACFCD (regional flood risk management function)
- LACDPW (bikeway components)
- Others (e.g., Friends of Ballona, Los Angeles Parks)

2.0 FUTURE REVISIONS TO PRELIMINARY OPERATIONS AND MAINTENANCE PLAN

This Preliminary O&M Plan details predicted operation and maintenance needs within the Ballona Reserve. However, as with most biological systems, restoration activities are changing environments, which can present additional issues that must be addressed (e.g., seasonal and annual fluctuations in precipitation, temperature, weed introduction, and other biotic factors) to create a successful restored ecosystem. Therefore, this Preliminary O&M Plan is written to allow adaptation and account for unpredicted future needs. Some of the revisions to the O&M Plan may be minor in nature and decided solely by on-site CDFW staff and management, while other revisions may include major changes to infrastructure and management. All revisions (minor or major) will be subject to applicable environmental reviewvrequire4ment.

2.1 Minor Revisions

Minor revisions to the O&M Plan could include adaptive management of restorations, including replanting failed plantings, increasing or decreasing initial irrigation (if employed), tide gate and culvert replacement without a change in location, weed management, trespasser violations and vandalism, and other adaptations to restoration habitats. Minor revisions also could include changes to who (which state or local entity) is responsible for implementing particular operation and maintenance tasks. These types of minor revisions will require informal decisions and discussion and documentation of the changes.

2.2 Major Revision

Major revisions to the O&M Plan could include activities such as levee replacement, changes to the restoration plan and location of restored areas, and other large-scale activities. Major revisions would require detailed discussion with all affected agencies and analysis of proposed changes by scientific experts to determine the necessity for the revision, as well as to ensure the major revision follows CDFW requirements, regulatory procedures, and environmental compliance and permit requirements.

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APPENDIX B6
Mitigation Monitoring and Reporting Program

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PRELIMINARY MITIGATION MONITORING AND REPORTING PROGRAM

for the

BALLONA WETLANDS RESTORATION PROJECT

prepared by the

California Department of Fish and Wildlife
as lead agency under the
California Environmental Quality Act

State Clearinghouse No. 2012071090

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1. Introduction

This document describes a preliminary mitigation, monitoring, and reporting program (MMRP) proposed by the California Department of Fish and Wildlife (CDFW) as the lead agency under the California Environmental Quality Act (CEQA, Pub. Res. Code §§21000 et seq.) and its implementing guidelines (CEQA Guidelines, 14 Cal. Code Regs. §15000 et seq.) for the Ballona Wetlands Restoration Project (Project). The purpose of the MMRP is to ensure the effective implementation of the mitigation measures recommended in the joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR) prepared for the Project by CDFW as the CEQA lead agency and by the U.S. Army Corps of Engineers (Corps) as the lead agency under the National Environmental Policy Act (NEPA, 42 U.S.C. § 4321 et seq.). CDFW proposes a large-scale restoration of the Ballona Wetlands Ecological Reserve (Ballona Reserve) that would entail restoring, enhancing, and establishing native coastal wetland and upland habitats within the Ballona Reserve. To implement the proposal, CDFW is working with the Los Angeles County Department of Public Works-Flood Control District (LACFCD) to modify Los Angeles County Drainage Area (LACDA) project features (including the Ballona Creek channel and levee system) within the Ballona Reserve.

If and when the Project is approved by CDFW and the Corps, this preliminary MMRP would be refined, further developed, or supplemented as needed to identify the final, approved mitigation measures. Once finalized, the MMRP would serve as a self-contained general reference for the Mitigation, Monitoring, and Reporting Program adopted for the Project.

Current versions as of the publication of the Draft EIS/EIR of all mitigation measures identified in the Draft EIS/EIR are presented in Table 1, which is provided at the end of this MMRP.

2. Monitoring Requirements and Purpose

One of CEQA's fundamental purposes is to reduce potential significant adverse impacts when it is feasible to do so (Pub. Res. Code §§21002, 21002.1). To implement this requirement, a CEQA lead agency must adopt mitigation measures that are fully enforceable through permit conditions, agreements, or other measures (Pub. Res. Code §21081.6(b); CEQA Guidelines §15091(d)) and adopt an MMRP to ensure that the measures actually will be implemented as a condition of project approval, and not merely adopted and then neglected (*Environmental Council of Sacramento v. City of Sacramento* (2006) 142Cal. App. 4th 1018, 1035; *Federation of Hillside and Canyon Associations v. City of Los Angeles* (2000) 83Cal. App. 4th 1252, 1261).

This preliminary MMRP has been prepared in accordance with CEQA and the CEQA Guidelines. The measures presented below to avoid or mitigate the Project's potential significant adverse environmental impacts would be fully enforceable following final approval of the MMRP.

This preliminary MMRP: (a) describes all feasible mitigation measures recommended for the Project in the Draft EIS/EIR; (b) identifies the applicable "Monitoring Agency" for each mitigation measure, (c) establishes and describes the requisite implementing actions, and (d) provides an administrative procedure for the acceptance of each mitigation measure by including a column for the future listing of the approval/clearance date for each mitigation measure.

3. CDFW's Mitigation Authority

CDFW's authority to adopt mitigation measures to avoid or reduce potential significant adverse impacts is based on its regulatory authority under the California Fish and Game Code, including the Lake and Streambed Alteration Agreement sections (Fish and Game Code §§1603, 1605) and the California Endangered Species Act (Fish and Game Code §2081). CEQA does not provide independent legal authority for CDFW to impose or otherwise require the implementation of feasible mitigation measures for impacts that fall outside CDFW's regulatory/permitting jurisdiction (Pub. Res. Code §21004). The mitigation of those impacts may be imposed only by another agency with pertinent regulatory authority. To ensure enforcement of all non-biological resource related mitigation measures identified in the final MMRP, CDFW has made an enforceable commitment to implement all mitigation measures identified in the final MMRP to the Corps as a condition of the federal approvals required from the Corps to implement the Project.

4. General Monitoring Procedures

Mitigation Monitor

Many of the monitoring procedures will be conducted during the restoration phase of the Project. CDFW and the mitigation monitor are responsible for integrating the mitigation monitoring procedures into the restoration process and, insofar as the mitigation measures relate to modifications to the LACDA project facilities within the Ballona Reserve, with the LACFCD. To oversee the monitoring procedures and to ensure success, the mitigation monitor assigned to restoration activities must be on site during the activities that have the potential to create a significant environmental impact. The mitigation monitor is responsible for ensuring that all procedures specified in the MMRP are followed.

Restoration/Construction Personnel

A key feature contributing to the success of mitigation monitoring will be obtaining the full cooperation of restoration personnel and supervisors. Many of the mitigation measures require action on the part of the restoration supervisors or crews for successful implementation. To ensure success, the following actions, detailed in specific mitigation measures included in the MMRP, will be taken:

- Procedures to be followed by companies hired to do the work will be written into contracts between CDFW and any contractors. Procedures to be followed by crews will be written into a separate agreement that all on-site personnel will be asked to sign, denoting agreement.
- One or more meetings will be held before the start of work to inform and train all on-site personnel about the requirements of the MMRP.

- A written summary of mitigation monitoring procedures will be provided to supervisors of on-site workers for all mitigation measures requiring their attention.

General Reporting Procedures

Site visits and specified monitoring procedures performed by other individuals will be reported to the mitigation monitor assigned to the restoration activities. A monitoring record form will be submitted to the mitigation monitor by the individual conducting the visit or procedure so that details of the visit can be recorded and progress tracked by the mitigation monitor. A checklist will be developed and maintained by the mitigation monitor to track all procedures required for each mitigation measure and to ensure that the timing specified for the procedures is adhered to. The mitigation monitor will note any problems that may occur and take appropriate action to rectify the problems. CDFW or the mitigation monitor shall prepare written quarterly reports of the Project, which shall include progress of Project implementation, resulting impacts, mitigation measures implemented, and all other noteworthy elements of the Project. Quarterly reports shall be required as long as mitigation measures are applicable.

Public Access to Records

The public is allowed access to records and reports used to track the monitoring program. Monitoring records and reports will be made available for public inspection by CDFW upon request. CDFW will develop a filing and tracking system.

Condition Effectiveness Review

In order to fulfill its statutory mandates to mitigate or avoid significant effects on the environment and to design a MMRP to ensure compliance during Project implementation (14 Cal. Code Regs. §21081.6):

- CDFW may conduct a comprehensive review of conditions which are not effectively mitigating impacts at any time it deems appropriate; and

- If CDFW determines that any conditions are not adequately mitigating significant environmental impacts caused by the Project, or that recent proven technological advances could provide more effective mitigation, then CDFW may impose additional or different reasonable conditions to effectively mitigate these impacts.

TABLE 1
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Aesthetics			
Mitigation Measure AE-4a: *Construction Lighting*. Construction contractors shall ensure that all temporary construction lighting shall be designed and installed to be fully shielded (full cutoff) and to minimize glare and obtrusive light by limiting outdoor lighting that is misdirected, excessive, or unnecessary. Construction lighting shall be oriented away from nearby land use areas that are not being affected by construction.			
Mitigation Measure AE-4b: *Lighting Plan.* Prior to implementing any changes to the existing parking areas, a lighting plan shall be developed and implemented that requires all exterior lighting to be directed downward and focused away from adjacent sensitive uses and habitats to encourage way-finding and provide security and safety for individuals walking to and from parking areas.			
Air Quality			
Mitigation Measure AQ-1: *Odor Management Plan.* In order to reduce odors from the decomposition of organic materials during excavation and stockpiling activities, contractors shall submit and implement, for and upon CDFW approval, an odor management plan to limit hydrogen sulfide levels to 10 parts per billion at the site perimeter. This concentration is below the state 1-hour standard of 30 parts per billion. The plan shall be reviewed and approved by the CDFW and include the following elements: a) Monitoring and recording of hydrogen sulfide at the perimeter of the Ballona Reserve to ensure compliance and implementation of the plan. Monitoring shall occur periodically during the days when fill in Area A is being removed. Monitoring shall occur along the perimeter with the closest off-site receptors in addition to the perimeter that is most directly downwind from the removal activities; b) Procurement and local storage of an oxidizer that can be applied in liquid form to treat stock piles of sediment or particularly odorous excavation areas; however, the use of such an oxidizer shall be approved by the CDFW, in advance, to ensure that it would not be harmful to aquatic organisms or cause long-term adverse effects in the aquatic environment (Ventana 2010); and posting of signage at entrances to the Ballona Reserve (including at the Fiji Way entrance to the CDFW trailer, the Culver Boulevard entrance to the baseball fields, and the West Culver Parking Lot) listing the contact information for odor complaints			
Biological Resources			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Cultural Resources			
Mitigation Measure CR-1: *Archaeological Monitoring*. A Cultural Resources Monitoring Plan (CRMP) shall be developed and implemented for the Project. The CRMP also would be a component of a Historical Properties Treatment Plan (HPTP), per Section 106 of the NHPA, should the PA or MOA prepared for the project require an HPTP. A Secretary of the Interior Qualified archaeologist shall be retained to oversee preparation of the CRMP/HPTP, construction monitoring, and preparation of a final monitoring report. The qualified archaeologist shall develop the CRMP/HPTP based on Project design plans, the results of the archaeological and geoarchaeological studies prepared for the Project (Douglas et al. 2015; Lockwood 2015; Vader and Bever 2016), input from Native American representatives, and any other relevant information. The CRMP/HPTP shall provide measures for cultural resources construction worker sensitivity training; delineation of sensitive areas; archaeological and Native American monitoring; assessment and treatment of unanticipated discovery of archaeological resources and human remains; notification protocols; procedures for Native American coordination and input; weekly, monthly, and final reporting; and curation of cultural materials recovered during monitoring. The CRMP/HPHP shall be developed in coordination with CDFW, the Corps, and appropriate Native American representatives. The CRMP/HPHP shall specify the roles and responsibilities of involved parties, and also shall specify the location, duration and timing of monitoring, which minimally shall occur in areas of high or moderate sensitivity, and from the time of initial ground disturbance (which could include grading, vegetation removal, brush clearance, excavation, and other activities) until a depth at which the potential to encounter buried archaeological deposits is greatly reduced. These sensitive areas will include, minimally, archaeological sites CA-LAN-54 and CA-LAN-3784H (including a suitable buffer of at least 100 feet), and areas identified as highly sensitive in the geoarchaeological study. These areas shall be identified in maps to guide monitoring. The CRMP/HPTP shall outline procedures for determining when/where monitoring may be reduced or discontinued in consultation among CDFW, the Corps (in cases of an HPTP), qualified archaeologist, and appropriate Native American representatives. The CRMP/HPTP shall stipulate that archaeological monitoring shall be conducted by an archaeological monitor familiar with the types of resources that could be encountered and that the archaeological monitor shall keep daily logs detailing the types of activities and soils observed, and any discoveries. Monitors shall be empowered to halt and re-direct ground disturbing activities in the event of a discovery until it has been assessed for significance and treatment implemented, if necessary. The CRMP/HPTP shall state that avoidance or preservation in place shall be the preferred means of mitigating impacts to historical resources and unique archaeological resources but will provide procedures to follow should avoidance be infeasible (see Mitigation Measure CR-3).			
Mitigation Measure CR-2: ***Native American Monitoring*.** CDFW shall retain a Native American monitor who is traditionally and culturally affiliated with the Project site to carry out the monitoring as required by the CRMP/HPTP in CR-1. The monitor shall also be empowered to halt and re-direct work in the event of a discovery until it has been assessed for significance and treatment implemented,			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Cultural Resources (cont.)			
Mitigation Measure CR-3: *Treatment of Unanticipated Discoveries*. The CRMP/HPTP developed as part of Mitigation Measure CR-1 shall include protocols for the assessment and treatment of any unanticipated discoveries of archaeological resources during Project implementation, including procedures for assessing the significance of the resources according to the National Register and California Register. To accomplish this, the unanticipated discoveries component of the CRMP/HPTP will contain: 1. A research design to be used to guide the evaluation of cultural resources, including a regional cultural setting, appropriate regional research questions, and field methods for the testing and evaluation of cultural resources. 2. Prescribed actions to be taken in the event that unanticipated cultural resources are discovered during construction, or known resources are impacted in an unanticipated manner, consistent with Mitigation Measure CR-1, including (but not limited to): a. Notification procedures b. Establishment of buffers for resources that will be avoided Documentation of resources on DPR forms c. Inspection of the resource(s) by a qualified archaeologist d. Evaluation of the resource for listing in the California Register and National Register, or as a unique archaeological resource under CEQA, and as a contributor to the BLAD e. Monitoring of construction in the vicinity of the resource per Mitigation Measures CR-1 and CR-2 3. Treatment protocols for significant cultural resources that cannot be avoided, to be developed in consultation with CDFW, the Corps, the SHPO and appropriate Native American representatives, may include but not be limited to: a. Data recovery excavation, with preparation of an attendant data recovery plan b. Surface artifact collection c. Further site documentation, including photography, collection of oral histories, preparation of a scholarly work, or some form of public awareness or interpretation d. Special studies where sufficient data exists, including but not limited to radiocarbon dating, residue analysis, sourcing and other materials analysis e. Historical research, as appropriate, with the aim to target the recovery of important scientific or other data contained in the portion of the significant resource to be impacted by the project f. A report documenting the methods and results of the treatment of the resource			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Cultural Resources (cont.)			
Mitigation Measure CR-4: *Compliance with Secretary of Interior's Standards***.** CDFW shall retain a Secretary of the Interior qualified architectural historian to ensure compliance with the Secretary of the Interior's Standards regarding the re-use of the Pacific Electric Railroad Bridge Abutments. The architectural historian shall prepare a character-defining features memorandum that outlines the characteristics of the bridge that convey its significance and that must be retained. In addition, the architectural historian shall provide guidance on the types of bridge spans that would be consistent with the Standards. The architectural historian shall review and approve the preliminary and final bridge design plans to confirm that it conforms to the Standards. The architectural historian shall also monitor construction of the new bridge span to ensure that the Project does not inadvertently damage or alter the character-defining features of the bridge abutments. Further, post-restoration plans for maintenance and repair of the bridge will need to be developed with input from an architectural historian and in accordance with the Standards to ensure that post-restoration use of the bridge will not impact the resource.			
Mitigation Measure CR-5: *Paleontological Resources Impact Mitigation Plan*. A Paleontological Resources Impact Mitigation Plan (PRIMP) shall be prepared prior to the start of restoration. The PRIMP shall be developed by a qualified paleontologist (defined as a paleontologist meeting the SVP Standards). The PRIMP shall identify areas where depth of excavation will extend into areas that are considered moderately to highly sensitive for paleontological resources, based on the final grading plans. Paleontological resource requirements shall be incorporated as a note on the grading plan cover sheet. The PRIMP shall include, but not be limited to: 1) During excavations in areas underlain by geologic units identified as having moderate to high paleontological sensitivity per the SVP guidelines and likely to contain paleontologic resources, a qualified vertebrate paleontologist, shall direct the paleontological monitoring. Areas of concern include all previously undisturbed paleontologically sensitive sediments of the fossiliferous San Pedro Sand (Qsp) and excavations beyond a depth of five feet into Quaternary alluvium (Qa). As shown in Table 3.5-1, Quaternary alluvium (Qa) underlies most areas of the project. San Pedro Sand (Qsp) underlies portions of South and Southeast Area B. Specific areas that will require monitoring will be developed in the PRMP based on the most current design plans. If no significant fossils are found, then, after an adequate amount of time, which the SVP (2010) considers to be 50% of the monitoring duration, the frequency of monitoring may be adjusted at the discretion of the qualified paleontologist. 2) Paleontological monitors shall be equipped to salvage fossils as unearthed to avoid construction delays, collect necessary paleontological data, and to remove samples of sediments likely to contain the remains of small fossil invertebrates and vertebrates. If it is determined by the qualified paleontologist that appropriate sediments are present that may yield significant microvertebrates, a test sample should be collected per the SVP (2010) guidelines. If scientifically significant microvertebrates are recovered from the test sample, the PRIMP shall direct the qualified paleontologist or paleontological monitor to collect and screen a standard sample per the SVP (2010) guidelines. Monitors shall be empowered to temporarily halt or divert equipment to allow removal of abundant or large specimens.			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Cultural Resources (cont.)			
3) The PRIMP shall stipulate that the preparation of recovered specimens shall be conducted to a point of identification and permanent preservation, including washing of sediments to recover small invertebrates and vertebrates. Preparation and stabilization of all recovered fossils are essential in order to fully mitigate adverse impacts to the resources. 4) The PRIMP shall specify that the identification and curation of specimens into an established museum repository with permanent retrievable paleontologic storage. These procedures are also essential steps in effective paleontological mitigation and CEQA compliance. The paleontologist should have a written repository agreement in hand prior to the initiation of mitigation activities. Mitigation of adverse impacts to significant paleontologic resources is not complete until such curation into an established museum repository has been fully completed and documented. 5) The PRIMP shall detail the preparation of a report of findings with an appended itemized inventory of specimens. The report and inventory, when submitted to the appropriate Lead Agency along with confirmation of the curation of recovered specimens into an established, accredited museum repository, would signify completion of the PRIMP to mitigate impacts to paleontologic resources. Included in the report will be recommendations for post-restoration management protocols that might be necessary to reduce indirect impacts following project completion. These could include management requirements for restricting access to significant paleontological resources through a combination of law enforcement, protective enclosures, land access restrictions, or other means. The final PRIMP shall be submitted to and approved by the CDFW and the Corps prior to commencement of grading in the Ballona Reserve. The qualified paleontologist also shall contribute to any construction worker cultural resources sensitivity training, either in person or via a module provided to the qualified archaeologist			
Mitigation Measure CR-6: *Discovery of Human Remains*. If human remains are encountered, the construction contractor shall immediately halt work in the vicinity (within 100 feet) of the find, notify CDFW and the Corps of the find, and unless CDFW decides to initiate contact, the construction contractor shall contact the Los Angeles County Coroner in accordance with Public Resources Code Section 5097.98 and Health and Safety Code Section 7050.5. If the County Coroner determines that the remains are Native American, the NAHC will be notified in accordance with Health and Safety Code Section 7050.5(c), and Public Resources Code Section 5097.98 (as amended by AB 2641). The NAHC will designate a Most Likely Descendant (MLD) for the remains per Public Resources Code Section 5097.98. Until the CDFW has conferred with the MLD and determined an appropriate course of action for protection, avoidance, or removal and disposition of the remains, CDFW and the Corps shall ensure that the immediate vicinity where the discovery occurred is not disturbed by further activity, is adequately protected according to generally accepted cultural or archaeological standards or practices, and that further activities take into account the possibility of multiple burials.			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Geology, Seismicity, and Soils			
Mitigation Measure GEO-1b: *Geotechnical Recommendations.* As a condition of approval, CDFW shall require that all the recommendations made in the July 1, 2013 Geotechnical Investigation Report for the Ballona Restoration Project by Group Delta Consultants, including revisions in response to Corps comments, are incorporated as part of Project designs. Recommendations that are applicable to earthwork, site preparation, levee design, and foundation design that were prepared for the project shall be incorporated in the Project. The final seismic considerations as well as recommendations for all other identified geotechnical hazards (including but not limited to expansive soils) for the site shall be in accordance with all current design requirements of the most recent California Building Code and any current Corps' standards. All recommendations and plans for all improvements proposed as part of the project shall be submitted to and approved of by the County and the Corps prior to the commencement of any ground breaking activities			
Mitigation Measure GEO-1c: *Geotechnical Investigation and Report.* As a condition to allowing the Los Angeles County Department of Beaches and Harbors to enter the reserve and construct the parking structure, CDFW shall require that entity, prior to proceeding with such construction to: 1) Commission a site-specific, design level geotechnical investigation for the proposed parking structure prepared by a registered geotechnical engineer. The investigation shall comply with all applicable state and local building code requirements and: a) Include an analysis of the expected ground motions at the site from known active faults using methodologies in accordance with the California Building Code; b) Determine and implement structural design requirements as prescribed by the most current version of the California Building Code, including applicable County amendments, to ensure that structures can withstand ground accelerations expected from known active faults; c) Determine the final design parameters for walls, foundations, foundation slabs, utilities, roadways, parking lots, sidewalks, and other surrounding related improvements in order to comply with the most current version of the California Building Code; 2) Ensure that project plans and specifications for foundation design, earthwork, and site preparation shall incorporate all of the recommendations contained in the site specific investigation. 3) Ensure that the project structural engineer shall review the site specific recommendations, provide any additional necessary amendments to meet Building Code requirements, and incorporate all applicable recommendations from the investigation in the structural design plans and shall ensure that all structural plans for the project meet current California Building Code requirements. 4) Ensure that the approval agency review all project plans for grading, foundations, structural, infrastructure and all other relevant construction permits to ensure compliance with the applicable geotechnical investigation and other applicable Code requirements. If expansive soils are present, the technical investigation shall provide recommendations to either remove or treat the expansive soils in accordance with current California Building Code Requirements and any local County amendments.			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Geology, Seismicity, and Soils			
Mitigation Measure GEO-4: *Corrosive Soil Testing*. Any native or other fill soils that contact concrete or metal foundation elements of structures constructed under the Project shall be tested for corrosivity. Those soils, as determined by laboratory analysis and reviewed by a California licensed geotechnical engineer, that exceed acceptable thresholds of corrosivity shall be managed in accordance with recommendations of a qualified geotechnical engineer or corrosion engineer. Engineering recommendations could include soil reconditioning through mixing with non-corrosive soils, replacement of the corrosive soils in the vicinity of the foundation, or corrosion reducing systems for exposed metal such as “sacrificial anodes.” In addition, the contractor shall use Type II cement for all concrete and steel foundation work to further reduce the potential for degradation of concrete through corrosion			
Hydrology and Water Quality			
Mitigation Measure WQ-1a-i: *Monitoring and Adaptive Management Plan (MAMP)*. A Monitoring and Adaptive Management Plan (MAMP) (Appendix F11 of the EIS/EIR) shall be prepared and implemented. The MAMP shall provide a framework for the assessment of the Project and watershed using the TMDL targets as assessment metrics. The MAMP shall use both Project monitoring, the sediment and water quality data gathered from the TMDL monitoring conducted by the Permittees (designated parties listed in the Ballona Creek and Ballona Creek Estuary TMDLs who are under a state-wide or LARWQCB NPDES MS4 Stormwater Permit), and monitoring conducted by the Corps in the Marina del Rey harbor entrance channel to determine if impairment conditions exist and provide protocols for any further measures to meet TMDLs and dredging requirements. The assessment of the effectiveness of the Project features and watershed measures (conducted by the Permittees) shall be determined through comparisons to the SQOs and fish tissue targets. If the SQO analysis indicated an impaired or likely impaired condition, then further source and delineation monitoring shall be conducted. Depending on the source of the impairment, reparative measures shall be implemented by the Project proponents, Permittees, or in cooperation with parties as outlined in the MAMP framework to reduce the impacts to sediment to below the SQOs and fish tissue targets. SQOs shall be the regulatory target used to protect against negative biological impacts and are considered the performance standard to identify negative impacts. In the event that sediment quality impairments are found to be a result of the project, the sediment shall be excavated and disposed of off-site or buried beneath uncontaminated material on-site. If sediment quality impairments in the Marina del Rey harbor entrance channel are found to be a result of the project, CDFW shall coordinate with the Corps to develop a mutually agreed upon course of action, which could include participating in reparative measures proportional to the amount of increased impairment due to the project. Additionally, the MAMP shall monitor and address any changes in sediment deposition in the entrance of Marina del Rey after project implementation is complete. The plan shall use bathymetric data collected by the Corps to determine if deposition has increased substantially after construction of the project. In the event that substantial deposition is identified, CDFW shall coordinate with the Corps to develop a mutually agreed upon course of action, which could include participating in dredging proportional to the amount of increased deposition due to the project. Dredged material shall be disposed of back in the marsh by spraying a slurry of sediment in a thin layer across the marshplain or disposed of on- or off-site by other means in accordance with necessary permits or other approvals. The MAMP would ensure that any increases to deposition would be monitored and addressed in order to maintain boat access to the Marina consistent with historic dredging efforts.			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Hydrology and Water Quality (cont.)			
The MAMP would also monitor water levels in South and Southeast Area B to determine operation of the culverts in order to prevent flooding. Over time, flap gates would be installed on the culverts as part of Alternative 1 to limit the flow into South and Southeast Area B. Initial modeling indicated that adding a flap gate every 25 years would maintain the current level of flood protection, but the MAMP would ensure that water levels were monitored so that flap gates could be added as needed to maintain an acceptable level of flood risk			
Mitigation Measure WQ-1a-ii: *Sampling and Analysis Plan (SAP)*. A SAP shall be prepared and implemented prior to commencement of construction to identify any levels of constituents that may have been missed in previous sampling efforts. The results of the sediment sampling shall determine which materials shall be used as wetland surfaces (highest quality), as wetland foundation, or buried in the uplands (lowest quality) in accordance with the ER-Ls and ER-Ms developed by Long et al. (1995). The SAP shall also include, without limitation: a) In addition to the sampling and analysis of soil as identified in the SAP, soil and groundwater samples shall also be collected from any excavations that encounter groundwater. The soil samples shall be collected at or just below the static water level to sample soil that may have been affected by contaminated groundwater migrating from offsite properties. Each soil sample shall be labeled with a unique sample identification number, placed in to plastic bags in coolers with ice packs, along with the appropriate chain of custody documentation, and delivered to the analytical testing laboratory within the required testing method holding times. b) All soil samples collected for the analyses described below shall be collected into Teflon-lined metal or plastic tubes and sealed to minimize the loss of volatile compounds. The groundwater samples shall be collected into glass bottles with Teflon-lined lids and the appropriate preservatives to seal in and preserve volatile compounds, if any. Each sample shall be labeled with a unique sample identification number, placed in to plastic bags in coolers with ice packs, along with the appropriate chain of custody documentation, and delivered to the analytical testing laboratory within the required testing method holding times. c) All soil and groundwater samples shall be analyzed for petroleum hydrocarbons using US EPA Test Method 8015 or equivalent, including a silica gel cleanup (USEPA Test Method 3630C or equivalent) to remove naturally occurring polar non-petroleum hydrocarbons that could interfere with the analyses. d) All soil and groundwater samples shall be analyzed for VOCs using USEPA Test Method 8260 or equivalent (at a minimum, the test methods shall be capable of detecting PCE). e) Following receipt of laboratory results of the chemical testing, soil or groundwater material that exceeds the reuse screening levels, CHHSLs, or PRGs and cannot be reused on site shall be transported by a DTSC-licensed hazardous waste hauler and disposed of at an offsite disposal facility licensed to receive the contaminated soil and groundwater. Alternative disposal options, such as onsite burial, shall be considered for soil and groundwater found not to contain contaminates or having concentrations below the regulatory thresholds.			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Noise			
Mitigation Measure NOI-1-i: The construction contractor(s) shall locate stationary noise sources as far as possible from noise-sensitive uses, to the extent feasible, and ensure that they are muffled and enclosed within temporary sheds, incorporate insulation barriers, or other measures to the extent feasible			
Mitigation Measure NOI-1-ii: All mobile off-road construction equipment operating at the Project site shall be equipped with properly operating mufflers.			
Mitigation Measure NOI-1-iii: Restoration-phase activities shall, to the extent feasible, be scheduled so as to avoid operating several pieces of heavy diesel-powered equipment simultaneously, which causes high noise levels.			
Mitigation Measure NOI-1-iv: Temporary barriers such as plywood structures or flexible sound control curtains at least 8 feet in height shall be erected, to the extent feasible, around the perimeter of the active work area to minimize the amount of noise on the surrounding sensitive receptors during noise-generating restoration activities.			
Mitigation Measure NOI-1-v: Project-related noise levels at the property line of the multi-family residential buildings located west of Area A and north of West Area B in the County of Los Angeles shall undergo spot check monitoring with a sound level meter that meets the requirements identified in Chapter 12.08 (Noise Control) of the County of Los Angeles Municipal Code to ensure that noise levels from the Project's implementation activities would not exceed 80 dBA at multi-family residences during active work hours. Where noise levels exceeding 80 dBA are detected, the construction contractor must be notified immediately and corrective actions must be implemented to reduce the noise levels to below 80 dBA. These corrective actions may include, but are not limited to, the erection of a noise barrier along the boundary of the Project site or the reduction in the amount of construction equipment operating concurrently to meet the County's noise standards for mobile equipment.			
Mitigation Measure NOI-1-vi: All construction staging areas during site restoration activities shall be located to maximize the distance between staging areas and occupied residential structures.			
Mitigation Measure NOI-1-vii: Two weeks prior to the commencement of restoration activities within Area A; North, East, Southeast, South, or West Area B; North or South Area C; or the SoCalGas Property, notification must be provided to all existing off-site residential uses located directly adjacent to the active work area that discloses the general work schedule, including the various types of activities and equipment that would be occurring throughout the duration of the construction period.			
Mitigation Measure NOI-1-viii: Signs shall be posted at the Project site that include permitted work days and hours, a contact number for the job site, and a contact number with the appropriate CDFW enforcement officers.			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Noise (cont.)			
Mitigation Measure NOI-1-ix: All Project noise-generating activities occurring in Area A shall be limited to the hours of 7:00 a.m. to 7:00 p.m. from Monday through Saturday and prohibited on Sundays or holidays as permitted under the County of Los Angeles Municipal Code, and all Project noise-generating activities occurring in Areas B and C and on the SoCalGas Property shall be limited to the hours of 7:00 a.m. to 9:00 p.m. from Monday through Friday, 8:00 a.m. to 6 p.m. on any Saturday or national holiday, and prohibited on Sundays as permitted under the City of Los Angeles Municipal Code, unless otherwise authorized or exempted under each of the respective municipal codes.			
Mitigation Measure NOI-2: The operation of construction equipment at the Project site that generates high levels of vibration, such as large bulldozers, loaded trucks, and drill rigs, shall be prohibited within 100 feet of existing residential structures in both the County of Los Angeles and City of Los Angeles during restoration activities. Instead, small rubber-tired bulldozers, which generate vibration levels as low as 0.003 at 25 feet, shall be used within these areas during site preparation, grading, and excavation operations to ensure that vibration levels experienced at the off-site receptors would not be perceptible.			
Transportation and Traffic			
Mitigation Measure TRANS-1a: *Construction Traffic Management Plan.* The construction contractor(s) shall prepare a construction traffic management plan for each phase of the Project at the time of final design, prior to commencement of construction. This Plan would address details related to haul routes, dust control, noise control and City and County regulations. The construction management plan ensures that the construction activities and workers follow the City regulations and provides details of activities planned on-site. The Plan shall be developed on the basis of detailed design plans for the approved project, and shall include, but not necessarily be limited to, the elements listed below: a) Develop circulation and detour plans to minimize impacts on local streets. Haul routes that minimize truck traffic on local roadways and residential streets shall be used. As necessary, warning lights, signage and/or flaggers shall be used to guide vehicles through the construction work areas. b) Control and monitor construction vehicle movements by enforcing standard construction specifications through periodic on-site inspections. c) Install traffic control devices where traffic conditions warrant, as specified in the applicable jurisdiction's standards (e.g., the California Manual of Uniform Traffic Controls for Construction and Maintenance Work Zones). d) Schedule truck trips outside of peak morning and evening commute hours to minimize adverse impacts on traffic flow (i.e., if agencies with jurisdiction over the affected roads identify highly congested roadway segments during their review of the encroachment permit applications). e) Post detour signs along affected roadways to notify motorists of alternative routes. f) Perform construction that crosses on-street and off street bikeways, sidewalks, and other walkways in a manner that allows for safe access for bicyclists and pedestrians. Alternatively, provide safe detours to reroute affected bicycle/pedestrian traffic.			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Transportation and Traffic (cont.)			
g) At least two weeks prior to construction, post signage along all potentially affected roadways, recreational trails, bicycle routes, and pedestrian pathways, to warn motorists, bicyclists, and pedestrians of construction activities. The signs shall include information regarding the nature of construction activities, duration, and detour routes. Signage shall be composed of or encased in weatherproof material and posted in conspicuous locations for the duration of the closure period. At the end of the closure period, the contractors shall retrieve all notice materials.			
h) Construction activities shall be scheduled to minimize impacts during heavy recreational use periods (e.g., weekends and holidays).			
i) Implement a public information program to notify motorists, bicyclists, nearby residents, and adjacent businesses of the impending construction activities (e.g., media coverage, email notices, websites, etc.). Notices of the location(s) and timing of road closures shall be published in local newspapers and on available websites to allow motorists to select alternative routes.			
j) Store all equipment and materials in designated contractor staging areas.			
k) Maintain alternate one-way traffic flow past the construction zones where possible.			
l) Install detour signs to direct traffic to alternative routes around the closed road segment if alternate one-way traffic flow cannot be maintained past the construction zone.			
m) Limit lane closures during peak hours.			
n) Restore roads and streets to normal operation by covering trenches with steel plates outside of normal work hours or when work is not in progress.			
o) Comply with roadside safety protocols to reduce the risk of accidents. Provide “Road Work Ahead” warning signs and speed control (including signs informing drivers of state-legislated double fines for speed infractions in a construction zone) to achieve required speed reductions for safe traffic flow through the work zone. Train construction personnel to apply appropriate safety measures as described in the traffic control and safety assurance plan.			
p) Maintain access for emergency vehicles at all times. Coordinate with facility owners or administrators of sensitive land uses such as police and fire stations, transit stations, hospitals, and schools. Provide advance notification to local police, fire, and emergency service providers of the timing, location, and duration of construction activities that could affect the movement of emergency vehicles on area roadways.			
q) Avoid truck trips through designated school zones during the school drop-off and pickup hours to the extent feasible.			
r) Provide flaggers in school areas at street crossings to manage traffic flow and maintain traffic safety during the school drop-off and pickup hours on days when pipeline installation would occur in designated school zones.			
s) Coordinate with the local transit providers to enable temporary bus routes or bus stops relocations within work zones as necessary. For example, access for Santa Monica Big Blue Bus Line 3 would be maintained at all times through the construction zone on Lincoln Boulevard during bridge construction.			

TABLE 1 (Continued)
MITIGATION MONITORING AND REPORTING PROGRAM FOR THE BALLONA WETLANDS RESTORATION PROJECT

Mitigation Measure	Monitoring Agency	Monitoring/Reporting Requirements	Approval/Acceptance Dates
Energy Conservation			
Mitigation Measure EC-2a: The parking garage operator shall use appropriate lighting levels for safety (estimated to be 1-2 foot candles) and shall use energy-efficient fixtures (e.g., LED or other lighting that provides efficiency comparable to or better than 55-watt induction lamps, which draw 58 watts per fixture).			
Mitigation Measure EC-2b: Parking garage operators shall turn off unneeded lights in the garage during the daytime in areas where ambient light is sufficient. Lights in emergency exit pathways shall remain on at all times for safety.			
Mitigation Measure EC-2c: If fans are installed to disperse exhaust fumes in the parking garage, a demand-control ventilation (DCV) system shall be installed rather than an “on/off” system. The DCV system shall continuously operate fans at less than 3% of the full-speed power draw and only increase the air flow when prompted by a sensor.			

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APPENDIX B7
Ballona Wetlands Inundation Memo

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memorandum

date September 28, 2015

to

from Lindsey Sheehan, P.E

subject DRAFT- Ballona Wetlands Habitat Elevations Inundation Analysis

Introduction

Salt marsh and intertidal habitats establish within zones corresponding to tidal inundation (Adams 1963, Earle and Kershaw 1989). Tides and tidal inundation at Ballona are therefore important processes affecting the habitats. The proposed alternatives in the EIR/S include three different tidal conditions: existing managed, post-restoration managed, and fully tidal. Under existing conditions, the wetlands in West and South Area B experience managed tides due to the SRT gates between West Area B and Ballona Creek. The tides behind the SRT gates are muted (i.e. high tides in the managed marsh are lower than high tides in Ballona Creek). In Alternatives 1 and 2, the area south of Culver Boulevard would experience post-restoration managed tidal conditions. The new culverts would allow a larger tidal range, but the tides would still be slightly muted post-restoration, and managed over time with sea level rise. In Area A for all of the alternatives, North Area B for Alternatives 1 and 2, and West Area B for Alternative 1, tides would not be limited- these areas would experience fully tidal conditions. Table 1 summarizes the different tidal conditions for each alternative and area.

Table 1. Tidal Influence by Area and Alternative

	Area A	North Area B	South Area B	West Area B
Existing Conditions				
	-	-	Existing Managed Tidal	Existing Managed Tidal
Alternative 1				
Phase 1	Fully Tidal	Fully Tidal	Post-Restoration Managed Tidal	Existing Managed Tidal
Phase 2	Fully Tidal	Fully Tidal	Post-Restoration Managed Tidal	Fully Tidal
Alternative 2				
Phase 1	Fully Tidal	Fully Tidal	Post-Restoration Managed Tidal	Existing Managed Tidal
Alternative 3				
Phase 1	Fully Tidal	-	Existing Managed Tidal	Existing Managed Tidal
Alternative 4				
Phase 1	-	-	Existing Managed Tidal	Existing Managed Tidal

Methods to Determine Habitat Elevations

Three methods were used to determine habitat elevations for each tidal condition. Habitat elevation data from the literature was used to develop initial habitat ranges. This data was then compared to data from the San Dieguito Lagoon as a reference site. Lastly, these elevations were compared to extreme tide levels and storm events data to examine the frequency of inundation for upper elevation habitats.

Using data from the literature, ESA determined habitat elevations for fully tidal conditions with input from WRA. ESA then calculated the corresponding percent of time that each habitat was inundated using NOAA's verified Tides and Currents data at Santa Monica. To establish habitat elevations for existing managed conditions, ESA analyzed water level data measured from within the existing managed wetland (collected by LA County) and determined the managed water levels that correspond to the same percent inundation as the fully tidal habitat elevations. ESA also analyzed modeled water levels for post-restoration managed conditions to establish post-restoration managed habitat elevations with the same percent inundation as the full tidal habitat elevations. Table 2 presents the elevations and percent inundation for each habitat.

Table 2. Habitats by Percent Inundation

Habitat Transitions	% Inundation[1]	Habitat Elevations under Fully Tidal Conditions[1] (ft NAVD)	Habitat Elevations under Managed Tidal Conditions[2] (ft NAVD)	Habitat Elevation under Post-Restoration Managed Tidal Conditions[3] (ft NAVD)
Upland/Transition Zone	~3yr tidal inundation	7.3	4.3	6.5
Transition Zone/High Marsh	1%	6.3	3.6	5.8
High Marsh/Mid Marsh	5%	5.4	3.3	5.0
Mid Marsh/Low Marsh	26%	3.8	2.7	3.8
Low Marsh/Mudflat	51%	2.7	2.1	2.8
Mudflat/Subtidal	MLLW	-0.2	-0.2	-0.2

1. ESA determined habitat elevations from the literature (with input from WRA) and calculated the corresponding percent inundation based on the Santa Monica predicted tides (NOAA Tides and Currents). ESA used these elevations to calculate the percent inundation based on the verified measured tides.
2. Managed tidal habitats were calculated using water level data from Los Angeles County, recorded within the managed marsh.
3. Post-restoration managed tidal habitats were calculated using modeled water levels within South Area B (ESA, 2015)

The habitat elevations were compared to elevations of pickleweed and cordgrass at San Dieguito Lagoon in San Diego County. At San Dieguito, average pickleweed elevations (± one standard deviation) ranged from 4.5-5.6 ft NAVD, which falls in the mid to high marsh categories. Average cordgrass elevations at San Dieguito (± one standard deviation) occurred from 3.5 to 3.9 ft NAVD, which falls in the low to mid marsh categories.

The habitat elevations were also compared to extreme tide levels and storm events. The extreme tidal water level analysis used two different extreme distributions, the GEV and Gumbell. Table 3 presents the range of water levels by return period.

Table 3. Extreme Tide Levels

Return Period (years)	Still Water Level (ft NAVD)
1	7.1
5	7.3 - 7.4
10	7.4 - 7.5
20	7.5 - 7.6
50	7.7 - 7.8
100	7.8 - 7.9

Rainfall-runoff storm events in Ballona Creek were modeled to evaluate the flood risk under project conditions in the Ballona Wetlands Hydraulics and Hydrology Report (ESA PWA 2013). Water levels from this modeling are provided in Table 4 with the corresponding storm event recurrence.

Table 4. Flood Water Levels

	Water Level (ft NAVD)		
Event	Upstream, Station 10207	Mid-Site, Station 6292	Downstream, Station 3055
500-yr	15.98	14.01	10.44
200-yr	14.95	12.95	9.43
150-yr	14.62	12.57	9.15
100-yr	14.09	11.96	8.76
50-yr	13.26	11.02	8.05
25-yr	12.16	9.85	7.24
10-yr	11.32	8.98	6.73
5-yr	10.37	8.05	6.25
2-yr	8.75	6.69	5.69

Future Habitat Elevations Under Sea Level Rise

Future habitat elevations were estimated using the USACE NRC-III sea level rise curve (high range; Table 5). To determine the future habitat elevations for the fully tidal conditions, the sea level rise for each year was applied to the habitat elevations shown in Table 2 (Table 6 through Table 9). To determine the habitat elevations for managed and post-restoration managed tidal conditions, water levels from the South Area B modeling analysis were used (ESA 2015).

The habitat elevations described above were applied to the existing and proposed topography to develop maps of habitat change over time with sea level rise. Figures 1-4 show habitat change for Alternative 1 and Figures 5-8 shows habitat change for Alternative 4 (existing conditions).

Table 5. USACE NRC-III Sea Level Rise Estimates

Year	High Sea Level Rise from 1992 (in)	Sea Level Rise from 1992 Range (in)
2030	9	4-9
2050	19	7-19
2070	32	12-32
2100	59	20-59

Although sea level rise is typically described as a range of values for a specific year, it can also be described as an amount of sea level rise that will occur over a certain timeframe. For example, even if emissions begin to track on the lower end of the USACE sea level rise estimates, 59 inches of sea level rise will still occur, just at a date later than 2100. So it could either be said that 7-19 inches of sea level rise will occur by 2050, or that 19 inches of sea level rise will occur sometime between 2050 and 2100. Tables 6 through 9 present habitat elevations for each of the points along the USACE high sea level rise curve, with the corresponding time frame for when this is expected to occur included in the title for each table.

Table 6. Habitat Elevations with 9-in of Sea Level Rise (2030 – 2060)

Habitat Transitions	Habitat Elevations under Fully Tidal Conditions (ft NAVD)	Habitat Elevations under Managed Tidal Conditions (ft NAVD)	Habitat Elevation under Post-Restoration Managed Tidal Conditions (ft NAVD)
Upland/Transition Zone	8.05	4.70	7.05
Transition Zone/High Marsh	7.05	4.00	6.35
High Marsh/Mid Marsh	6.16	3.89	5.64
Mid Marsh/Low Marsh	4.52	3.60	4.58
Low Marsh/Mudflat	3.43	3.22	3.54
Mudflat/Subtidal	0.55	0.55	0.55

Table 7. Habitat Elevations with 19-in of Sea Level Rise (2050 – 2100)

Habitat Transitions	Habitat Elevations under Fully Tidal Conditions (ft NAVD)	Habitat Elevations under Managed Tidal Conditions (ft NAVD)	Habitat Elevation under Post-Restoration Managed Tidal Conditions (ft NAVD)
Upland/Transition Zone	8.88	4.88	7.3
Transition Zone/High Marsh	7.88	4.18	6.6
High Marsh/Mid Marsh	6.99	4.13	6.1
Mid Marsh/Low Marsh	5.35	3.99	5.2
Low Marsh/Mudflat	4.26	3.78	4.4
Mudflat/Subtidal	1.38	1.38	1.4

Table 8. Habitat Elevations with 32-in of Sea Level Rise (2070 – 2135)

Habitat Transitions	Habitat Elevations under Fully Tidal Conditions (ft NAVD)	Habitat Elevations under Managed Tidal Conditions (ft NAVD)	Habitat Elevation under Post-Restoration Managed Tidal Conditions (ft NAVD)
Upland/Transition Zone	9.97	5.57	7.2
Transition Zone/High Marsh	8.97	4.87	6.5
High Marsh/Mid Marsh	8.08	4.75	6.3
Mid Marsh/Low Marsh	6.44	4.42	5.7
Low Marsh/Mudflat	5.35	4.15	5.2
Mudflat/Subtidal	2.47	2.47	2.5

Table 9. Habitat Elevations with 59-in of Sea Level Rise (2100 – 2195)

Habitat Transitions	Habitat Elevations under Fully Tidal Conditions (ft NAVD)	Habitat Elevations under Managed Tidal Conditions (ft NAVD)	Habitat Elevation under Post-Restoration Managed Tidal Conditions (ft NAVD)
Upland/Transition Zone	12.22	6.96	8.3
Transition Zone/High Marsh	11.22	6.26	7.6
High Marsh/Mid Marsh	10.33	6.23	7.40
Mid Marsh/Low Marsh	8.69	6.04	7.08
Low Marsh/Mudflat	7.60	5.64	6.63
Mudflat/Subtidal	4.72	4.72	4.72

Salt Pan Habitat Under Sea Level Rise

To evaluate the sustainability of the salt pan habitat in West Area B, it was assumed that once the salt pan topography (or surrounding berm, in Alternative 1) drops into the mid marsh elevation, the salt pan would be inundated frequently enough that salt pans would convert to marsh (or mudflat in the case of Alternative 1, where the salt pan would be preserved by a berm until the berm reaches mid marsh elevation). This assumption is based on the fact that salt pans typically occur within high marsh areas of tidal wetlands that are infrequently inundated, but not in mid marsh areas that are inundated daily. Under existing conditions (and Alternatives 2 and 3), the salt pan would convert to marsh before 2050. This process appears to be occurring at present in the northern portion of the existing salt pan through the formation of tidal channels extending into the salt pan, which appear to be increasing tidal inundation, leaching salt from the soil, and allowing pickleweed vegetation to establish. With the berm in Alternative 1, the salt pan would convert before 2070, extending the life of the salt pan habitat by approximately 10 years.

Assessment of Habitat Change with Sea Level Rise

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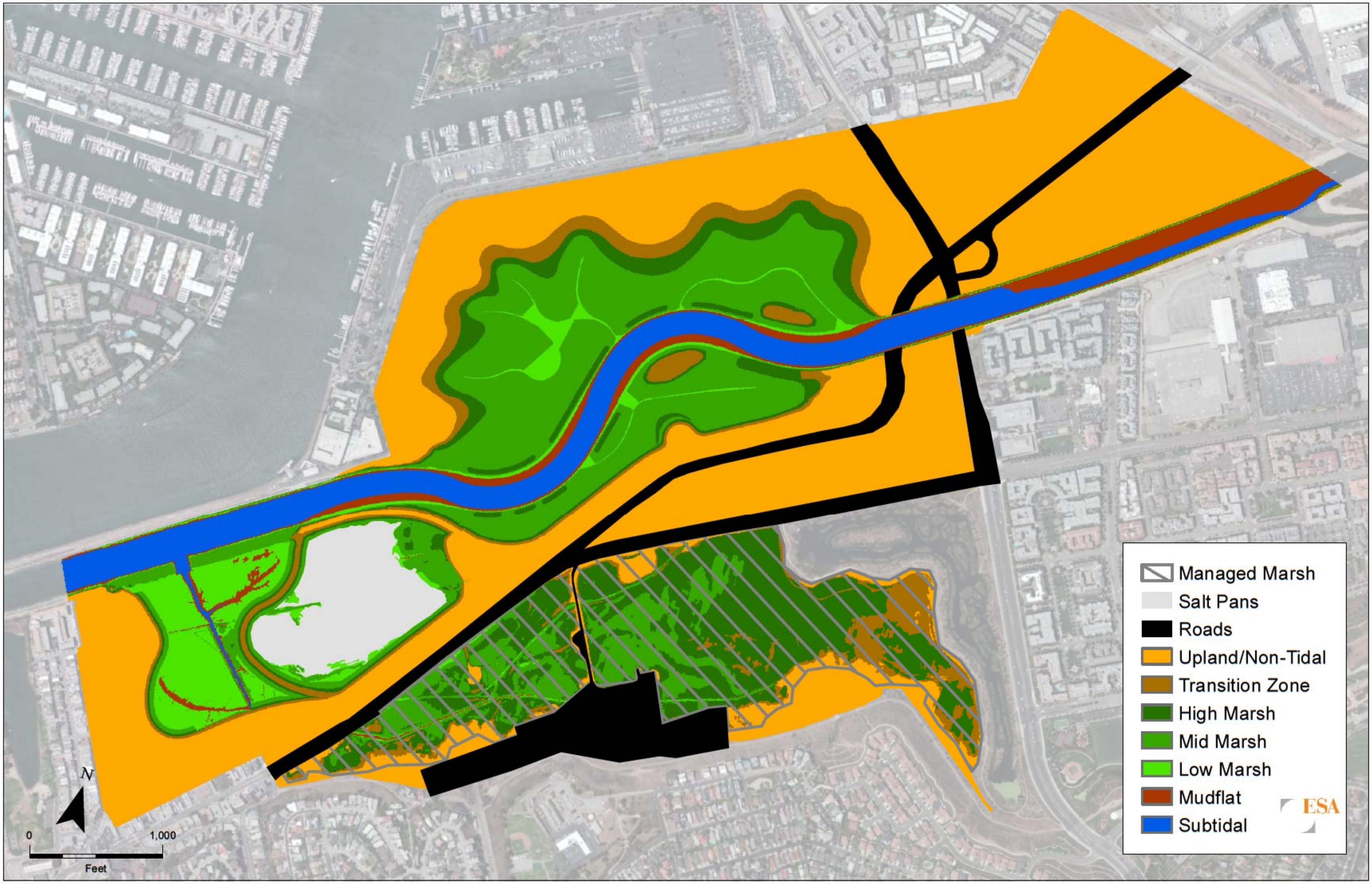
ESA. 2015. Draft Area B Managed Wetlands Preliminary Design Memorandum. August 3, 2015.

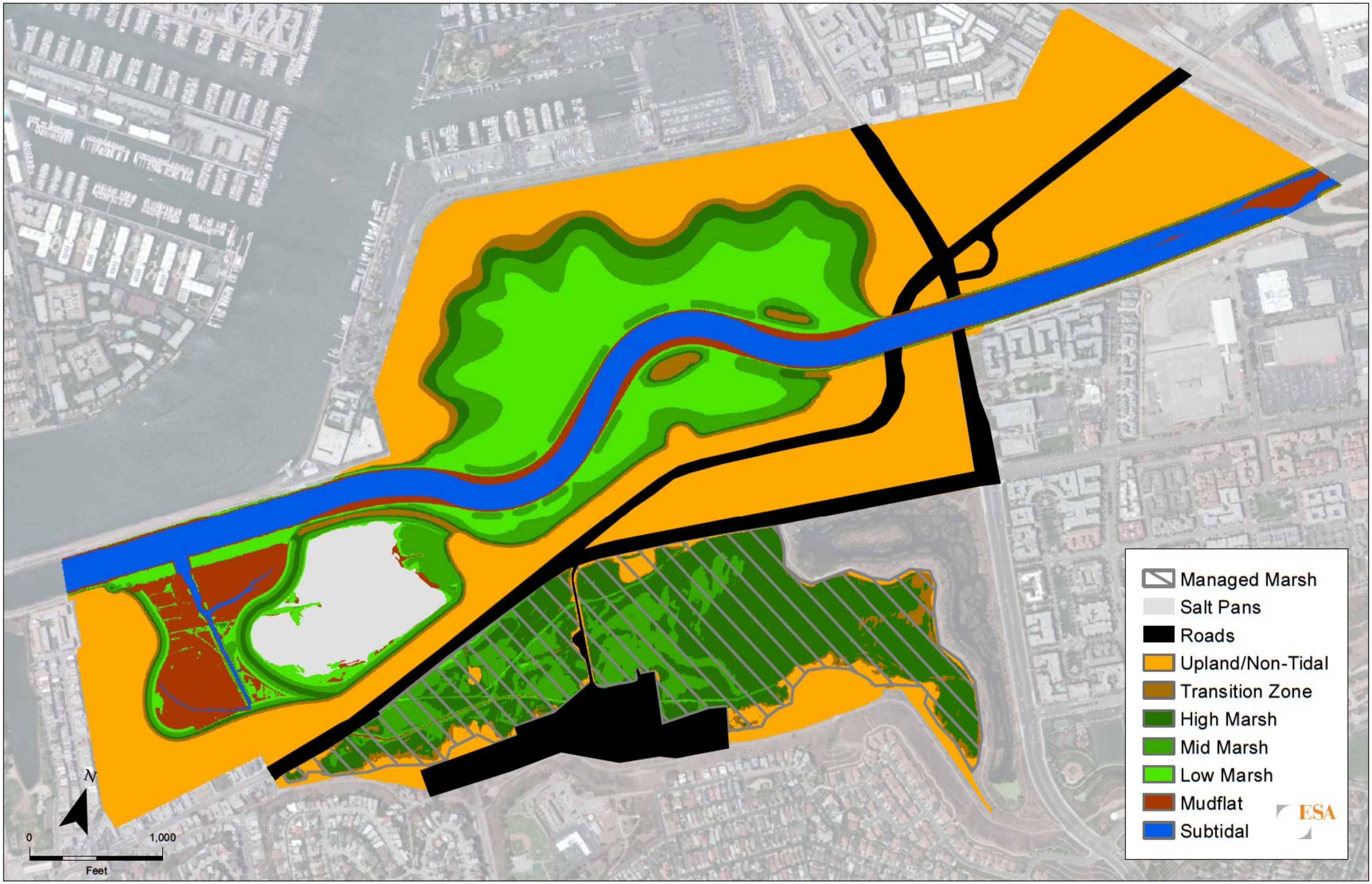
Ballona Wetlands Restoration Project

Figure 1
Alt 1, Now



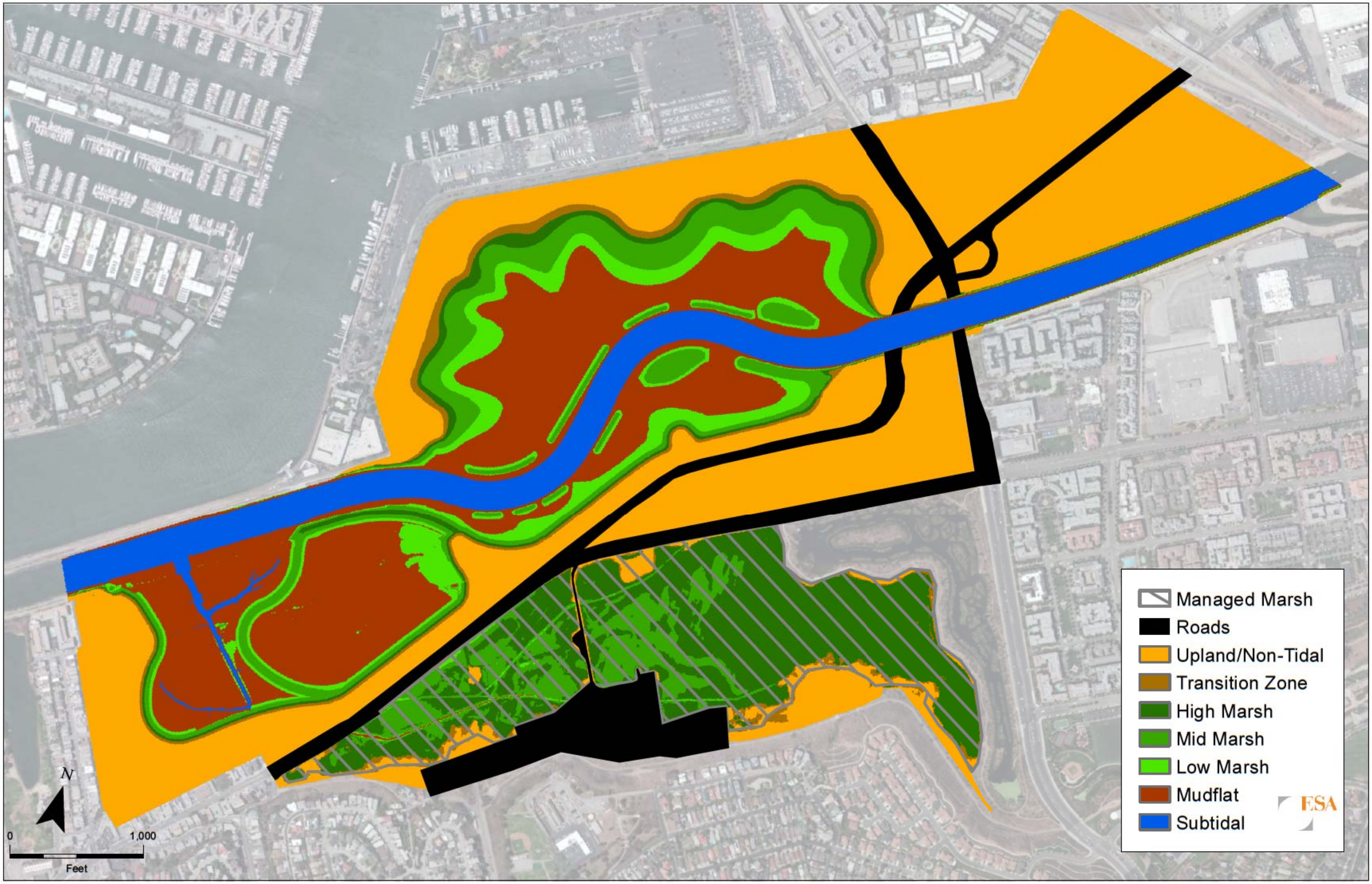
Ballona Wetlands Restoration Project

Figure 2
Alt 1, 2030



Ballona Wetlands Restoration Project

Figure 3
Alt 1, 2050

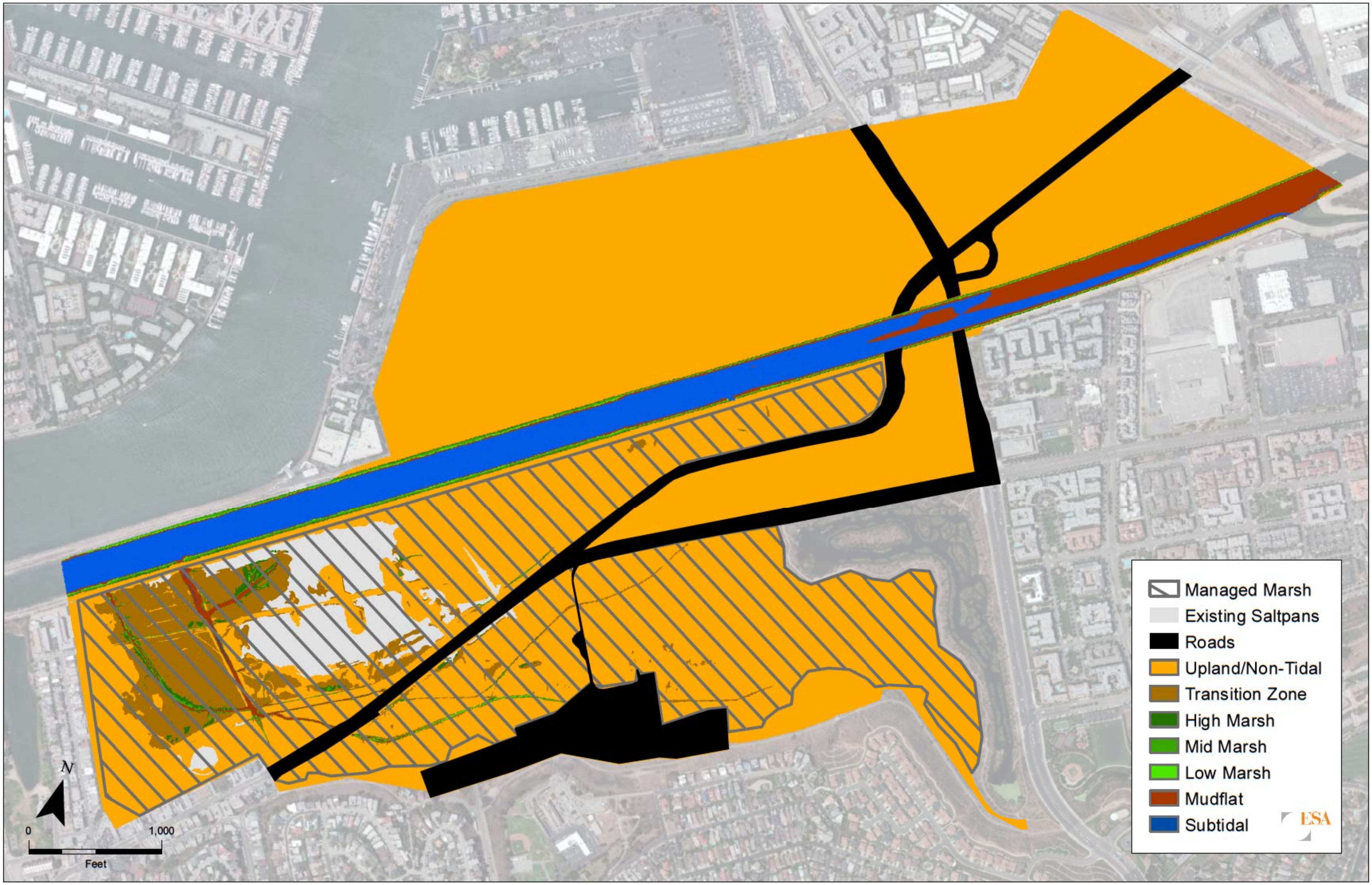


Ballona Wetlands Restoration Project

Figure 4
Alt 1, 2070

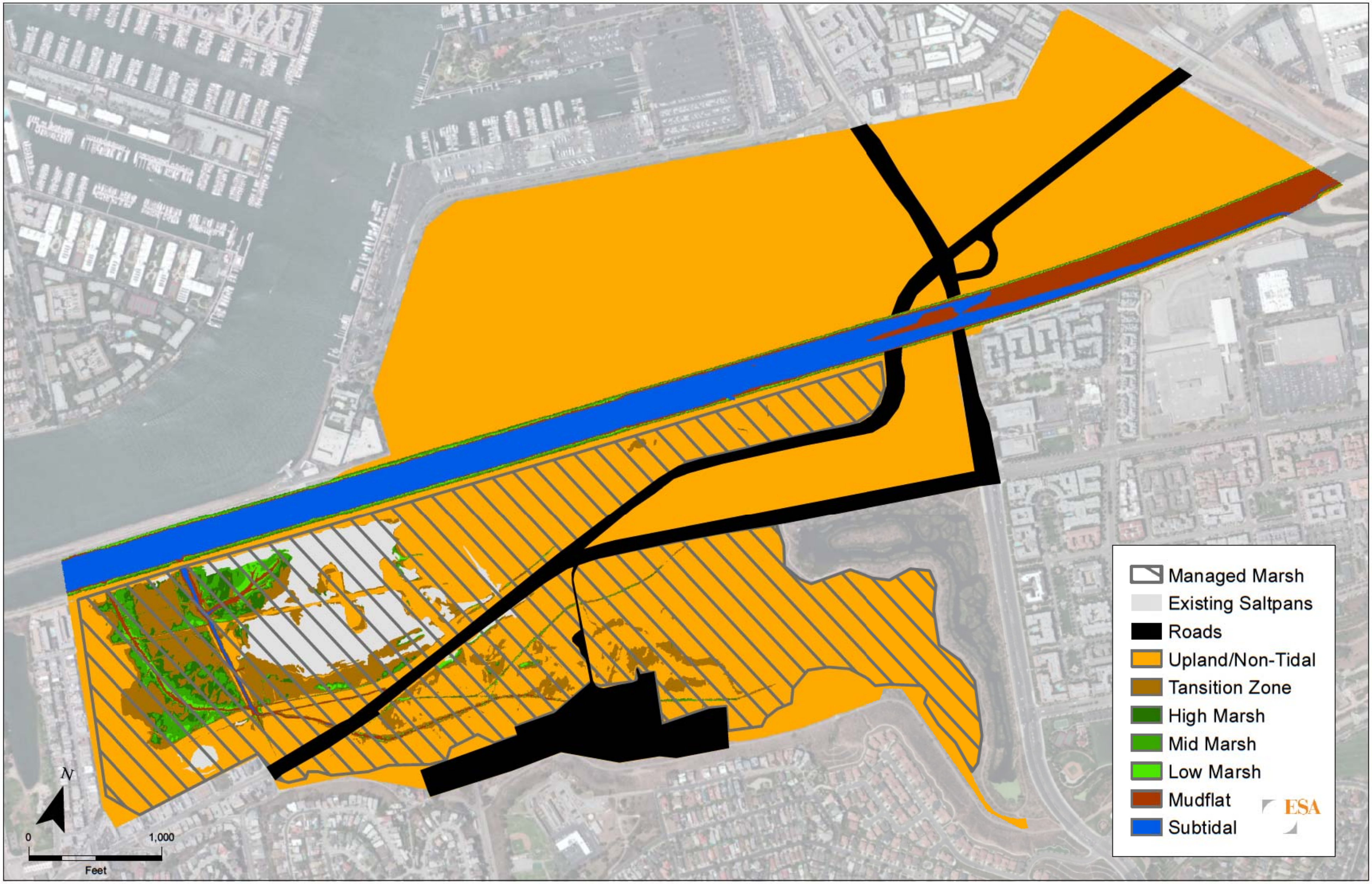
Ballona Wetlands Restoration Project

Figure 5
Alt 1, 2100



Ballona Wetlands Restoration Project

Figure 6
Alt 4 (No project), Now

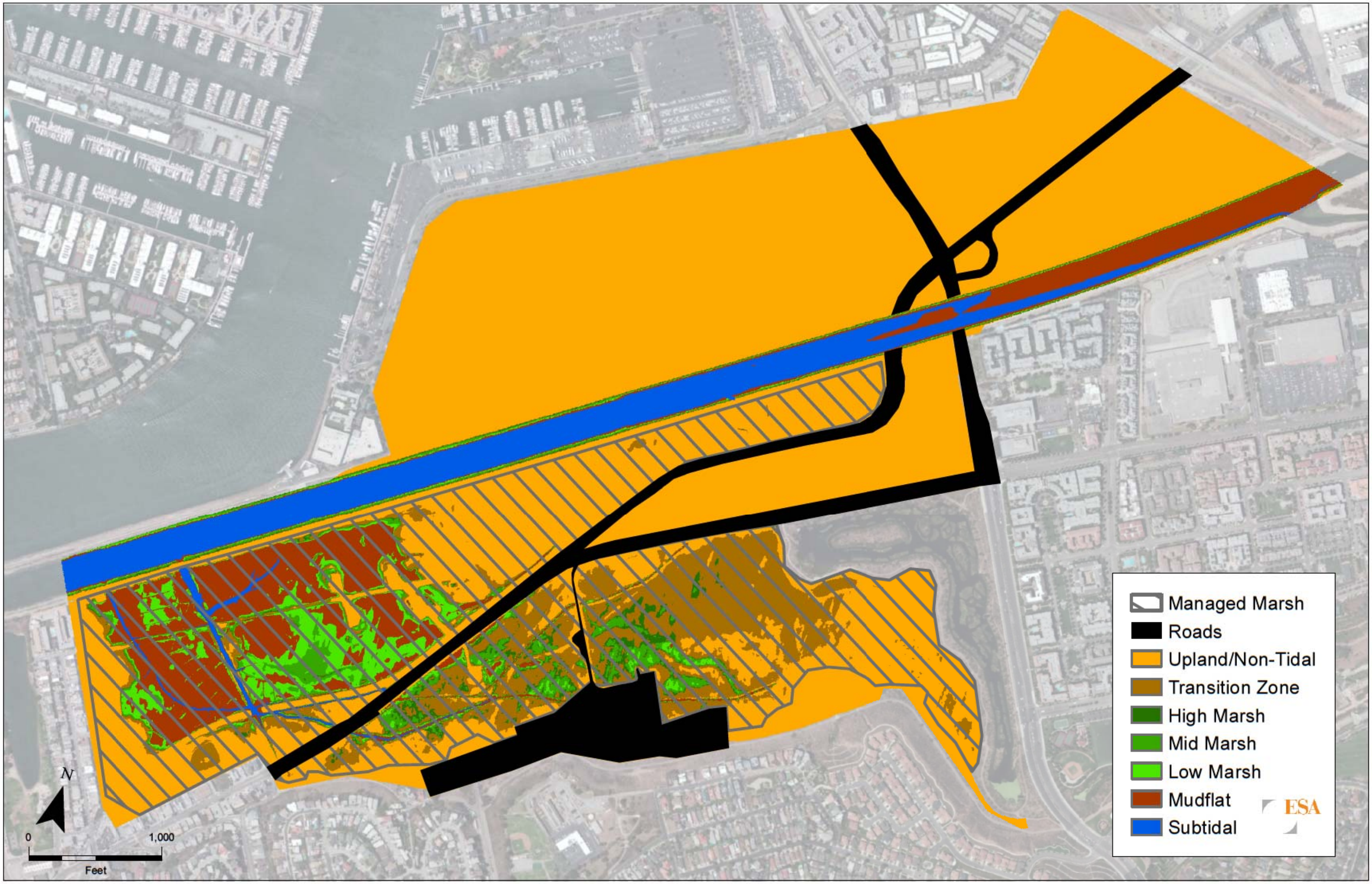


Ballona Wetlands Restoration Project

Figure 7
Alt 4 (No project), 2030

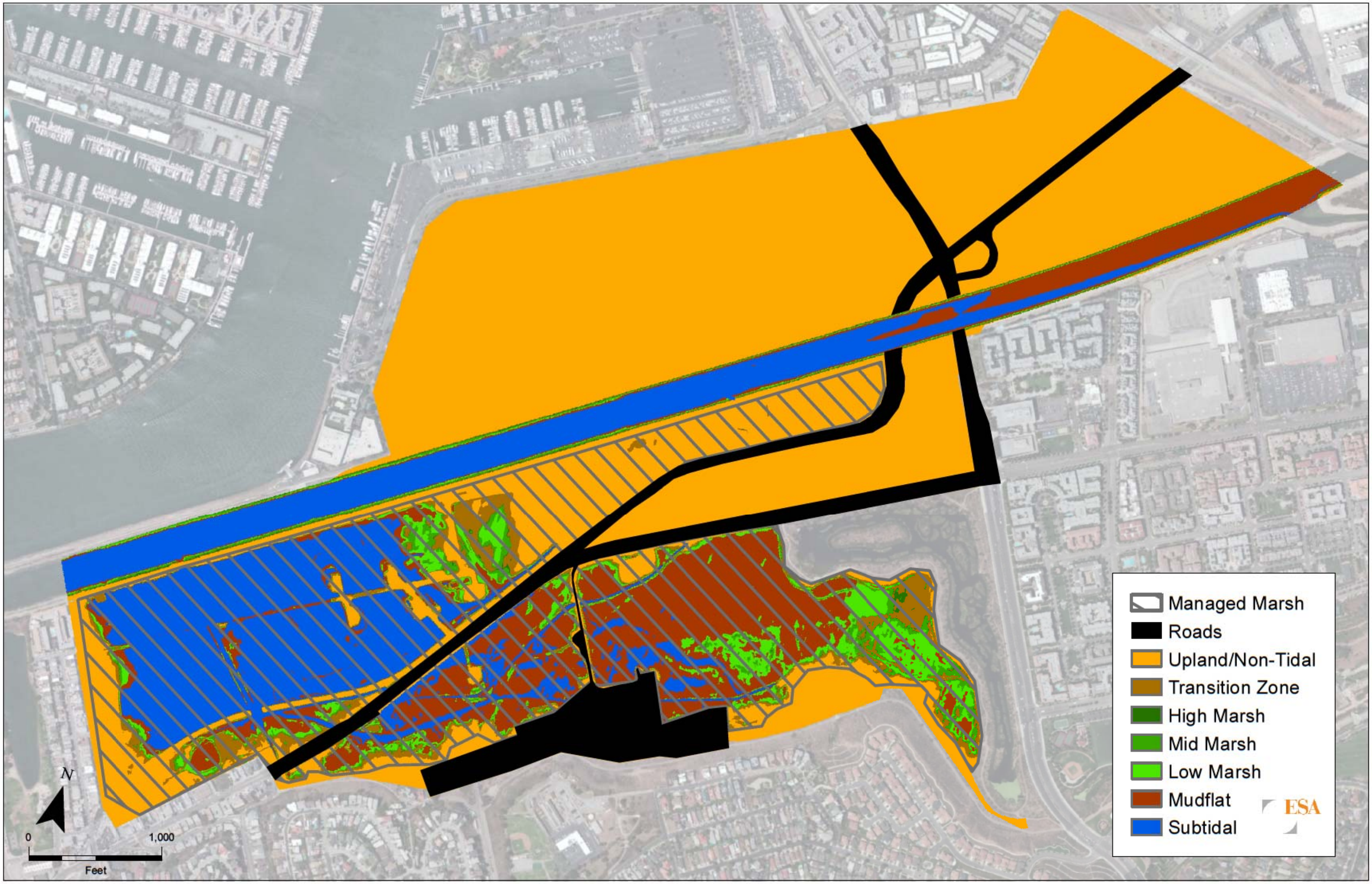
Ballona Wetlands Restoration Project

Figure 8
Alt 4 (No project), 2050



Ballona Wetlands Restoration Project

Figure 9
Alt 4 (No project), 2070



Ballona Wetlands Restoration Project

Figure 10
Alt 4 (No project), 2100

APPENDIX B8
Ballona Wetland Feasibility Report

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September 2008

Ballona Wetland Feasibility Report

Prepared For *California State Coastal Conservancy*

Prepared By

Philip Williams & Associates, Ltd.

with

EDAW,
Nordby Biological Consulting,
Tierra Environmental, and
Weston Solutions

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Ballona Wetlands Restoration
Feasibility Report

Prepared for

California State Coastal Conservancy

Prepared by

Santa Monica Bay Restoration Commission
Philip Williams & Associates, Ltd.

with

EDAW
Nordby Biological Consulting
Tierra Environmental
Weston Solutions

September 2008

PWA REF. # 1793.00

Services provided pursuant to this Agreement are intended solely for the use and benefit of the California State Coastal Conservancy.

No other person or entity shall be entitled to rely on the services, opinions, recommendations, plans or specifications provided pursuant to this agreement without the express written consent of Philip Williams & Associates, Ltd., 550 Kearny Street, Suite 900, San Francisco, CA 94108.

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1. INTRODUCTION

In 2004, the State of California took title to 600-acres of the remaining Ballona Wetlands in Los Angeles (Figure 1-1). The property is owned by two state agencies, the Department of Fish and Game (DFG) and the State Lands Commission. The State Coastal Conservancy (Conservancy) has funding for planning and restoring the property. Together, the three agencies are working with stakeholders, scientists and other agencies to develop a plan to restore this extraordinary resource. The Conservancy is providing funds for the planning effort and manages the work plan, budget, and schedule. DFG would be the applicant for any permits needed for the restoration project and the lead agency for purposes of CEQA. A restoration plan would be developed for all of the lands owned by the state. Planning is being conducted within the landscape and watershed context, incorporating adjacent and ecologically related resources.

This document characterizes the differences between five preliminary alternatives for the Ballona Wetlands Restoration Plan developed and refined by the Project Management Team (PMT), with the advice of the Ballona Wetlands Working Group, Science Advisory Committee, Agency Advisory Committee, and the consultant team. The aim is to provide a consistent set of information for each alternative using measures of change developed from the project's Goals and Objectives (Appendix A). These measures of change provide the ability to objectively determine how each alternative moves towards a specific project objective from the existing baseline conditions. The PMT would use this information to screen out infeasible or undesirable alternatives from advancing to the EIS/EIR process.

While the report is structured around five alternatives, they are discussed for each subarea within the Ballona Wetlands when appropriate, allowing the preferred alternative(s) to be developed from a combination of alternatives from different subareas. Area A refers to the portion of the Ballona Wetlands north of Ballona Creek to the west of Lincoln Boulevard. Area B refers to the portion south of Ballona Creek. Area C refers to the area north of Ballona Creek and east of Lincoln Boulevard.

Chapter 2 of the report provides an overview of the five alternatives, highlighting the changes from the existing conditions of the site, as well as the habitat restoration and public access objectives accomplished by each alternative. The alternatives encompass a reasonable range of options for restoring estuarine habitat within each of the different subareas (see Appendix B for habitat descriptions). These options include:

- Enhance existing habitat with minimal grading
- Muted tidal wetland restoration within existing constraints
- Full tidal wetland restoration, supporting all associated habitat types, and requiring significant site alteration

- Full tidal wetland and subtidal habitat restoration, providing a connection between these habitats with the project site, and requiring significant site alteration.
- Realignment of Ballona Creek, allowing interaction between the creek and wetland, and providing much more habitat and functional connectivity; and, requiring significant site alteration.

For each habitat restoration alternative, a public access alternative has been developed which includes trails, gateway entrances, overlooks and pullouts.

Chapter 3 applies information from existing sources, in particular the Existing Conditions Report and hydrodynamic modeling (Appendix C), to compare the potential effects of the restoration alternatives based on the measures of change. The main themes of the feasibility assessment are:

- Habitat Acreages
- Quality of Habitat
- Habitat Connectivity (Regional and Local)
- Biodiversity
- Hydrology (Tidal Circulation and Flood Protection)
- Sediment and Water Quality
- Sustainability
- Public Access, Recreation and Safety
- Phasing and Relative Costs

These themes are based on the goals and objectives for the project. Each theme is discussed in terms of how different site conditions might improve or effect desired characteristics of the theme. The evaluation is summarized in a Chapter 4 which describes the main characteristics of each alternative. The information provided in this section can then be used as an objective basis to determine how each of the alternatives accomplishes these project objectives. A summary is provided that compares the alternatives to each other based on a list of common, favorable characteristics. This summary also describes some of the trade-offs between the different approaches to restoration. A ranking of each alternative on a scale from 1 to 5 is given. These rankings are based on the best judgment of the Project Management Team, with input from the Science and Agency Advisory Committees.

1.1 SECTION 1 FIGURES

figure 1-1

Ballona Wetlands Restoration

Project Area

Proj. # 1793

PWA

2. DESCRIPTION OF ALTERNATIVES

2.1 ALTERNATIVE 1 - ENHANCE EXISTING HABITAT WITH MINIMAL GRADING

Alternative 1 (Figure 2-1) proposes minimal change relative to the existing conditions of the site. As such, this alternative emphasizes enhancement of existing upland habitats, in particular coastal sage scrub (CSS) and native grassland habitats, over creation or restoration of coastal wetland habitats. Alternative 1 would convert an area of freshwater marsh in the southeast portion of Area B to muted tidal marsh by replacing the existing Freshwater marsh culvert with a daylighted tidal channel that connects to Ballona Creek. This would provide one additional source of tidal influence to the project area. Existing tide gates would be modified to increase the muted tidal waters entering the southwest portion of Area B. Alternative 1 proposes little change to existing infrastructure such that the project area would remain fragmented and isolated by roads, Ballona Creek, berms and levees. Existing dune habitat, the constructed freshwater marsh and recreational facilities in Area C would be retained.

Area A would be managed to include seasonal wetland habitat, tidal low marsh and channel, transition zone and enhanced upland. The existing tidal connection to Berth H in Marina del Rey would not be changed.

Area B would remain similar to existing conditions with the following exceptions:

1. A small triangle of land located south of Culver Boulevard and west of proposed muted mid-marsh habitat that is currently mapped as non-tidal salt marsh/brackish marsh would be converted to CSS and transitional habitats.
2. The closing elevation of the tide gates that allow limited tidal influence in this area would be increased to admit lower high tides into the area. This would expand the area of muted tidal marsh.

Area C includes the highest elevations of the project area. Under Alternative 1, little excavation of this area is proposed. Instead, existing recreational facilities would be retained and enhanced CSS and native grassland habitat, and a small treatment wetland would be constructed.

In terms of Public Access (Figure 2-2), Area A would have a loop trail on the existing Gas Company access road, and a larger loop trail would provide access to the seasonal wetland area via a boardwalk. Gateway entrances, overlooks and a formal parking/staging area would be developed. For Area B, public access would include periphery trails, along Cabora Drive, and pedestrian crossings for a fully integrated trail network. Gateway entrances, overlooks and formal parking would be provided. Linkages between the east and west portions of Area B would be provided by two pedestrian crossings on Culver Boulevard. A pedestrian bridge located near the historic rail crossing would link Area B to Area A. Public access features in Area C would include two loop trails originating from the gateway entrances at La Villa Marina and near the Little League fields. A parking area would continue to be located at the Little League fields.

2.2 ALTERNATIVE 2 - A SMALLER AREA TIDAL WETLAND RESTORATION

Alternative 2 (Figure 2-3) includes a departure from existing conditions through excavation of fill to create fully tidal channels, low marsh, and mid-high salt marsh. Alternative 2 would also convert an area of freshwater marsh in the southeast portion of Area B to muted tidal marsh by replacing the existing Freshwater Marsh culvert with a daylighted tidal channel that connects to Ballona Creek. This would provide one additional source of tidal influence to the project area. Existing connections would be modified by adjusting the setting of the existing tide gates to increase the muted tidal waters entering the southwest portion of Area B. The connection under Dock 52 to Marina del Rey would be enhanced, creating a full tidal marsh in Area A. Alternative 2 proposes little change to existing infrastructure such that the project area would remain fragmented and isolated by roads, Ballona Creek, and berms and levees. Existing dune habitat, constructed freshwater marsh and recreational facilities would be retained.

Area A would be modified to include fully tidal channels, low and mid-high marsh, and associated transition zone habitats. This would be accomplished by increasing the tidal connection under Dock 52 to create an open culvert with a cross-sectional area of 100 ft^2. The remainder of Area A would be converted to enhanced CSS and native grassland habitat.

The southeast portion of Area B (Area B southeast) would be modified to include fully tidal channels, low and mid-high marsh, and associated transition zone habitats. In Area B southwest, the degree of tidal influence would be increased through modification of the existing tide gates. A new culvert with a cross-section of 100 ft^2 would provide a new fully tidal connection to Area B southwest. Like Alternative 1, a small triangle of land located south of Culver Boulevard that is currently mapped as non-tidal salt marsh/brackish marsh would be converted to CSS and transition zone habitats

Alternative 2 would create a small, deeper extension of Fiji Ditch in Area C beneath Lincoln Boulevard resulting in an incremental increase in fully tidal channel, low and mid-high marsh habitats and transition zone habitat beyond that proposed in Alternative 1. The recreational facilities, CSS and native grassland habitat would be retained and small areas of seasonal wetland and treatment wetlands created.

In Area A, a loop trail on the existing Gas Company Road, and a perimeter trail, around the new wetlands, connecting the gateway entrance along Fiji Way to the Ballona Creek Bicycle trail along the north levee would be developed (Figure 2-4). Boardwalk spur trails at the Fiji Way and Fisherman's Village gateway entrances would provide access to overlooks. Public access features in Area B would be similar to Alternative 1. Public access features in Area C would include two loop trails originating from the gateway entrances at La Villa Marina and near the Little League fields. A parking area would continue to be located at the Little League fields. An overlook would be located near the seasonal wetland area.

2.3 ALTERNATIVE 3 - A LARGER AREA TIDAL WETLAND RESTORATION

Alternative 3 (Figure 2-5) would create additional estuarine habitat relative to Alternative 2 resulting in further increases in fully tidal channel, low marsh and mid-high marsh habitats and associated transition zone habitat. Culver Boulevard, Jefferson Boulevard and the Gas Company road in Area B would be improved by raising the roads on levees or piles; these would provide greater hydraulic connectivity through larger culverts or between piles. Portions of the project area would remain fragmented and isolated by Ballona Creek and Jefferson Boulevard. Existing dune habitat, constructed freshwater marsh and recreational facilities would be retained.

Area A would be modified to include fully tidal channels, low marsh and mid-high marsh and associated transition zone habitats. This would be accomplished by increasing the tidal connection under Dock 52 to create an open culvert with a cross-sectional area of 160 ft^2. The remainder of Area A would be converted to enhanced CSS and native grassland habitat.

In Area B, Alternative 3 would increase the degree of tidal influence in the southwest wetland by replacing the SRT with a 100 foot wide breach. The alternative also includes extension of existing fully tidal channels and raising Culver Boulevard on pilings or levees and removal of the berm south of Culver Boulevard. Most available area would be converted to fully tidal habitats and transition zone habitat. The southeast wetland would be connected as in Alternative 2.

Alternative 3 would create a small, deeper extension of Fiji Ditch in Area C and excavation of a small tidal marsh resulting in an incremental increase in fully tidal channel habitat and an increase in transition zone habitat beyond that proposed in Alternative 2. The recreational facilities, CSS and native grassland habitat would be retained and two small areas of seasonal wetland would be created.

Key provisions for public access (Figure 2-6) in Area A are a looping perimeter trail along the banks of the restored wetland. This trail links gateway entrances along Fiji Way to those along the north levee. Gateway entrances would be located at the existing parking area near Fisherman's Village, along Fiji Way, and two along the Ballona Creek Bicycle Path. Boardwalk spur trails at the Fisherman's Village and Fiji Way gateway entrances would provide access to overlooks. These overlooks would provide both an easily accessible viewing point and a key location for interpretive and educational signage. A formal parking/staging area would be developed at the gateway entrance near Fisherman's Village. In Area B, roadside vehicular pullouts would be provided along Culver and Lincoln Boulevards. A link between the east and west portions of Area B would be provided by a pedestrian crossing located on Culver Blvd. A pedestrian bridge located near the historic rail crossing would link Area B to Area A. Formal parking areas would be located at the gateway entrance behind Gordon's Market and along Jefferson Blvd at the Freshwater Marsh. Public access features in Area C would include two loop trails originating from the gateway entrances at La Villa Marina and near the Little League fields. A parking area would continue to be located at the Little League fields. Overlooks would be located at viewing points for the seasonal wetland area near the Little League fields and north of Culver Blvd at the restored estuarine wetland area.

2.4 ALTERNATIVE 4 - A LARGE AREA TIDAL WETLAND RESTORATION WITH SUBTIDAL COMPONENT

Alternative 4 (Figure 2-7) resembles Alternative 3 with the exception of a larger connection with Marina del Rey and creation of shallow subtidal and intertidal habitats in Area A. This increased excavation would create a shallow subtidal basin and increased intertidal mudflats, while shifting the excavation to the northwest edge of Area A would allow for the creation of a more diverse marsh plain. Culver Boulevard and the levee system south of Culver Boulevard would be improved by raising the road on piles or a levee, these would provide greater hydraulic connectivity through larger culverts or between piles. Portions of the project area would remain fragmented and isolated by Ballona Creek and Jefferson Boulevard. Existing dune habitat, constructed freshwater marsh and recreational facilities would be retained.

Area A would be modified to include a shallow subtidal embayment, tidal channels, intertidal mudflat, low salt marsh, mid-high marsh and associated transition zone habitats. This would be accomplished by increasing the tidal connection under Dock 52 to create an open culvert with a cross-sectional area of 500 ft^2. A narrow, linear strip adjacent to Ballona Creek would be converted to enhanced CSS habitat.

In Area A there would be a loop trail on the existing Gas Company Road, and a perimeter trail along the southern edge of the restored estuarine wetland, portions of which would be boardwalk (Figure 2-8). Gateway entrances would be located at the existing parking area near Fisherman’s Village and along the Ballona Creek Bicycle Path. The loop and perimeter trails would link the gateway entrance near Fisherman’s Village to the Ballona Creek trail located along the north levee and the two gateway entrances along Ballona Creek. Overlooks would be located near the Fisherman’s Village gateway entrance and along the perimeter trail. A formal parking/staging area would be developed at the gateway entrance near Fisherman’s Village. Public access features in Area B and C would be the same as Alternative 2.

2.5 ALTERNATIVE 5 - A REALIGNMENT OF BALLONA CREEK

Alternative 5 (Figure 2-9) proposes the greatest amount of change to the project area, including the greatest degree of fully tidal wetland creation. The most obvious change would be the removal of the Ballona Creek flood control channel levees and creation of a sinuous natural creek and associated tidal basins through the site. The site would be interconnected across all areas, with shallow subtidal and mudflats grading through all marsh habitats to higher wetland-upland transition habitat. The channel would be free to migrate across the tidal floodplain, limited where necessary by buried rock protection. The existing Ballona Creek channel would be filled where necessary. The intersection of Culver and Jefferson Boulevards would be moved westward, closer to Lincoln. Culver and Lincoln Boulevard would be raised on pilings above the fully tidal marshlands. The gas/oil monitoring facilities in Area A and recreational facilities in Area C would be minimized and converted to fully-tidal channel, low, and. mid-high marsh, transition zone and enhanced CSS. The constructed freshwater marsh and existing dunes would be retained.

Phasing would be an important aspect of this alternative. Phase 1 would lower the levees and surface elevations and excavate the main channel in Area A; Phase 2 would extend the channel into Area B; Phase 3 would extend the channel into Area C following the raising of Lincoln Boulevard.

Areas A, B and C would be modified to include the reengineered fully-tidal Ballona Creek, two shallow tidal ponds, tidal channels, low salt marsh, mid-high marsh and associated transition zone habitats. The northern breakwater of Ballona Creek would be lowered to allow flood flows to spill into Marina Del Rey. Buried rock protection would be provided along the south east edge to prevent the channel meandering too far west. A narrow, linear strip in the north and west portions of the area would be converted to enhanced CSS habitat.

A perimeter trail would be constructed along Fiji Way and gateway entrances located at the existing parking area near Fisherman's Village and along Fiji Way (Figure 2-10). A boardwalk containing an overlook would link the two gateway entrances as well as overlooks located at both gateway entrances. A vehicular pullout would be located along Culver Blvd and would also provide an overlook. Linkages within Area A would be provided through two pedestrian crossings located along Lincoln Blvd. A formal parking/staging area would be developed at the gateway entrance near Fisherman's Village. Area B gateway entrances would be located behind Gordon's Market, along the southern bank of Ballona Creek, along Lincoln Blvd, and along Jefferson Blvd at the entrance to the Freshwater Marsh. Boardwalk spur trails leading to overlooks would be located along the Freshwater Marsh Trail and at a vehicular pullout along Culver Blvd. Overlooks would also be located at the existing Boy Scout Overlook Platform, at the gateway entrance along the south levee, and along the Cabora Drive trail at Pershing Drive. Linkages throughout Area B would be provided by three pedestrian crossings located on Culver Blvd. An upland area along Lincoln Boulevard provides for a possible visitor center location. Formal parking areas would be located at the gateway entrance behind Gordon's Market, at the visitor center, and along Jefferson Blvd at the Freshwater Marsh.

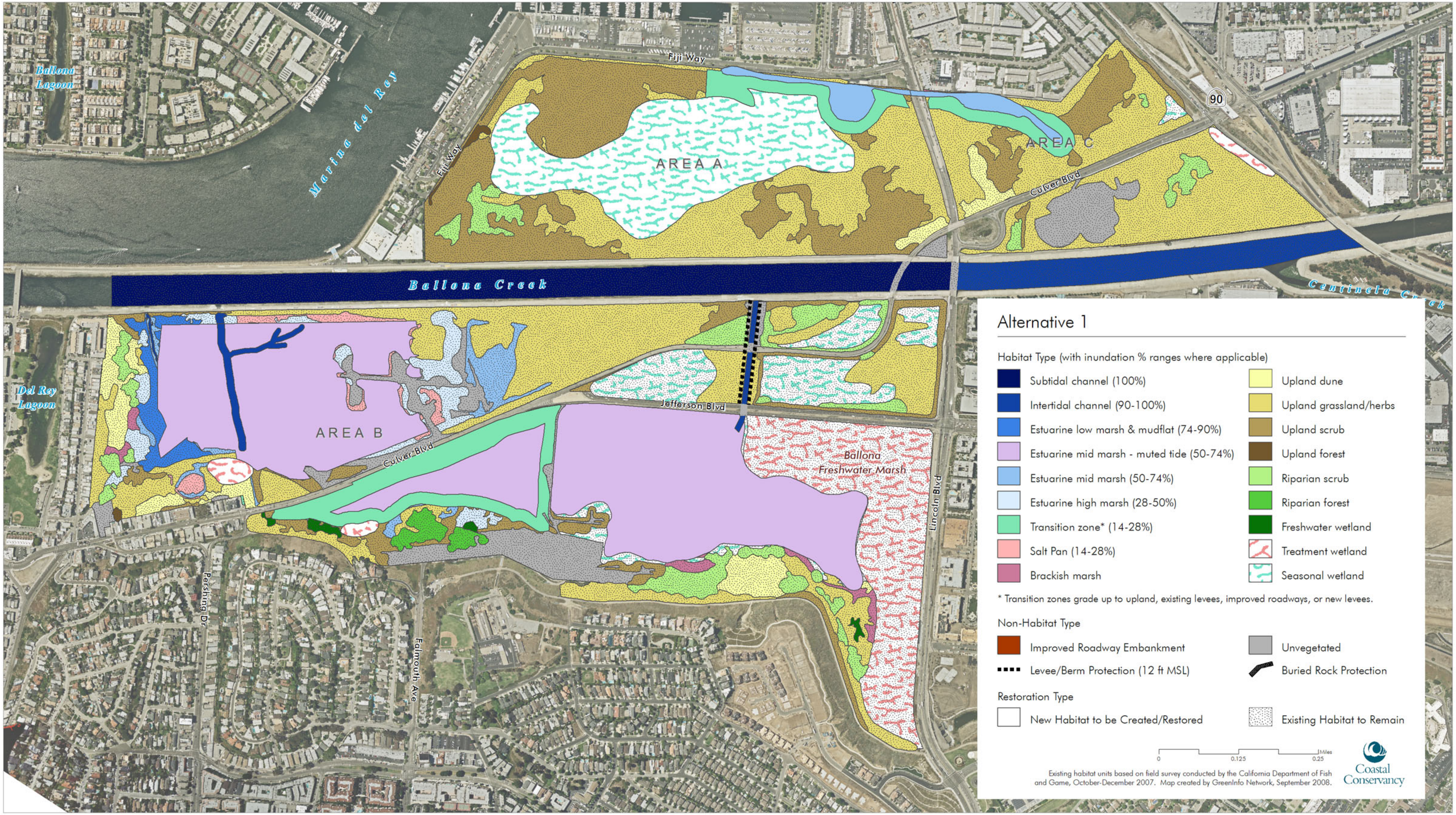
Public access features in Area C would include a perimeter trail from the La Villa Marina gateway entrance to the Lincoln Blvd pedestrian crossing to Area A. Regional trail connectivity would be preserved by connecting the Ballona Creek Bicycle Trail (previously located on the north levee) to a dual pedestrian and bicycle trail along the southern boundary of Area C. This trail would continue both to the north along Lincoln Blvd and to the south along Culver Blvd. Since both roads would be improved within this restoration alternative, improved bicycle lanes would facilitate this regional connectional. A pedestrian bridge would cross Ballona Creek connecting this new trail alignment to the existing Ballona Creek Bicycle Trail. An overlook would be located at the La Villa Marina gateway entrance.

2.6 SECTION 2 FIGURES

Ballona Wetlands
Restoration Project

FIGURE 2-1

Alternative 1 - Habitat Restoration



Ballona Wetlands Restoration Project

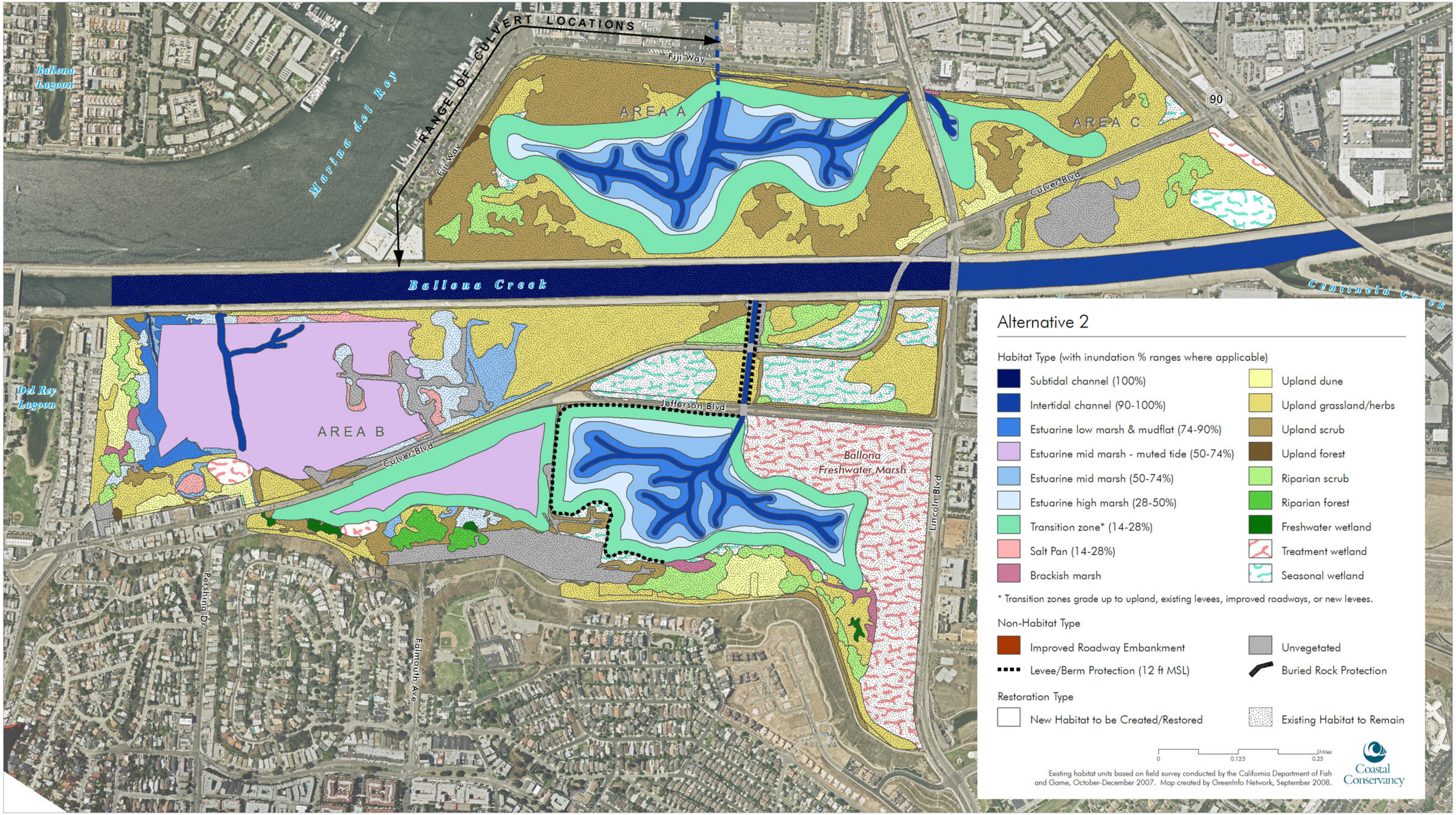
FIGURE 2-2 Alternative 1 - Public Access

Habitat concepts created by Philip Williams and Associates (PWA) and EDAW. Map created by GreenInfo Network and EDAW, September, 2008.

Ballona Wetlands
Restoration Project

FIGURE 2-3

Alternative 2 - Habitat Restoration



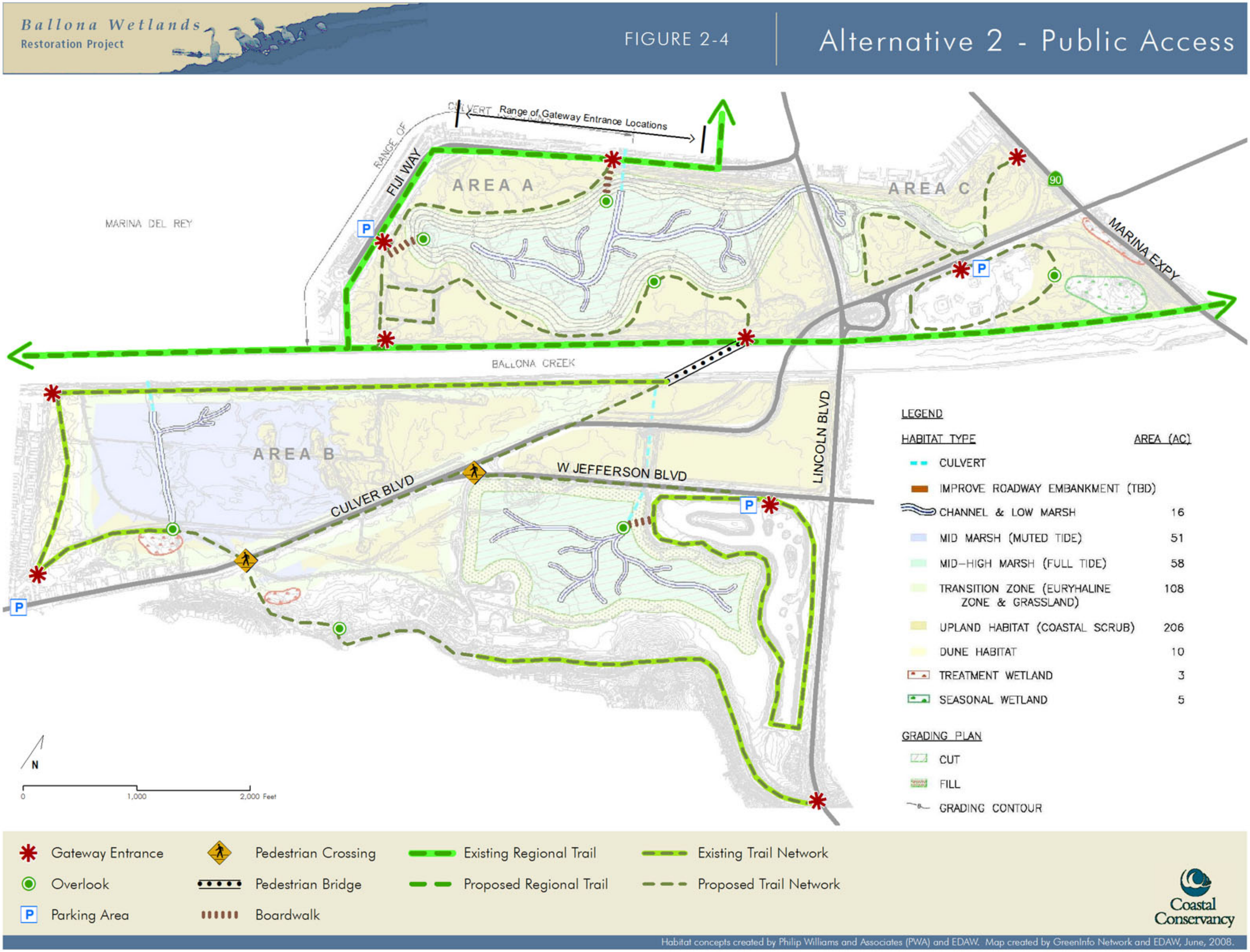

Ballona Wetlands
Restoration Project
FIGURE 2-4
Alternative 2 - Public Access
Range of Gateway Entrance Locations
CULVERT
RANGE OF
FIJI WAY
AREA A
AREA C
AREA B
MARINA DEL REY
90
MARINA EXPY
BALLONA CREEK
LINCOLN BLVD
W JEFFERSON BLVD
CULVER BLVD
LEGEND
HABITAT TYPE
AREA (AC)
CULVERT
IMPROVE ROADWAY EMBANKMENT (TBD)
CHANNEL & LOW MARSH 16
MID MARSH (MUTED TIDE) 51
MID-HIGH MARSH (FULL TIDE) 58
TRANSITION ZONE (EURYHALINE ZONE & GRASSLAND) 108
UPLAND HABITAT (COASTAL SCRUB) 206
DUNE HABITAT 10
TREATMENT WETLAND 3
SEASONAL WETLAND 5
GRADING PLAN
CUT
FILL
GRADING CONTOUR
N
0
1,000
2,000 Feet
Gateway Entrance
Overlook
Parking Area
Pedestrian Crossing
Pedestrian Bridge
Boardwalk
Existing Regional Trail
Proposed Regional Trail
Existing Trail Network
Proposed Trail Network
Coastal Conservancy
Habitat concepts created by Philip Williams and Associates (PWA) and EDAW. Map created by GreenInfo Network and EDAW, June, 2008.

FIGURE 2-5

Alternative 3 - Habitat Restoration

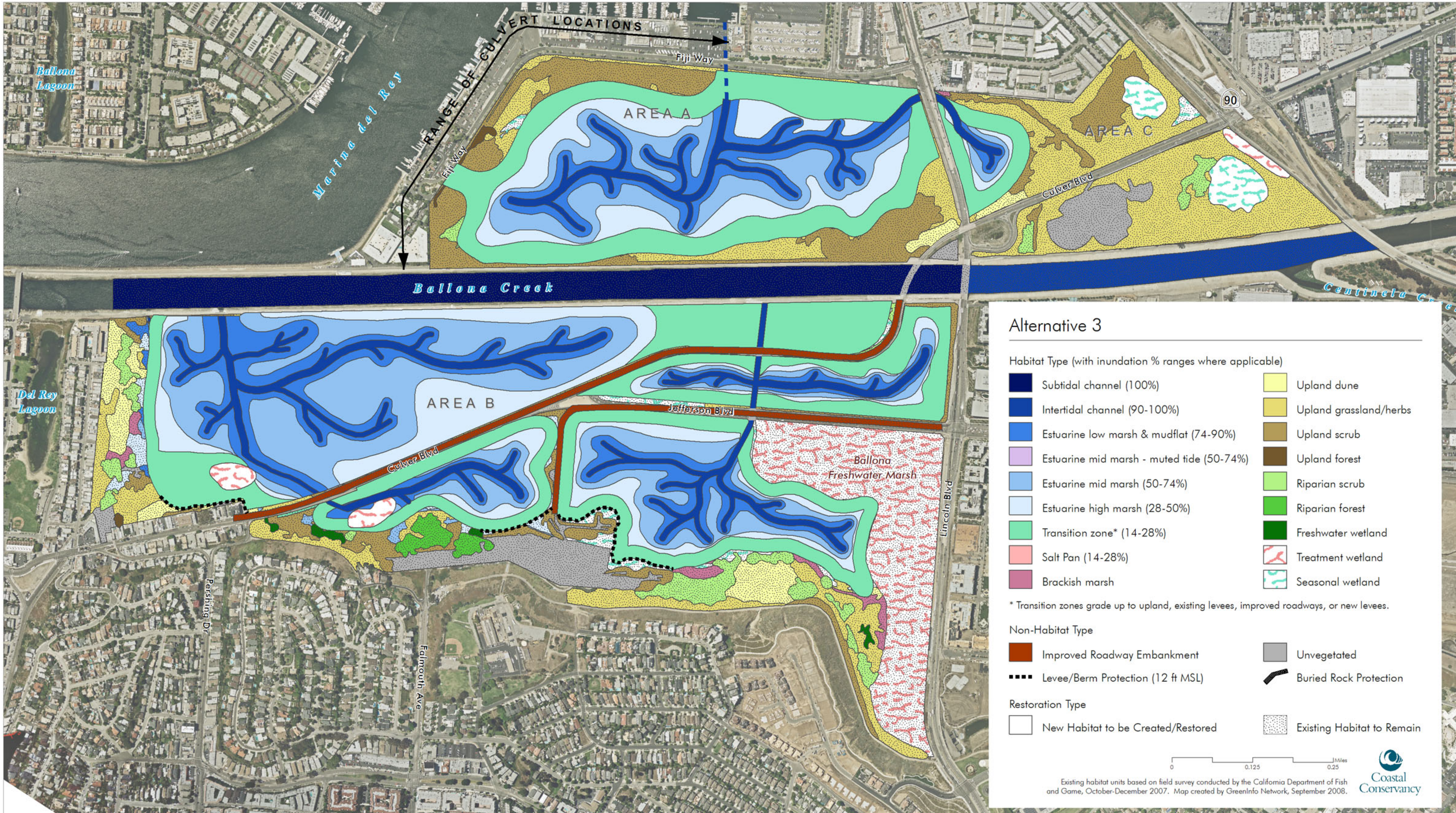


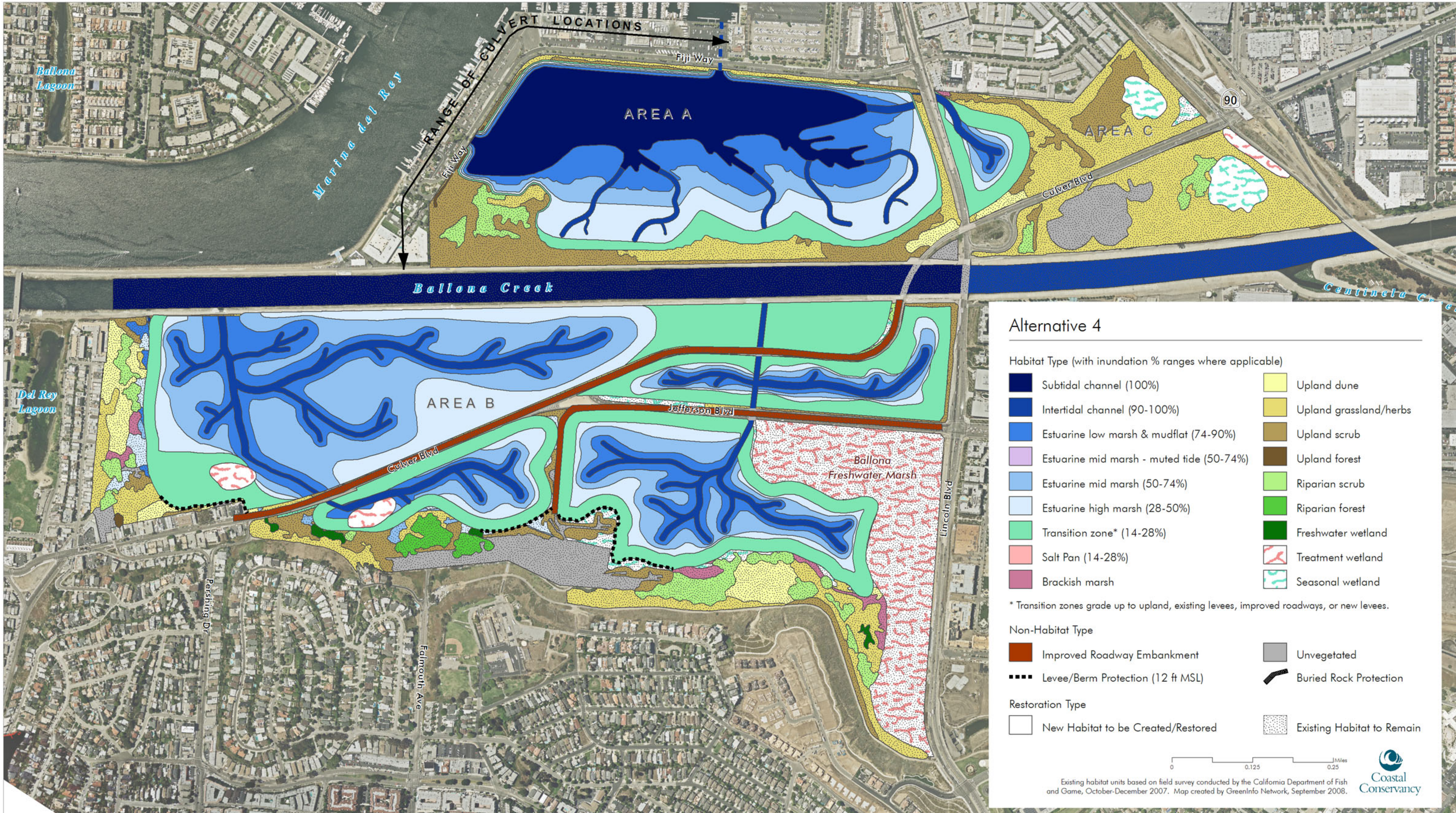
FIGURE 2-6

Alternative 3 - Public Access

Habitat concepts created by Philip Williams and Associates (PWA) and EDAW. Map created by GreenInfo Network and EDAW, June, 2008.

FIGURE 2-7

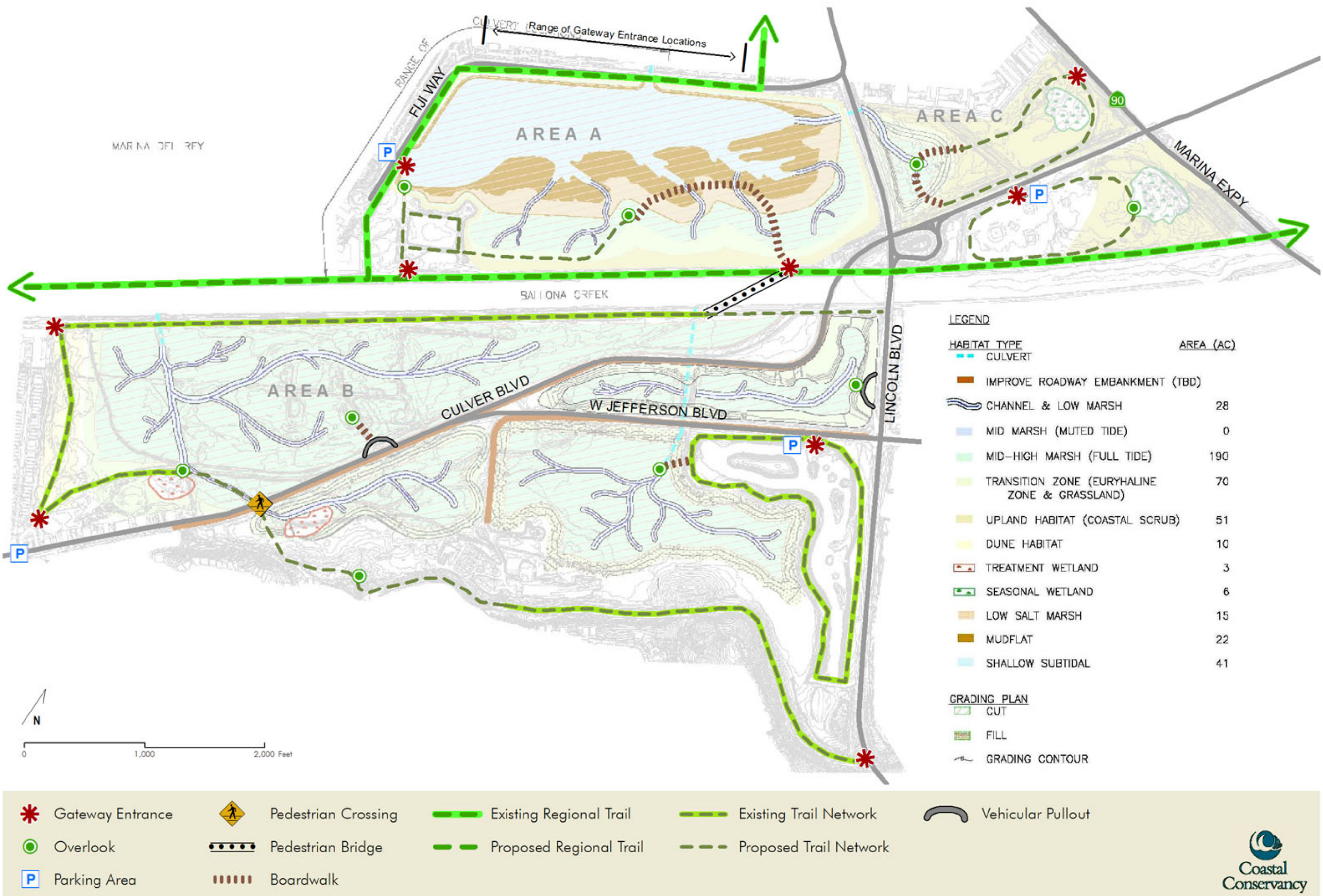
Alternative 4 - Habitat Restoration



Ballona Wetlands
Restoration Project

FIGURE 2-8

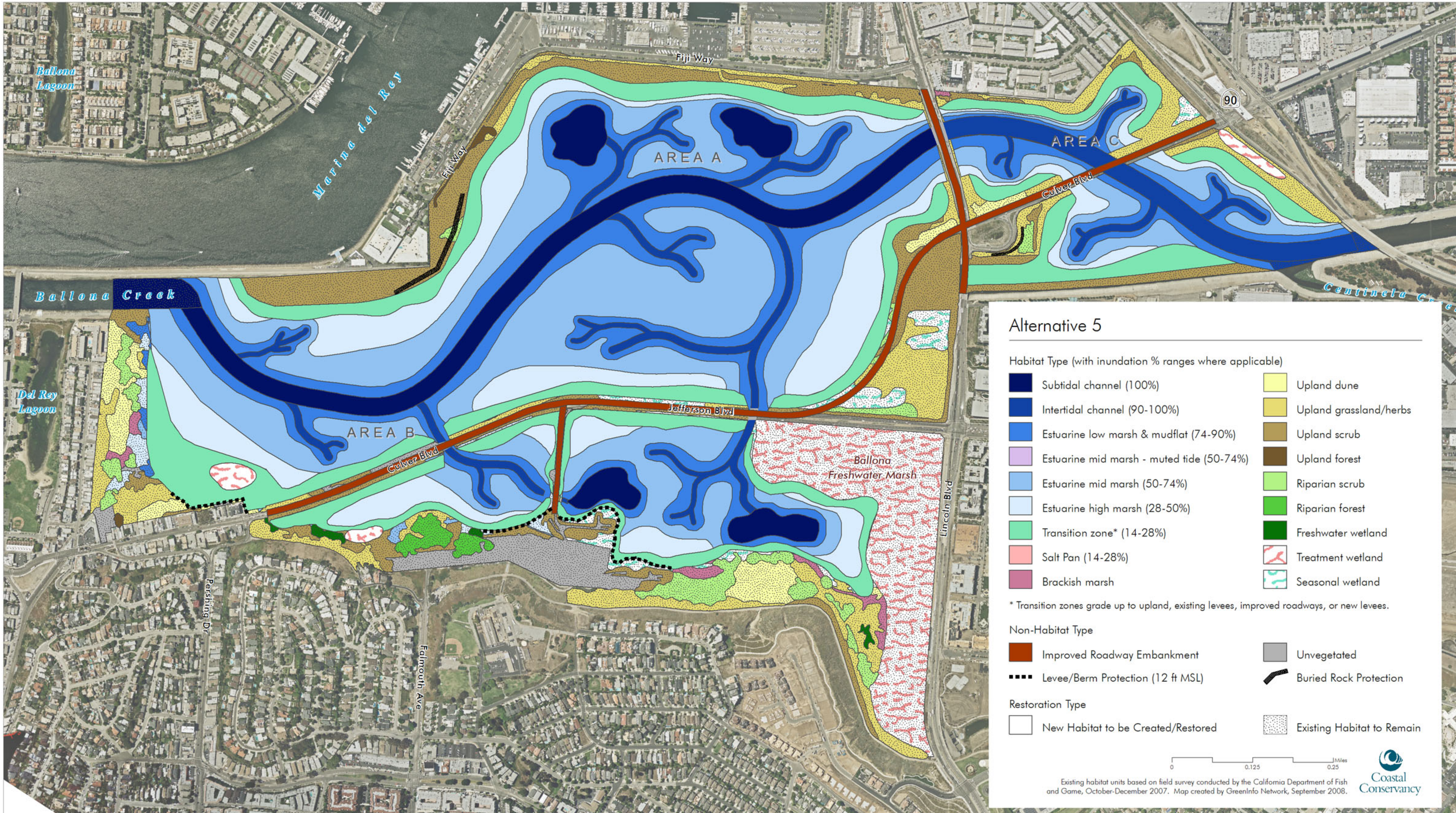
Alternative 4 - Public Access



Habitat concepts created by Philip Williams and Associates (PWA) and EDAW. Map created by GreenInfo Network and EDAW, June, 2008.

FIGURE 2-9

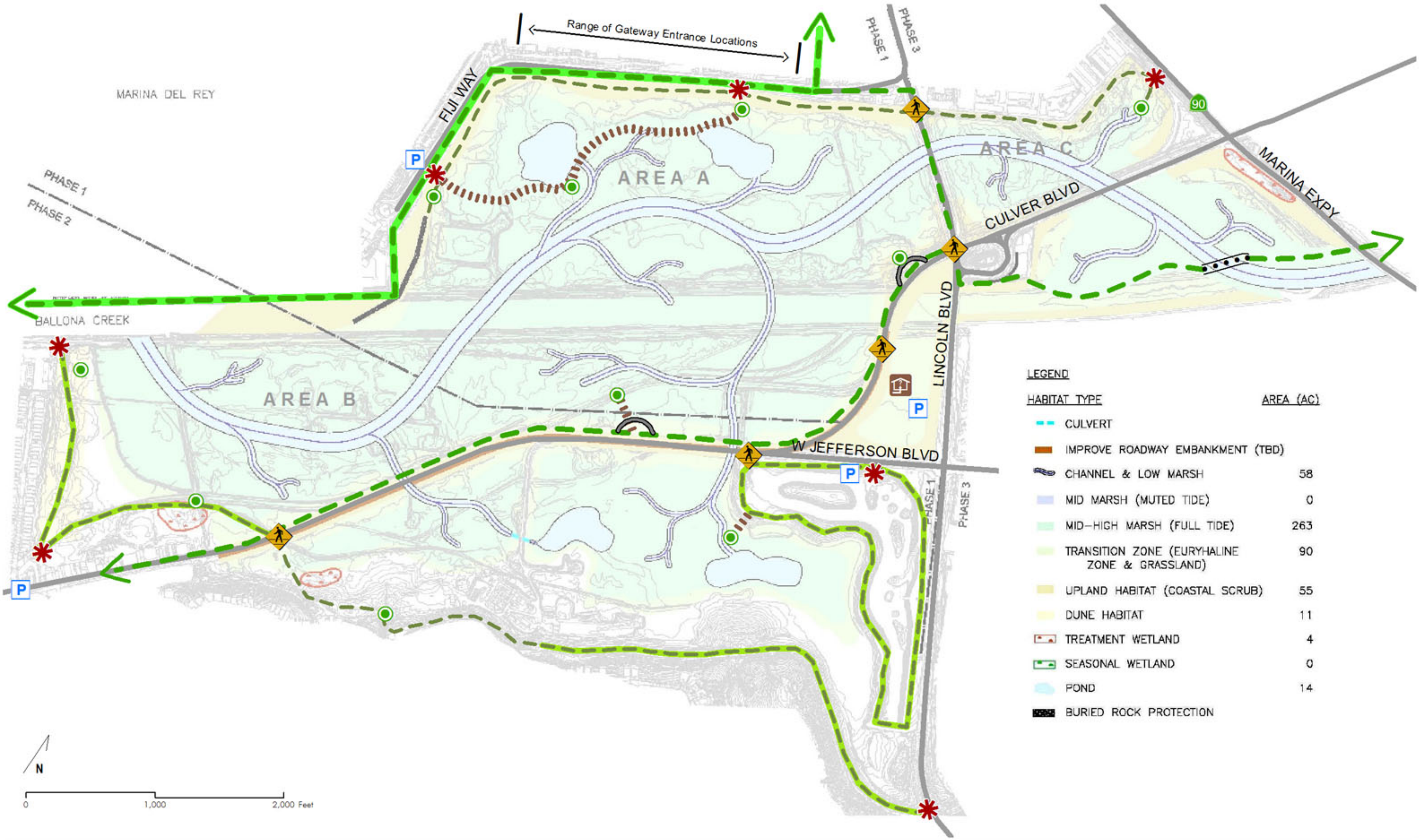
Alternative 5 - Habitat Restoration



Ballona Wetlands Restoration Project

FIGURE 2-10

Alternative 5 - Public Access



Gateway Entrance	Pedestrian Crossing	Existing Regional Trail	Existing Trail Network	Vehicular Pullout
Overlook	Pedestrian Bridge	Proposed Regional Trail	Proposed Trail Network	Visitor Center
Parking Area	Boardwalk			

Coastal Conservancy

Habitat concepts created by Philip Williams and Associates (PWA) and EDAW. Map created by GreenInfo Network and EDAW, June, 2008.

3. MEASURES OF CHANGE

3.1 HABITAT

The Ballona Wetlands historically covered over 2000-acres and likely included a mix of fluvial, tidal, deltaic and dune habitat types. Today this wetland has been reduced to less than 170 acres within the project area and the hydrology of the watershed has been severely altered by extensive development. Remnant areas of the historic wetland complex include Del Rey Lagoon, Ballona Lagoon, Grand Canal, Oxford lagoon, Marina Del Rey, and the Venice Canals. Given the significant alteration, restoring Ballona Wetlands to its historic condition is infeasible; however, the opportunity to recreate a vibrant wetland system would still require consideration of the mix of habitat types that would benefit the ecological functioning.

This section provides a brief description of the different habitat types that would be restored under each of the alternatives (for more detail see Appendix B). A number of broad habitat types are identified in the alternatives: shallow subtidal and open water habitats, intertidal channels and mudflat habitats; low, mid and high marsh and salt pan habitats; wetland-upland transition habitat; brackish marsh; seasonal wetland habitat; freshwater marsh and riparian scrub habitats; and coastal dune, coastal sage scrub and native grassland habitats. Estuarine intertidal wetland habitat includes shallow subtidal, intertidal channels, mudflats, and low, middle and high marsh, salt pan, and transition zone habitats. Each component is necessary to recreate the Ballona Ecosystem and without each component the estuarine wetlands within the system would not function properly. Some components are currently absent from Ballona, and may be important additions in the restoration of Ballona Wetlands.

Tidal Wetlands

Given the estuarine location of the site, the degree of tidal inundation would be a major factor in influencing the habitat type. The period, depth, and frequency of inundation by tidal water are dependent upon the tidal range, density of soil, degree of slope, and ground elevation.

Shallow subtidal habitats include channels, embayments, basins and other features, which at extreme low water do not drain with the outgoing tides. This estuarine water regime results in permanently flooded habitats and permanent open water bodies. These habitats are generally considered truly aquatic systems and are adjacent to and downslope from tidal estuarine wetlands. Estuaries with extensive subtidal habitat areas often support extensive intertidal low marsh and mudflat habitats, providing refugia for fish during low tides, and feeding opportunities for wetland birds.

Intertidal channels and creeks play a critical role in salt marshes as they convey tidal waters and associated nutrients and dissolved gases. They also support a complex assemblage of plants and animals. Estuarine channels and creeks are subjected to a wide variety of environmental conditions. Typically, tidal flushing is greatest at the tidal inlet and decreases with distance from the inlet. This general gradient, in turn influences, water movement, salinity, temperature, nutrients, and dissolved gases. These environmental factors influence the species composition, distribution, and population dynamics of the channel fauna.

Intertidal mudflats are situated low in the intertidal zone, between subtidal open water and vegetated salt marsh (low marsh), at the open water edge and along channel banks. Mudflats are inundated and exposed during most tide cycles. Mudflat habitat support invertebrate population and provides valuable foraging habitat, particularly for shorebirds.

Intertidal salt marsh ranges from low marsh, dominated by California cordgrass (*Spartina foliosa*), to a diverse mosaic of species that comprises the mid-marsh, to very high marsh species that transition to upland. Salt marsh vegetation changes gradually with elevation. Nearly every species has its peak occurrence at its unique elevational band and the vegetation forms a continuum rather than a set of zones. However, the presence of shrub-like succulents at the uppermost elevations and tall cordgrass at the lowest elevations helps to delineate low to high marsh.

Low salt marsh is regularly inundated by tides and is dominated by California cordgrass that forms dense monotypic stands. At its lower elevation, cordgrass intergrades with mudflat habitat; at its upper elevation it intergrades with a mosaic of mid-marsh species. This highly productive species decomposes to form the base of the detrital food chain that supports many lower order estuarine consumers. Many of the animals of the low marsh are adapted to periods of frequent inundation.

Intermediate elevations within the salt marsh are inundated irregularly by tides but at a greater frequency than are higher elevations. As a result, the plant species that inhabit this elevation are adapted to highly saline soil conditions due to long periods of exposure. The animals of the mid-marsh are abundant and diverse. Food is abundant in the form of algae and the epifaunal invertebrates and insects that feed on algae. In addition, when flooded by the tides, fish move into the marsh plain to forage on these abundant invertebrates. Several bird species such as the Beldings' savannah sparrow and light footed clapper rail also forage in this zone.

High marsh habitats are also irregularly to intermittently inundated by tidal water and generally range from saline to hypersaline conditions. The vegetation varies depending on the density of the soil (i.e. ratio of clay to sand), which often is correlated with salinity.

Salt pans form in the high marsh where drainage is poor. These higher elevation areas along the upland edge are only inundated during the highest spring tides and typically have no tidal channels. As a result, ponded areas are formed that become hypersaline as water evaporates, thereby inhibiting vegetation establishment. These salt pans provide habitat diversity and have habitat value for foraging and refugia.

The wetland transitional zone represents that area where the halophytic (salt-tolerant) and hydrophytic salt marsh vegetation overlaps with upland communities. Scrub-shrub plant species of the transition zone overlap with the highest of the salt marsh species. The animals at the higher elevations of the transition zone are primarily terrestrial species. The transitional zone may also include nontidal palustrine habitats both salt influenced and non-saline types. Seeps from perched water tables on deltas and the toe of slopes and along dune transitions often support a variety of palustrine emergent and scrub-shrub types. Seasonal wetlands also occur in this area, especially in low-gradient deltaic deposits and may include salt pans. Transitional zones provide refugia during extreme weather or tides, as well as foraging opportunities. These areas also support a unique set of plant species, which may only occur or coexist in the habitat conditions provided in these transition zones.

Muted tidal habitats are created by the installation of gate structures and flow restrictions, which typically reduce tidal flows and the tide range compared to a fully tidal wetland. Muted tidal wetlands may support subtidal, mudflat, and vegetated wetland habitats. Hydraulic control structures have proven to severely limit fish passage, decrease tidal flushing, and restrict the diversity of habitat of a restored tidal wetland. A muted tidal system typically limits the creation of upper marsh and transitional habitat.

Additional habitats, which either occur on the site or are included in the alternatives consist of, brackish marsh, seasonal wetlands, freshwater and riparian habitat, and upland habitats, including coastal dune, coastal sage scrub and native grassland habitats. Some of these additional habitats are important to the restoration of the tidal wetland system; they may provide buffers from human disturbances, refugia during extreme weather or tides, or complementary habitats. These habitat types may also be significantly impacted in the region due to limited range along the coast.

Brackish conditions, with intermediate salinities, occur where freshwater mixes with seawater. This phenomenon is less frequent in southern California where many estuaries are less influenced by runoff from rainfall than in more northerly latitudes. Local influence from seeps and springs and seasonally impounded stream and river-mouths can produce brackish environments that support emergent vegetation and aquatic bed species.

Non-tidal Wetlands

Seasonal wetlands are non-tidal wetlands and transitional habitats that are flooded to varying degrees by seasonal rainfall and runoff. If there are sufficient salts in the soil, the seasonal wetland may support plant species more typical of coastal salt marsh. If the soils do not contain salts, the seasonal wetlands may support freshwater marsh species and a mixture of weedy opportunists. “Vernal pools” and seasonal saline wetlands in transition zones can occur on alluvial and deltaic deposits adjacent to estuarine habitats and are known to support special-status plants and invertebrate animals. A majority of the existing seasonal wetlands at Ballona occur on saline dredge spoils from the excavation of Marina del Rey. These habitats only support common intertidal plant species in a severely degraded state, and provide little habitat for wildlife. Some of the alternatives include the creation of seasonal wetlands in areas that do not support salt marsh plant species; in these areas freshwater seasonal wetlands may be created that could support vernal pool habitat.

Riparian scrub and woodland occurs in small groves or in riverine corridors that drain into estuaries. As with other riparian habitats, riparian scrub supports a diverse assemblage of wildlife species, especially passerine bird species. Mammal assemblages are similar to those found in freshwater marsh habitats as the two often intergrade. In an undisturbed estuarine system, wouldow scrub habitat would generally occur upstream of tidal influence as wouldows are very sensitive to salt. Like freshwater marsh, this habitat is dependent upon a constant source of freshwater.

Uplands

Most of the peripheral uplands of estuaries have been disturbed in southern California. Historically, upland communities of the systems were likely comprised of coastal dunes, scrub, or grasslands, and woodlands in some cases.

Dune habitat represents a form of transition zone between the land and the sea and includes Coastal Dune Scrub and Dune Herb vegetation. Coastal dune habitats have been largely lost due to development in southern California. Prior to development, plants stabilized the loose sand, and the dunes were thereby anchored. Following human disturbance, many of the native plants were eliminated and exotics, such as sour-fig (*Carporotus edulis*) and sea rocket (*Cakile maritima*) invaded or were planted.

Coastal sage scrub can be described as low, soft to woody shrubs and subshrubs that occur in a variety of situations and are characterized by a variety of dominant plant species. Coastal Sage Scrub is now generally rare along the coast. This vegetation community is typically dominated by coastal sagebrush (*Artemisia californica*) and California buckwheat (*Eriogonum fasciculatum*), together with laurel sumac (*Malosma laurina*), white sage (*Salvia apiana*) and others. Other forms of upland coastal scrub include, for example, Delta Scrub and Baccharis Scrub, which can be transitional to wetland scrub types. A variety of terrestrial animals, including amphibians, reptiles, mammals and birds are supported by coastal scrub habitat.

Native grasslands were a common upland vegetation associated with estuarine ecosystems in southern California. Existing conditions within coastal ecosystems often include extensive areas of non-native annual grassland and forblands generally dominated by introduced species. The function and importance of perennial and annual grasslands, however, are often similar for the support of small mammals and the raptors that prey upon them.

The proposed creation of treatment wetlands provide a means of cleaning contaminated water before it enters the wetlands. Treatment wetlands require periodic maintenance, including harvesting of wetland plants and removal of sediments as they accumulate contaminants. Thus, treatment wetlands are not considered valuable for their structure, but for their function.

3.1.1 Habitat Acreages

Each of the alternatives would make changes to the existing distribution of habitats. In some places there would be enhancement of the existing habitat, either by management or by increasing tidal inundation (for the case of muted tidal areas). In some places, there would also be replacement of existing habitat by a different habitat type, which would generally involve the regrading of the existing ground elevation and introduction of tidal flows.

For each alternative the area for each habitat type was calculated. Where the alternative did not change the existing habitat then that habitat was assumed to remain. Where a muted tidal regime has been proposed, the distribution of low, mid and high marsh has been defined by the specified tidal inundation regime.

Table 3-2 shows the acreage of each habitat type by subarea and alternative. Table 3-3 show the area of habitat type by alternative. Totals are given for estuarine, freshwater/riparian and upland habitats. These show the shift in emphasis from upland and muted tidal habitat, in the existing situation, to increasing proportion of fully tidal estuarine habitat. Alternatives 3, 4 and 5 each create over 450 acres of estuarine habitat. Included in Table 3-3 is the acreage of shallow subtidal habitat adjacent to mudflat habitat for each alternative. As noted earlier, extensive dredging and development along the southern California coastline has reduced the amount of functional subtidal habitat adjacent to mudflats and wetlands. Alternatives 4 and 5 are the only alternatives that create subtidal habitat adjacent to mudflats, each with over 40 acres.

3.1.2 Quality of Habitat

Each of the proposed restoration alternatives implies varied degrees of improvement over the current existing conditions. Alternative 1, for example, proposes minimal grading and creation of wetland habitats; however, it offers enhancement of existing uplands and seasonal wetlands, resulting in an increase in the quality of the existing habitats (CSS and palustrine wetlands on fill). For the purposes of this document, quality of habitat is described based on a variety of factors: the regional "rarity" of each habitat; the characteristics of habitat patches; the connectivity between habitats both within the project site and with adjacent complimentary habitats; the relationship to adjacent developed areas; and the degree of transition from wetland to upland habitats.

3.1.2.1 Regional Rarity

One important factor in prioritizing habitats for restoration is to identify those habitats that are rare in the region. This includes habitat types that have been lost due to development as well as habitats that require a specific combination of natural processes so that they can only be created in a few, specific places. Regional rarity, which may be considered both in terms of local (Santa Monica Bay or Los Angeles County) or regional (Southern California coast) extent of habitats, can be used to aide in this selection.

Estuarine Wetlands

Due to the dredging of wetlands and the expansion of harbors, subtidal habitat is not regionally rare; but it is often severely degraded. Shallow subtidal habitat connected to functioning wetland habitat is rare.

Estuarine wetlands, including vegetated tidal marsh, intertidal channels, mudflats and salt pans, are a regionally rare habitat that can only be restored in very specific locations. The Ballona Wetlands has long been identified as a significant regional opportunity for estuarine wetland restoration. The Southern California Wetlands Recovery Project, identifies tidal wetland restoration as a key priority in their Regional Strategy. The Regional Strategy states tidal wetlands can only be established within a small elevation range and a compatible geologic setting, and the region's rugged topography and extensive development restricts opportunities for restoration of tidal wetlands in Southern California. The project site represents the only opportunity to restore a large tidal wetland in Santa Monica Bay, and fills a large gap in the chain of wetlands along the Southern California coast.

Transitional zones provide a rare habitat due to the unique conditions created as tidal wetlands convert to uplands with increasing elevation. These habitats are regionally rare and have been significantly impacted as tidal wetlands have been lost.

Brackish marsh habitat is found at the transition of freshwater and intertidal marsh. These habitats are regionally rare and have been significantly impacted as tidal wetlands have been lost.

Non-tidal Wetlands

The seasonal wetlands in Ballona are on saline dredge spoils and are not a naturally occurring habitat type. However, seasonal wetlands may be created that could support vernal pool habitat of much more significant value. Vernal pool habitat has been nearly extirpated from Los Angeles County. These unique habitats support plant and wildlife species that rarely occur elsewhere.

Freshwater marsh and riparian scrub/woodland have also been severely degraded throughout southern California. These habitats require a consistent surface or subsurface freshwater input. While there are additional sites in the region to restore riparian and freshwater habitat, few occur in the vicinity of the Ballona Wetlands.

Upland Habitats

Coastal dunes habitats once stretched from Torrance to Santa Monica. Some of the small remaining patches are currently being restored along the south bay. Dune habitats are also rare in the sense that they require sandy substrate and specific physical processes (wind) to be maintained. Given impacts of the development surrounding the project area, there are limited opportunities to restore functioning dune systems and there may be better opportunities for coastal dune restoration adjacent to the coast.

Coastal sage scrub habitat is considered sensitive by the CDFG, but it is much more common in southern California than coastal wetland habitats. The bluffs immediately adjacent to the site and the nearby Baldwin Hills provide significant areas for potential restoration of coastal sage scrub.

Grassland habitats provide essential foraging habitat, and much of this habitat has been lost or severely impacted along the southern California coast. Restoration of upper marsh and transitional zones may provide equivalent foraging opportunities.

3.1.2.2 Habitat Patch Characteristics

The number, size and shape of habitat patches can determine the long-term stability of the created ecosystem. Restoration plans that incorporate numerous, small patches of different habitats are less likely to be self-sustaining in the long term due to edge effects. Edge effects may include colonization by invasive exotic plant species and/or competition with dominant plant species from other nearby created native habitats. Edge effects may also be reduced in habitat patches of similar area with smaller perimeters (edges). Small patches are also more susceptible to disease as fewer individual plants or clones may equate to reduced genetic diversity. Additionally, specialized pollinators may not be supported by small habitat patches. In general, larger more genetically diverse patches are more likely to survive in the long term without active management.

Edge to area ratio and edge to area index for each alternative is presented in Table 3-4. Patches have been defined by combining together all connected estuarine habitats. Edge to area ratio is simply the ratio of perimeter length to habitat patch size. Alternatives with larger patch sizes would have a lower edge to area ratio. Edge to Area Index is the ratio of the shape's edge-to-area ratio compared to the edge-to-area ratio for a circle of the same total area. The lower the index the closer patch shape is to a circle; the shape that maximizes area and minimizes edge length.

3.1.2.3 Connectivity Between Habitat Patches

Habitat connectivity includes the connection between similar habitats, as well as the connection between complementary habitats. The degree of habitat connectivity within each restoration alternative is an important factor to determine the quality of habitat which may result. Connectivity of similar habitats allows for local migration of plant and animal species providing alternative sites for these species when conditions of one site or patch become unsuitable, i.e., during drought. While bird and insect species may be able to migrate across roads and waterways, terrestrial animals, such as reptiles, amphibians and mammals, are prevented or discouraged from by these barriers. Tidal exchange is an important component of connectivity in a wetland system. Tidal exchange provides diurnal replenishment of gases and nutrients; conveys pelagic eggs and larvae of marine organisms, and distributes floating propagules of salt marsh and other plant species. Connectivity of wetland and to transitional or upland habitat is also important to the quality of a restored wetland, allowing migration terrestrial species to migrate to dry areas during high tides. Thus, habitat connectivity can be measured on at least three scales within a restoration project: 1) connectivity of similar habitats within the project area, 2) hydraulic connectivity between wetland/estuarine habitats and the ocean, and 3) connectivity between wetland habitats and the uplands or transition zones.

Roads or levees can affect the connectivity within the project area. They bisect habitat areas, restrict movement of species, increase the area of disturbed habitat and force channels through culverts. Alternatives 1 through 4 contain 3 miles of roads and 3.8 miles of levees, while Alternative 5 has 2.2 miles of roads and no levees within the project area.

3.1.2.4 Relationship to Adjacent Developed Areas

Transition zones affect the species diversity and function of both the intertidal wetland and the adjacent upland. This habitat supports a unique assemblage of both plants and animals that may not exist in either the adjacent upland or wetland. Thus, the inclusion of transitional habitats in restoration projects is highly desirable. Table 1 gives the areas of transitional habitat for each alternative. The approximate slopes for transitional habitats in the alternatives is about 1:50 to 1:100.

In addition to a wetland-upland transition zone, buffer areas are important for various wetland functions, such as area for transgression, sediment filtration or retention, pollution retention, habitat and food web support, and flood protection. These would improve the quality of the wetland habitat.

Typically, southern California wetlands are bounded by homes, roads and levees that create abrupt, narrow transitions from wetland to upland. This adjacency does not allow animal species the refugia needed during some tides and introduces human disturbances to the wetlands. For example, during extreme high tides, species like light-footed clapper rail are subjected to predation by cats as they are forced from their preferred low marsh habitat into adjacent uplands. In some cases, adjacent developed areas provide habitat for desirable species. For example, non-native cedar trees located to the north of the Area A provide nesting habitat for a small colony of great blue herons. These herons may forage in the wetland and upland habitats of Ballona, but it is the adjacent habitat that serves as the rookery.

3.1.3 Connectivity

Connectivity may be measured in terms of geographical position of the restored wetland relative to other similar or complimentary habitats, locally and regionally.

3.1.3.1 Connectivity Within the Greater Ballona Ecosystem

Within the greater Ballona system there exist areas of complimentary habitat. These include Del Rey Lagoon, Grand Canal, El Segundo Dunes, Oxford Lagoon, adjacent bluff areas, nearshore and beach habitat, Ballona Creek and Marina del Rey jetties and breakwater, and the Pacific Ocean. Some of these sites are hydraulically connected and support a limited wetland component; those that are not provide upland habitat primarily for avian and insect species.

Connectivity within the greater Ballona ecosystem can be accomplished, via improved hydraulic connection, for fish and other aquatic species and for wetland and upland plants. This allows exchange of nutrients gases; transportation of eggs, larvae, juveniles and adult aquatic organisms; provides habitat for avian species and a pathway for water-dispersed seed. Connection by air is possible for flying insects and birds, as well as wind-dispersed seeds. The ability to access similar habitats within the greater system provides refugia for animal species during times of environmental instability; provides greater genetic variation and a greater potential foraging area.

3.1.3.2 Regional Connectivity to Other Southern California Wetlands

A further measure of connectivity is the position of the restored wetland to other wetlands in southern California, such as Mugu Lagoon and Upper Newport Bay. Such connectivity applies primarily to avian and fish species. It may also apply to aquatic plankton and nekton and plant propagules, as these are transported tidally. Certain habitats, such as mudflat, may be created in order to facilitate the connectivity between these wetland systems by providing a string of mudflats along the southern Californian coast.

3.1.4 Tables

Table 3-1. Tidal Habitat Types with Elevation Limits and Inundation Regime
(Based upon Ferren et al, 2007)

Habitat Type	Lower	Upper	Lower	Upper
	NAVD ft	NAVD ft	% time tide exceeds	% time tide exceeds
Subtidal	-5.0	-3.0	100%	100%
Intertidal Channel /Mudflat	-3.0	1.0	100%	90%
Salt pan	4.5	5.5	28%	14%
Low Marsh	1.0	2.5	90%	74%
Mid Marsh	2.5	3.5	74%	50%
High Marsh	3.5	4.5	50%	28%
Transition Zone	4.5	5.5	28%	14%

Table 3-2. Acreage of each habitat type by area and alternative

Habitat Type	Existing					Alternative 1					Alternative 2					Alternative 3					Alternative 4					Alternative 5	
	Area A	Area B	Area C	Ballona Creek	Total	Area A	Area B	Area C	Ballona Creek	Total	Area A	Area B	Area C	Ballona Creek	Total	Area A	Area B	Area C	Ballona Creek	Total	Area A	Area B	Area C	Ballona Creek	Total	All Areas	Total
TOTAL Existing	**137.6**	**347.5**	**71.4**	**74.0**	**630.5**	**137.6**	**347.5**	**71.4**	**74.0**	**630.5**	**137.6**	**347.5**	**71.4**	**74.0**	**630.5**	**137.6**	**347.5**	**71.4**	**74.0**	**630.5**	**137.6**	**347.5**	**71.4**	**74.0**	**630.5**	**137.6**	**630.5**
TOTAL for Alternative						**137.7**	**334.7**	**71.8**	**74.0**	**618.1**	**139.8**	**335.4**	**71.7**	**74.0**	**620.9**	**141.4**	**357.3**	**71.5**	**74.0**	**644.2**	**141.4**	**356.7**	**71.5**	**74.0**	**643.5**	**632.4**	**632.4**
Subtidal				74.0	**74.0**				74.0	**74.0**				74.0	**74.0**				74.0	**74.0**	41.4			74.0	**115.4**	48.6	**48.6**
Intertidal Channel /Mudflat		1.7			**1.7**	0.3	10.2			**10.4**	2.9	8.7	0.1		**11.7**	5.6	14.5	0.3		**20.4**	25.7	14.5	0.3		**40.6**	26.2	**26.2**
Salt pan		22.4			**22.4**					**0.0**					**0.0**					**0.0**					**0.0**		**0.0**
Muted Low Marsh		8.5			**8.5**		64.7			**64.7**		37.0			**37.0**					**0.0**					**0.0**		**0.0**
Muted Mid Marsh		17.6			**17.6**		34.3			**34.3**		19.6			**19.6**					**0.0**					**0.0**		**0.0**
Muted High Marsh		40.6			**40.6**		17.8			**17.8**		10.2			**10.2**					**0.0**					**0.0**		**0.0**
Fully Tidal Low Marsh					**0.0**	1.3				**1.3**	14.7	14.2	0.4		**29.3**	27.8	72.5	1.6		**102.0**	13.5	72.5	1.6		**87.6**	131.0	**131.0**
Fully Tidal Mid Marsh					**0.0**	0.8				**0.8**	9.5	9.2	0.2		**19.0**	18.1	47.1	1.1		**66.3**	10.3	47.1	1.1		**58.4**	85.2	**85.2**
Fully Tidal High Marsh					**0.0**	0.8				**0.8**	9.5	9.2	0.2		**19.0**	18.1	47.1	1.1		**66.3**	10.3	47.1	1.1		**58.4**	85.2	**85.2**
Transition Zone					**0.0**	5.7	26.1			**31.9**	28.9	44.4	7.7		**81.1**	38.4	79.2	5.9		**123.5**	10.0	79.2	5.9		**95.2**	96.1	**96.1**
Brackish Marsh		3.0	0.1		**3.1**		2.6	0.1		**2.7**		2.6			**2.6**		2.6			**2.6**		2.6			**2.6**	2.6	**2.6**
TOTAL Estuarine	**0.0**	**93.8**	**0.1**	**74.0**	**167.9**	**8.9**	**155.6**	**0.1**	**74.0**	**238.7**	**65.6**	**155.2**	**8.6**	**74.0**	**303.5**	**108.0**	**263.0**	**10.0**	**74.0**	**455.0**	**111.2**	**263.0**	**10.0**	**74.0**	**458.2**	**474.8**	**474.8**
Fresh Water Marsh		1.1			**1.1**		1.0			**1.0**		1.0			**1.0**		1.0			**1.0**		1.0			**1.0**	1.0	**1.0**
Seasonal Wetland	10.9	74.2	0.6		**85.7**	10.9	2.5	0.6		**14.0**		2.5	4.0		**6.5**		2.5	5.8		**8.3**		2.5	5.8		**8.3**	2.5	**2.5**
Riparian Scrub	3.2	15.1	3.3		**21.6**		5.1	1.7		**6.7**		5.1	0.5		**5.6**		5.1	0.5		**5.6**		5.1	0.5		**5.6**	5.6	**5.6**
Riparian Woodland		2.9			**2.9**		2.9			**2.9**		2.9			**2.9**		2.9			**2.9**		2.9			**2.9**	2.9	**2.9**
TOTAL Freshwater/Riparian	**14.1**	**93.3**	**3.9**	**0.0**	**111.3**	**10.9**	**11.5**	**2.2**	**0.0**	**24.6**	**0.0**	**11.5**	**4.6**	**0.0**	**16.0**	**0.0**	**11.4**	**6.3**	**0.0**	**17.7**	**0.0**	**11.4**	**6.3**	**0.0**	**17.7**	**11.9**	**11.9**
Grassland/Herbaceous	64.0	62.7	49.7		**176.4**		13.3	30.0		**43.4**		13.3	7.3		**20.7**		13.2	7.3		**20.5**		13.2	7.3		**20.5**	13.5	**13.5**
Coastal Scrub	58.9	26.0	8.9		**93.9**	117.2	91.7	30.6		**239.5**	73.5	92.9	44.4		**210.9**	32.9	7.3	41.1		**81.3**	29.7	7.3	41.1		**78.1**	69.8	**69.8**
Coastal Dunes		9.9	2.1		**12.0**		8.3	2.1		**10.4**		8.3			**8.3**		8.3			**8.3**		8.3			**8.3**	8.3	**8.3**
Forest/Woodland	0.6	0.2			**0.7**		0.1			**0.1**		0.1			**0.1**		0.1			**0.1**		0.1			**0.1**	0.1	**0.1**
TOTAL Upland	**123.5**	**98.8**	**60.7**	**0.0**	**283.0**	**117.2**	**113.5**	**62.7**	**0.0**	**293.4**	**73.5**	**114.7**	**51.8**	**0.0**	**240.0**	**32.9**	**28.9**	**48.4**	**0.0**	**110.2**	**29.7**	**28.9**	**48.4**	**0.0**	**107.0**	**91.7**	**91.7**
Unvegetated/Paved		10.9			**10.9**	0.7	0.7			**1.4**	0.7	0.7			**1.4**	0.6	0.7			**1.2**	0.6				**0.6**	0.7	**0.7**
Ballfields			6.7		**6.7**			6.7		**6.7**			6.7		**6.7**			6.7		**6.7**			6.7		**6.7**		**0.0**
Gas Company		10.9			**10.9**		13.6			**13.6**		13.6			**13.6**		13.6			**13.6**		13.6			**13.6**	13.6	**13.6**
The Freshwater Marsh		39.8			**39.8**		39.8			**39.8**		39.8			**39.8**		39.8			**39.8**		39.8			**39.8**	39.8	**39.8**
TOTAL Other areas	**0.0**	**61.6**	**6.7**	**0.0**	**68.3**	**0.7**	**54.1**	**6.7**	**0.0**	**61.5**	**0.7**	**54.1**	**6.7**	**0.0**	**61.5**	**0.6**	**54.0**	**6.7**	**0.0**	**61.3**	**0.6**	**53.4**	**6.7**	**0.0**	**60.6**	**54.0**	**54.0**

Table 3-3. Summary of Habitat Acreages

Habitat Type	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Subtidal	74.0	74.0	74.0	115.4 (41.4†)	48.6 (48.6†)
Intertidal Channel And Mudflats	10.4	11.7	20.4	40.6	26.2
Low Marsh	66.0 (64.7††)	66.3 (37.0††)	102.0	87.6	131.0
Mid Marsh	35.1 (34.3††)	38.6 (19.6††)	66.3	58.4	85.2
High Marsh	18.6 (17.8††)	29.2 (10.2††)	66.3	58.4	85.2
Transitional Habitat	31.9	81.1	123.5	95.2	96.1
Brackish Marsh	2.7	2.6	2.6	2.6	2.6
Total Estuarine	**238.7**	**303.5**	**455.0**	**458.2**	**474.8**
Freshwater/Riparian	10.6	9.5	9.5	9.5	9.5
Seasonal Wetland	14.0*	6.5	8.3	8.3	2.5
Upland	293.4	240.0	110.2	107.0	91.7
Unvegetated	8.1	8.1	7.9	7.3	0.7

† Area of shallow subtidal habitat adjacent to mudflats
†† Area of muted tidal
* Habitat created on saline soils

Table 3-4. Edge/Area indices for Estuarine Wetland Habitats

Alternative	Edge to Area Ratio (ft/ac)	Edge to Area Index*
ALT1	218.3918	4.4645
ALT2	243.0364	4.7857
ALT3	193.1576	4.6057
ALT4	178.0851	4.4550
ALT5	111.3358	2.8696

* Edge to Area Index is the ratio of the shape's edge-to-area ratio compared to the edge-to-area ratio for a circle of the same total area.

3.2 BIODIVERSITY

Habitat restoration provides opportunities for the preservation of the region's plant and animal species as well as the opportunity for the recovery of lost or declining biodiversity. The biological communities of coastal southern California have experienced a decline in species richness, or diversity, as a result of loss of over 90% of their wetland habitat following urban and agricultural development. Declining biodiversity includes plant and animal species that are listed as threatened or endangered, many of which are associated with wetland habitats. Restoration of Ballona wetlands offers the opportunity to create refuges for these species and habitats for other species to recover locally and potentially act as a "seed" source for other nearby wetland systems. Because a major goal of this restoration project is to restore estuarine habitats and processes, diversity of species supported by estuarine habitats would be of particular interest. Therefore, for the purpose of this document, biodiversity is discussed in terms of the sustainable richness of representative interdependent native estuarine habitats along with their associated and expected species biodiversity. The diversity of species dependent upon other habitat types (eg. freshwater wetland or coastal dune habitats) included in the alternatives is also noted.

The five restoration alternatives for Ballona range from preservation and enhancement of large areas of upland habitat with limited wetland habitat to restoration and creation of large areas of wetlands with less upland habitat. Upland-dominated restoration should increase the biodiversity of the existing upland habitats. This would primarily benefit woody vascular plants and associated animals at the expense of opportunities to increase diversity of wetland plant and animal groups. Wetland-dominated restoration would benefit non-vascular aquatic plants, vascular plants, aquatic invertebrates, aquatic vertebrates, terrestrial invertebrates and terrestrial vertebrates.

Biodiversity is discussed at the level of large taxonomic groups. Some specific examples are given; however, not all species that may be supported by each of the restoration alternatives are discussed. For the purposes of this document, taxonomic groups are defined as vascular and nonvascular plants; terrestrial invertebrates (insects); terrestrial vertebrates (birds, herpetofuana, mammals); aquatic invertebrates (infauna and epifauna); and aquatic vertebrates (fish).

Estuarine Wetlands

Maximizing shallow subtidal habitat would benefit the biodiversity of the system especially for birds and fishes. Non-vascular plants (e.g., phytoplankton) would presumably be most functional in the upper water column where light penetration is greatest and thus would not necessarily benefit from deeper water. Similarly, vascular plants, insects, benthic invertebrates, herpetofuana and small mammals would not directly benefit from deeper salt water.

Fishes, primarily those associated with the nearshore ocean habitat, would be supported by deeper waters with a connection to the open coast. Such species as Queenfish (*Seriphus politus*), white croaker (*Genyonemus lineatus*), northen anchovy (*Engraulis mordax*) that inhabit the mid- to upper water column would increase the biodiversity of the system as would demersal species such as California halibut and shovel-nose guitarfish (*Rhinobatos productus*).

Gulls and terns, including California least tern and such species as double-crested cormorant (*Phalacrocorax auritus*) and brown pelican (*Pelicanus occidentalis*) would be supported by increased fish diversity and abundance. Osprey (*Pandion haliaetus*) may also forage for fish in the subtidal areas.

As more tidal wetland habitat is included in an alternative, additional taxonomic groups are supported. Creation of channel, low and mid-high marsh would support non-vascular aquatic plants, vascular plants, aquatic invertebrates, aquatic vertebrates, terrestrial invertebrates and terrestrial vertebrates.

Non-vascular plants include phytoplankton, micro-algae, and macro-algae, that are found in the channels and marsh habitats. Salt marsh micro-algae are dominated by diatoms. Macro-algae include green algae and blue-green algae. Tidal influence, light penetration and nutrients are factors that can limit salt marsh algal populations.

Vascular plants that inhabit a typical Southern California tidal salt marsh include the perennials Pacific cordgrass (*Spartina foliosa*), common pickleweed (*Sarcocornia pacifica*) and fleshy jaumea (*Jaumea carnosa*), as well as annual pickleweed (*Salicornia bigelovii*). They occur in narrow elevation zones determined by the frequency of tidal inundation, salinity, duration of saturated soil, and temperature. These plants, along with non-vascular algae, contribute to the complex food web that supports the high productivity of coastal wetlands. The detritus of vascular and non-vascular plants provides food for aquatic invertebrates, including both infauna (organisms that live within the sediment) and epifauna (those that live on the surface of the sediment).

Common infauna associated with mud or sand bottoms of channel and low marsh habitats include polychaete worms and filter-feeding bivalves, such as California jackknife clam (*Tagelus californica*), littleneck clam (*Prototheca staminea*) and bent-nose clam (*Macoma nasuta*). Common epifuana of channels include detritivores, such as California horn snail (*Cerethidia californica*), bubble snail (*Bulla gouldiana*), and *Nassarius* sp., and omnivores such as lined shore crab (*Pachygrapsus crassipes*) and yellow shore crab (*Hemigrapsus oregonensis*).

Restoring intertidal mudflat area would increase the biodiversity of benthic infauna, including polychaetes, which in turn would support a higher diversity of wading birds. Perhaps the most conspicuous animals of the intertidal mudflats are the shorebirds that feed and rest there during low tide. Many of their invertebrate prey items are widely distributed, from the subtidal channels to the lower limit of the salt marsh. Wading shorebirds, such as western sandpiper (*Calidris mauri*), semipalmated sandpiper (*C. pusilla*) and dowitchers (*Limnodromus* spp.) would be expected to forage on the mudflats during their migration.

Cordgrass associated with low marsh habitat provides structure, and possibly food, for insect species, such as the larvae of *Incertella* and *Cricotopus* species, the beetle *Coleomegilla fuscilabris* and the plant hopper (*Prokelesia* sp.). The longjaw mudsucker (*Gillichthys mirabilis*) forages in the low and mid-high marsh, especially along creek banks during high tides. Mid-high marsh habitat provides food and structure for California horn snails, amphipods, and snails of the genus *Assiminea*. Water boatmen (*Trichocorixia* spp.) feed on algae in pools and in turn provide food for California killifish (*Fundulus parvipinnis*) that feed in the marsh during high tides

The wetland-dominated restoration alternatives would create/restore large blocks of habitat that would be connected via channels and tidal flows. These large blocks of habitat would be more sustainable in the long-term as they would be less susceptible to edge effects of invasive species. They would also be less susceptible to human disturbance, as many areas would be inaccessible.

Creation of channels and mudflats provides habitat for breeding and foraging for estuarine fishes. Some, such as gobies (Gobiidae), complete their life cycle in southern California estuaries, attaching their eggs to the burrows of commensal invertebrates. Other common wetland fish species, such as topsmelt (*Atherinops affinis*), attach their eggs to filamentous algal mats that also shelter their larvae and post-larvae. Species such as California halibut spawn offshore but spend the first few years of life in protected coastal waters. Still others, such as striped mullet (*Mugil cephalus*) live their lives in protected inshore habitat but spawn offshore. In general, the channels and low marsh habitats of southern California coastal wetlands act as nursery grounds for coastal fisheries.

Larger aquatic benthic invertebrates, such as snails and crabs, as well as fish, are preyed upon by a number of bird groups, including herons and egrets, wading birds and terns and gulls. Southern California coastal wetlands support dozens of species and many thousands of individual birds that migrate along the Pacific flyway. Herons, egrets, gulls, terns, shorebirds, ducks, geese, coots, gallinules and rails occur in southern California wetlands throughout most of the year. Most of these birds appear to prefer intertidal flats to salt marsh habitats for foraging and other activities. However, marsh habitats contribute to the support of birds by: providing food (either directly or indirectly), cover from predators, and structure for nesting and roosting. Birds of the low marsh include rails, such as Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), and the endangered light-footed clapper rail (*Rallus longirostris levipes*).

Common bird species of the mid-high marsh include wading species such as willet (*Catoptrophorus semipalmatus*), marbled godwit (*Limosa fedoa*), long-billed curlew (*Numenius americanus*) and great blue heron (*Ardea herodias*). These species prey upon fishes and aquatic invertebrates and, in the case of herons, upland terrestrial animals such as small mammals and herpetofauna.

Terns and gulls observed in southern California coastal wetlands occur primarily in intertidal flats and on the adjacent beaches; however, some taxa do utilize salt marsh habitats. Western gull (*Larus occidentalis*) and ring-billed gull (*Larus delawarensis*) forage and roost in intertidal salt marsh habitats while the endangered California least tern (*Sterna antillarum browni*) forages in intertidal channels. Forster's tern (*Sterna forsteri*) and elegant tern (*S. elegans*) can use a variety of wetland habitats, including salt marsh. Most of the bird groups, with exception of a few small species, forage and roost in southern California wetlands but breed elsewhere.

The mid-high marsh provides structure for some nesting birds, including the state endangered Belding's Savannah sparrow (*Passerculus sandwichensis beldingi*). This small songbird builds its nest low to the ground under marsh vegetation, such as pickleweed. Belding's Savannah sparrows forage on insects, often at the interface of marsh and channel.

Small mammals associated with southern California tidal wetlands include the western salt marsh harvest mouse (*Reithrodontomys megalotis limicola*) and meadow mouse (*Microtus californicus stephensi*). Harvest mice are granivorous, while meadow mice are primarily herbivorous. While little is known about their diets, neither feeds on pickleweed, the most common vascular plant species at Ballona.

Both upland-dominated and intermediate tidal restoration alternatives preserve areas that are currently muted-tidal wetlands. Muted-tidal wetlands provide functions similar to fully-tidal wetlands, but reduced in terms of biodiversity. For example, muted tidal channels may have similar species composition and densities of phytoplankton and benthic micro-algae but may support fewer salt marsh vascular plant species than do fully tidal channels. Similarly, fewer fish species might occur in muted tidal systems. With less tidal influence, muted tidal areas would be susceptible to periodic fresh water inflows. Conversely, during neap tides, muted tidal systems may be subjected to prolonged drying and increased salinity, unless they impounded water continuously, in which case, they would not support vascular plants. Thus, muted tidal systems are likely to be less sustainable than fully tidal systems.

Creation of wetland habitats allows for creation of transitional habitats, which would increase the regional diversity of vascular plants and terrestrial vertebrates. Examples of transition zone vascular plants include boxthorn *(Lycium californicum)*, bush seepweed *(Suaeda nigra)*, coast golden bush (*Isocoma menziesii*), and Parish's glasswort (*Arthrocnemum subterminale*). These overlap with the highest elevation salt marsh species including, for example, saltgrass, alkali weed *(Cressa truxillensis)*, and shoregrass *(Monanthochloe littoralis)*. Boxthorn is a common perch for birds and various small mammals and herpetofauna burrow beneath it or use it for shade.

The transition zone of southern California wetlands, such as Carpenteria salt marsh, have a euryhaline zone that fluctuates between wet season low salinities and dry season hypersaline conditions. The habitat is characterized by winter annual plant species such as salt marsh daisy (*Lasthenia glabrata* ssp. *coulteri*), salt marsh sand-spurry (*Spergularia marina*), toad rush (*Juncus bufonius*), and hutchinsia (*Hutchinsia procumbens*), which tolerate the fluctuating salinities by growing in the wet season.

The animals of the higher elevations of the transition zone are primarily terrestrial species. These include various snakes, lizards, small mammals and birds. Herpetofauna may include California kingsnake *(Lampropeltis getulus californiae)*, San Diego gopher snake *(Pituophus melanoleucus annectens)* and side-blotched lizard *(Uta stansburiana)*. Common mammals of the shrub-dominated transition zone include western harvest mouse, deer mouse *(Peromyscus maniculatus)*, pocket gopher (*Thomomys* sp.), and California ground squirrel *(Spermophilus beechyi)*. The small mammals are preyed upon by a variety of birds including northern harrier *(Circus cyaneus)* and white-tailed kite *(Elaneus caeruleus)*. Ground-nesting bees that pollinate salt marsh bird's-beak (*Cordylanthus maritimus* spp. *maritimus*) live above the high tide in this habitat.

<u>Non-tidal Wetlands</u>

It is anticipated that brackish marsh would develop in areas where fresh water marsh and salt marsh intergrade. This habitat supports many of the taxa associated with both of those habitats, although species that cannot tolerate either extreme are likely to be absent. Brackish water marsh habitat has a range of conditions from briefly fresh to briefly hypersaline and would provide a small increase in the biodiversity of the wetlands. For example, *Juncus acutus* is regionally rare and can thrive where soil is at least briefly brackish; tall tules can provide critical cover for rails during high tide.

Seasonal wetlands would support regional biodiversity of non-vascular and vascular plant species, herpetofauna, birds and small mammals. However, much of the existing seasonal wetlands are on saline fill soils that would not support biodiversity. Vascular plants that might be supported include common pickleweed (*Sarcocornia pacifica = Salicornia virginica*), alkali weed (*Cressa truxellensis*), and alkali heath (*Frankenia salina*). Smaller areas of freshwater seasonal wetlands would provide breeding grounds for toad and frog species, such as Pacific chorus frog (*Pseudacris regilla*) and California tree frog (*Hyla cadaverina*). Ponded water provides nesting and foraging habitat for American avocet (*Recurvirostra americana*), black-necked stilt (*Himantopus mexicanus*) and killdeer. Small mammals common to upland habitats could also use seasonal wetlands.

Creation of vernal pool habitat has been proposed as part of upland-dominated restoration schemes. Vernal pools are regionally rare habitats, and adding water-holding depressions would increase the biodiversity of the Ballona ecosystem. Vernal pools are formed over impervious substrates, such as a soil with a subsurface clay layer that impounds seasonal rainfall. Such topography and soils are lacking from Ballona upland areas. Creation of vernal pools would benefit primarily non-vascular and vascular plants, aquatic invertebrates, and herpetofauna, although small mammals and birds may also benefit. Non-vascular species that inhabit vernal pools include diverse phytoplankton, green and blue-green micro-algae, and occasional macro-algae. These are food sources for a number of invertebrates, including fairy shrimp (*Branchinecta* spp.), several species of which are listed as endangered. Many of the vascular plants associated with vernal pools are unique in their adaptations to water levels that fluctuate widely over short periods of time. These range from fairly common species, such as isoetes (*Isoetes* spp.) to the endangered San Diego mesa mint (*Pogogyne abramsii*). Herpetofauna, such as discussed above, would benefit from vernal pools, although survival through metamorphosis depends on the amount of rainfall and the duration of impoundment.

Created vernal pools, especially those requiring importation of clay to line the pools so they would hold water for the appropriate duration, would not only be difficult build but subject to invasion by unwanted species once wetted. Imported soils often contain plant propagules, such as non-native grasses, that could invade the proposed restoration. Furthermore, small vernal pools would be subject to edge effects. Pools that dry early in the growing season of vernal pool vascular plants would be subject to invasion by non-desirable species, such as non-native grasses.

Fresh water marsh and riparian habitats would, in some way, provide support to all of the taxonomic groups. Detritus from vascular plants, such as cattail (*Typha* spp.) and bulrushes (*Scirpus* spp.), and a variety of non-vascular algae would provide food for aquatic invertebrates, including gastropods, copepods, amphipods and decapods, and insects, such as beetles (Coleoptera), flies (Diptera) and true bugs (Hemiptera). These taxa provide food for passerine birds, such as blackbirds (*Agelaius* spp.), wrens (*Cistothorus* spp.), rails (*Rallus* ssp.) and waterfowl; fishes, primarily non-native species; herpetofauna, including Pacific chorus frog and California tree frog, and snakes, such as two-striped garter snake (*Thamnophis couchi hammondi*); and small mammals. Larger mammals, such as raccoon (*Procyon lotor*), may forage directly on invertebrates and fish.

Treatment wetlands could support similar species as fresh water marsh habitat. However, these areas would require active management and removal of sediments, contaminants, and invasive plants, all of which would limit their value for biodiversity support.

Upland Habitats

Existing disturbed uplands would be preserved and their biota enhanced through the removal of exotic plant species and planting of native coastal sage scrub and native grassland species. Coastal sage scrub habitat (CSS) would be enhanced through planting of species such as coastal sagebrush (*Artemisia californica*), California buckwheat (*Eriogonum fasciculatum*), deerweed (*Lotus scoparius*), sage species (*Salvia* spp.) and lemonadeberry (*Rhus integrifolia*). Planting of these vascular plant species would, in turn, provide nesting and foraging habitat for a number of migratory and non-migratory terrestrial passerine bird species, including the federally-listed threatened coastal California gnatcatcher (*Pilioptila californica californica*), towhees (*Pipilo* spp), wrens (*Troglodytes* spp.), and finches (*Cardeulis* spp.). Many of these passerine birds rely on insects and seeds for food. CSS enhanced by more diverse flowering plants would support insects that provide forage for the above birds. Enhanced CSS would also support insect pollinators, including bees and flies. The diversity of other insects, such as butterflies and moths, would be enhanced by providing plant species that serve as larval foods and adult nectaring plants.

Native grassland habitat would be created from disturbed upland habitat through the removal of exotics and planting with a variety of native grasses and annual forbs. Examples include purple needlegrass (*Nassela pulchra*), nodding needlegrass (*N. cernua*), bluegrass (native *Poa* spp.) goldenstar (*Bloomeria* spp.), brodiaea (*Brodiaea* spp.), clarkia (*Clarki*a spp.) and valley tassels (*Castilleja attenuata*). Populations of these vascular plant species would enhance nesting and foraging habitat for passerine birds such as western meadowlark (*Sternella neglecta*) and grasshopper sparrow (*Ammodramus savannarum*), and also wading birds such as killdeer (*Charadrius vociferous*) and owls, including burrowing owl (*Athene cunicularia*). Grasslands are important foraging grounds for raptors including red-tailed hawk (*Buteo jamaicensis*) and white-tailed kite (*Elanus leucurus*). Like coastal sage scrub, this upland habitat would increase the diversity of flowering plants which, in turn, would support a variety of insects.

A number amphibians and reptiles occur in upland habitats, including Gilbert's skink (*Eumeces gilberti rubricaudatus*), western toad (*Bufo boreas*), spadefoot toad (*Scaphiphus hammnodi*), western fence lizard (*Sceloporus occidentalis*), side-blotch lizard (*Uta stansburiana*), rosy boa (*Charina trivirgata roseofusca*), gopher snake (*Pituophis catinefer*), horned lizard (*Phrynosoma coronatum*) and various species of rattle snake (*Crotalus* sp.). Enhancement of the existing habitat would increase foraging and breeding habitat for these and other herpetofauna.

Upland habitats also support numerous small mammals. Examples include shrews (*Sorex* sp.), deer mice (*Peromyscus* spp.), voles (*Microtus* sp.), rabbits (*Sylvilagus* spp.), and skunks (*Mephitis mephitis*). These small mammals are preyed upon by larger upland mammals, such as coyote (*Canis latrans*) and grey fox (*Urocyon* sp.), and birds of prey, such as red-tailed hawk and northern harrier (*Circus cyaneus*).

The existing disturbed upland habitats at Ballona are dominated by non-native vascular plant species, such as crown daisy (*Chrysanthemum coronarium*), mustard (*Brassic*a spp.), wild radish, fennel, castor bean, pampas grass and brazillan pepper tree. Seeds of many of these and other invasive plants are wind dispersed and off-site sources are numerous. Non-native animal species, such as Virginia opossum (*Didelphis virginianus*) and house mouse (*Mus mus*) are also common. Non-native animals that are adapted to humans are also likely to disperse into created upland habitats, competing for food with native species. Additionally, upland predators, including red fox and feral cats, can significantly affect birds nesting in the wetland as well as small mammals. Because restored upland habitats are highly susceptible to invasion by non-native plants and animals, their sustainability is constrained by the urban landscape.

All alternatives include the preservation and enhancement of coastal dune habitat at Ballona. Similar to CSS and native grassland, coastal dunes would support flowering vascular plants, such as lupines (*Lupinus* sp.), which would support and benefit from insect pollinators and provide larval and adult food sources. Coastal dune habitats provide habitat for reptiles, including horned lizard (*Phrynosoma* spp.) and California silvery legless lizard (*Anniella pulchra pulchra*). Passerine birds and small mammals could forage on seeds produced by vascular plants.

3.3 HYDROLOGY

The hydrology of each of the alternatives would have a significant impact on the functioning of the habitats. The depth and period of tidal inundations is a major influence on the type of habitats that would each alternative would support. The flow of water would erode, deposit and transport sediment. The period of time water stays on the wetlands and the amount it mixes with water from other water bodies would affect water quality. The hydrology of each alternative also affects the flood protection for existing infrastructure surrounding the wetlands. Hydrology is one of the main processes that link both the different project areas with each other and with Ballona Creek and Marina del Rey. The hydrology of the site would be sensitive to climate change and sea level rise in particular; the sustainability of the alternatives is discussed in Section 3.5.

Each restoration alternative proposed for the project has varying degrees of tidal inundation in terms of area and tidal range. Alternative 1 has minimal grading and most of the tidally inundated areas have a muted tidal range in portions of Area B. Alternative 2 and 3, by contrast, have fully tidal wetlands covering significant portions of Areas A and B. Alternative 4 has a large subtidal component connected to Marina del Rey. Alternative 5 has the greatest hydraulic connectivity with the main channel and between the restoration areas, due to the removal of levees. The degree of tidal inundation has a fundamental impact on the vertical and horizontal distribution of habitat types that would be supported.

The degree of tidal inundation inside the wetlands would also change the way the wetlands interact with Ballona Creek and Marina Del Rey. Larger, fully tidal wetlands would have larger tidal prisms which would have a greater impact on the surrounding water bodies, in particular on the amount of mixing. The location of the tidal connections is also important; a location inside Basin H, with its smaller tidal prism, would have a greater local effect on mixing than one connected to the main channel of Marina del Rey, which has a very large tidal prism.

3.3.1 Muted Tidal System versus Full Tidal System

A fully tidal wetland at Ballona would experience a tidal range equivalent to the oceanic tide in Santa Monica Bay. Mean Lower Low Water (MLLW, the long term average of the lowest tide each day) is -0.21 ft NAVD, Mean Higher High Water (MHHW, the long term average of the highest tide each day) is 5.29 ft NAVD and the diurnal tidal range (MHHW-MLLW) is 5.49 feet. The land area between the upper and lower limits of tidal range is the total area of intertidal habitat.

A muted tidal wetland experiences a more limited tidal range than a fully tidal wetland. Existing muted tidal wetlands at Ballona have Self-Regulating Tide gates (SRT), which close when the water surface elevation reaches a set height. Muted tidal systems would tend to compress the vertical range of wetland habitat types and would cause intertidal habitats to be created at lower elevations. Connections through culverts, open breaches and removal of levees are intended to allow the full oceanic tide to enter the site.

Inundation regime is the percentage of time that a given water level is exceeded during a Neap-Spring tidal cycle. It a useful parameter for characterizing the tidal inundation at a particular location with a specific elevation. The inundation regime for the unrestricted tidal system in the Santa Monica Bay is shown in Table 3-3; for example 2 ft NAVD is exceeded for 80% of the time and 4 ft NAVD for 38% of the time.

The inundation regime in some of the alternatives can be modified by setting the closure of the SRT in Area B at different elevations, which limits the maximum tidal elevation but maintains the rate of rise and fall of the tide. The inundation regimes were estimated for three SRT closure elevations using hydraulic modeling. The existing gate is set to close at 3.6 ft NAVD. Two additional closure elevations were modeled at 4.9 ft NAVD and 6.6 ft NAVD.

Table 3-3 shows how the inundation regime varies with different closure elevations. The inundation regime for lower elevations stays roughly the same between gate settings (e.g. 2 ft NAVD is exceeded about 77% of the time in all cases, which is comparable to the 80% for Santa Monica Bay). The effect of the muting is more pronounced at higher elevations (e.g. 4 ft NAVD is exceeded 38% of the time in Santa Monica Bay, but only 6% with a gate that closes at 4.9 ft NAVD). The inundation regime for intermediate closure elevations can be estimated by interpolation.

The vertical zonation of intertidal habitats can be estimated from the inundation regime. Different species would favor being inundated for different frequencies. For instance, high marshes are inundated approximately 28 to 50% of the time, while for low marsh the range of frequencies are 74 to 90%. Table 3-4 shows the inundation regime for intertidal habitats and the corresponding elevations for the oceanic tide in Santa Monica Bay (based on Ferren *et al*, 2007 in Appendix B). Each of the marsh habitat types covers a vertical range of about one foot.

Habitat zonations for the muted tidal regimes have been derived by determining the muted tidal elevation that has the same inundation regime as the open ocean. Table 3-4 shows the expected habitat distribution for different closure elevations for the SRT. Muting can also be achieved by undersized culverts that constrict the flow. These change the rate at which the tide rises in the site such that maximum elevation would not be the same on each tide. However, undersized culverts cause problems of erosion, backwater effects, and drainage.

For muted tidal systems the elevation range for the intertidal habitats is compressed which in turn limits the areal extent of these habitats compared to fully tidal alternatives. The zonation for intermediate closure elevations can be estimated by interpolation. This compression is most significant for the highest zones of the marsh (e.g. high marsh, transition zone). For instance, with the existing SRT closure elevation of 3.6 ft NAVD, mid marsh has the same vertical range as in a fully tidal system (1 foot) but occurs 0.3 feet lower. However, for the same SRT setting, the high marsh has a much reduced vertical range of 0.3 ft (between elevations 3.2 -3.5 ft NAVD).

In summary:

- varying the SRT closure elevation would mute the inundation regime in a predictable manner in Area B;
- vertical zonation of habitat would be compressed, particular at higher elevations, by muting of the tidal inundation;
- habitat area would be limited by the reduced vertical range of habitats.

3.3.2 Tidal Prism

The tidal prism is the volume of water entering the wetland on each tide. The tidal prism is a function of the topography and the tidal range of the site. For example, Alternatives 2 to 5 include substantial grading which would increase the volume of tidal water entering the site on each tide. If the tidal range is muted, the tidal prism would be reduced. The tidal prism was evaluated for each restoration area and for each of the main water connecting water bodies (Basin H, Marina Del Rey and Ballona Creek).

The tidal prism is important both within and outside the wetland:

- the tidal prism would influence the channel geometry and channel network properties.
- the tidal prism would influence the source of tidal water (as it affects the excursion length) and the residence time.

Table 3-5 shows the tidal prism of Ballona Creek in relation to the southwest wetland of Area B. In this case the main variable is the type of connection, either a SRT (Alt 1) or open breach (Alt 3). The muted tidal wetland has a tidal prism of about 30 ac-ft. Replacing muted tidal wetlands in Area B with fully tidal wetlands (Alt 3), connected to the creek by a breach, adds about 150 ac-ft to the existing tidal prism. One effect of increasing the tidal prism of Ballona Creek would be to increase the potential for scour at the mouth, in the vicinity of the jetty heads. Increased scour at the mouth has both positive and negative implications. It may reduce the need for dredging of Ballona Creek, improving the flood conveyance of the channel; however, it may also remobilize contaminated sediment that has settled at the mouth and there is the potential for undermining the breakwater as the channel readjusts to the larger tidal prism.

Table 3-6 shows the variation of tidal prism in relation to the southwest wetland of Area B. For a muted tidal wetland in this area the tidal prism is about 15 ac-ft. A tidal wetland created in this area in Alternatives 2 to 4 has a tidal prism of about 30 ac-ft.

Table 3-7 shows the variation of tidal prism for Area A. For those alternatives that connect to Marina del Rey, the tidal prism across the mouth of Basin H was used as a measure as this allows the effect of restoring the wetland tidal prism on Basin H water quality to be assessed. The larger the combined tidal prism, the greater the turnover of water in Basin H. The existing tidal prism of Basin H is about 12 acre-feet. A 38 acre wetland in Area A (Alt 2) increases the tidal prism by about 25 ac-ft, a 73 acre wetland (Alt 3) adds about 46 ac-ft, and the large subtidal pond and wetland in Alternative 4 adds about 330 ac-ft. The same alternatives connected to Marina del Rey at Via Venetia do not have a significant effect on the overall tidal prism as the tidal prism of Marina del Rey is so large.

Alternative 5 has the largest tidal prism of all of the alternatives at 600 ac-ft. This is nearly three times the existing tidal prism and it is expected that tidal flow velocities through the mouth of Ballona Creek would increase.

In summary:

- in the southwest wetland of Area B, an open breach and full tide would have a tidal prism about 100 ac-ft greater than a muted tidal option;
- southeast wetland would have a tidal prism of about 30 ac-ft;
- a tidal connection from Area A at Dock 52 has a large impact on the circulation of Basin H, but no alternative has a tidal prism sufficiently large to impact the much larger Marina del Rey channel.
- Alternative 5 has the largest tidal prism at 600 ac-ft.

3.3.3 Connections

The nature of the connection between open water and the wetland would greatly influence tidal conditions within the wetland. Four types of connections are present in at least one of the five alternatives:

- open (non-gated) culverts,
- gated culverts (e.g. self-regulating tide gate (SRT) and flood gates)
- open breach, and
- complete levee removal

The large pipes which penetrate levees to convey water between Ballona Creek and the inundated areas are referred to as culverts. Conveyance through a culvert is limited by its dimensions, particularly its cross-sectional area. Flow through culverts can be controlled by different types of gates that prevent flow through the culvert. SRT include a mechanism to close itself when water levels reach a specified elevation. Manual flood gates can be closed manually as dictated by conditions. Gated culverts can be used to prevent contaminants entering the site from Ballona Creek or Marina del Rey or to reduce peak flood elevations. The SRT has an advantage of being adaptable so that the desired water surface elevation within the site may be controlled.

The second type of connection through a levee is a breach. Breaches would be sized to the same width and depth as the connecting marsh channel and would have no top boundary. Breaches would therefore convey water with negligible restriction during normal tides and much more effectively during flood conditions. Breaches may be combined with lowering of the levee to about marsh plain elevation, thereby allowing higher tides to enter the site. This would mimic the flood routing of natural overmarsh tides and restore the hydraulic connection between the creek and the marsh plain. Controlling regular tidal flows or flood events is not possible with either a breach or levee removal.

The capacity of connections would vary. The SRT and culvert would have fixed capacity dependent upon their physical dimensions. A breach, depending on the nature of the material in which it is excavated, may be able to erode wider or deeper. Sizing levee breaches and connecting channels to the predicted tidal prism is generally necessary to limit how much the channel and breach erode. Tidal exchange and sediment supply to a wetland would be limited if the levee breaches or channels are undersized compared to the tidal prism. As the breaches or slough channels erode in response to the large tidal prism, tidal exchange and sediment supply would increase. Levee removal provides the most complete connection for water exchange and sediment supply between wetlands and the tidal source.

The location of the connections would have an impact on the evolution of the wetland, in particular the channel network. The alternatives have been developed to maximize opportunities for creating a single unified channel network within each marsh unit rather than multiple smaller networks, each with their own connection to open water. Using two connections for a hydrologic unit may increase the circulation in subtidal areas if there is sufficient head difference between the two entrances; this would be most effective in Alternative 4, which has a large open water area. For intertidal channels, flow may occur preferentially through only one of the entrances. Ideally, each marsh unit should be large enough to sustain its own network, containing a range of channel sizes and habitat. The southwest wetlands in Area B have the only remnant channel system that could be rejuvenated.

The use of structures as part of the connection, while increasing control, does have a number of issues:

- Gates and trash grilles, common on such structures, can impede the movement of sediment, seeds, fish and fish larvae. These restrictions would not be present with breaches.
- Culverts and gates generally have a smaller cross-section than natural channels and flow velocities within the structures would generally be higher. Scour would therefore be expected in the vicinity of the structure, especially in the channels leading into the wetlands.
- The potential for blockage is greater for gates and culverts, compared to an open breach, due to the smaller size of the opening and the presence of moving parts.
- Failure of a gate in the open position, due to trapping of debris or the failure of the control mechanism, may allow increase the potential for flooding. Failure of a gate in the closed position could delay drainage of tidal habitats.

3.3.4 Channel Network

Vegetated wetlands are typically drained by a complex network of dendritic and sinuous tidal channels. A dendritic sinuous tidal channel network is expected to provide better habitat and support a wider range of wetland functions than linear channels. For examples, channel bends provide sheltered foraging habitat for birds. Each tidal channel within the channel network drains and fills an area of marsh or "tidal watershed." Marsh drainage areas in natural marshes are distinguished by very subtle changes in marsh plain elevation and inundation patterns. The channel size adjusts to the flow to and from the marsh drainage area (i.e., the tidal prism of the marsh drainage area). Tidal channels may scour or fill in with sediment (shoal) in response to changes in the tidal prism and/or sediment dynamics.

In a natural system, as mudflats accrete to intertidal elevations, mudflat tidal channels form and become fixed as vegetation establishes and the marsh plain develops. Within this channel network, the tidal channel geometry at any given point is mainly dictated by the tidal prism of the watershed upstream. If the channel geometry is too small for the tidal prism, current speeds would increase and erode a larger channel. If the channel geometry is too large for the tidal prism, current speeds would decrease, allowing sedimentation to decrease the channel geometry.

Much of the natural channel system in Ballona Wetlands has been lost and a new channel networks would be constructed in tidal marsh restoration areas using the same tidal prism channel geometry relations found in natural channels. Larger tidal channels may be graded by excavating channels with dimensions that closely mimic channels in natural tidal marshes. The smallest channels may only be partially excavated, allowing these channels to develop over time through channel scour. Channel dimensions would be sized relative to the tidal prism of the marsh drainage area. Table 3-8 shows the channel network characteristics expected for each alternative, including tidal prism, channel length and order of channels. The method of calculation is described in Appendix C.

Channel networks constructed within the Ballona restoration are expected to be relatively stable, with limited potential for channel scour or shoaling. Tidal habitat would be restored by excavating fill and grading the site to elevations suitable for high, mid, and low marsh plain; mudflat; and subtidal habitat. The restored marsh plain would be graded with gentle slopes from the channel edge to upland areas to allow for the transgression of tidal habitats with sea level rise (see Section 3.5.1 below). Sedimentation rates within restored marsh areas are expected to be slow due to low sediment supply from the urbanized Ballona Creek watershed. The tidal prism of the restored marsh is therefore not expected to change rapidly after construction. The constructed tidal prism and channel dimensions are expected to maintain a relatively stable equilibrium condition. Also, as the restored marsh would be graded to higher marsh elevations, the tidal prism would be less than for lower elevation tidal areas. The potential for channels to form through channel scour is therefore expected to be low.

The presence of roads and levees within the site somewhat constrain the channel pattern as flow through this infrastructure must be routed through culverts. These culverts would set both the location and capacity of the channel at that place, reducing the ability of the channels to evolve over time. The culverts should be oversized in anticipation of larger tidal prisms in the future to increase the sustainability of the wetlands.

Permanent ponds in the marsh plain may be constructed to increase the amount of subtidal habitat. These would be connected to the channel network. These ponds would be shallow, well-defined, persistent depressions, 1 to 2 ft deep, that contain about 0.5 ft of standing water at all stages of the tide. They would receive tidal inflow on most tides.

3.3.5 Residence Time

Residence time is an estimate of how long water would remain in a flooded area before it is replaced by water from outside the wetland. A shorter residence time indicates a faster rate of turnover of the water. For this study, the residence time is estimated as the fraction of volume exchanged each tidal period, calculated by dividing the total volume in the flooded area by the tidal prism.

The residence time would depend on the proportion of tidal prism to total (subtidal plus intertidal) volume. Intertidal areas with an open connection to the ocean would have a residence time equal to the average tidal period because they dry out each tide. In areas with a large subtidal volume relative to intertidal volume (such as in Area A in Alternative 4), the residence time can be as long as several tidal periods. Short residence times indicate rapid and continuous exchange with the ocean water, with positive effects, for example, on exchange of gases, nutrients, fish larvae, sedimentation and water quality. Longer residence times indicate delayed exchange with the ocean.

The method for estimating residence time is an average for the entire flooded area and range of tides. Actual residence time would vary across the site. For example, residence times would be longer for regions of the flooded areas which are far from the exchange outlet or during periods of reduced tidal prism, such as neap tides. Similarly, actual residence times would be shorter for regions of the flooded areas which are close to the exchange outlet or during periods of increased tidal prism, such as spring tides.

3.3.6 Excursion Length

Excursion length is an estimate of the distance traveled by water during a tidal period. It is analogous to dropping a buoy in the water and measuring how far the buoy travels during a single tide. Excursion length provides an indication of the spatial extent of water movement within the tidal timeframe. As a first approximation, the water within an excursion length of a particular location is the source of inflowing water, the destination for departing water, and the volume of water that would most rapidly mix with that location's water. Water within an excursion length can be categorized as hydraulically well-connected to that location.

A major influence on excursion length is the addition of intertidal area upstream of a location which increases the flow of water past that location. In accordance with increasing flow, current speeds and hence, excursion length, also increase. Alternatives with the largest intertidal area would yield the largest excursion lengths.

Water in Ballona Creek, at the western side of the project area, exchanges with Santa Monica Bay on each tide. In contrast, water at the eastern side of the project area remains in Ballona Creek for more than a single tide. The different outlets from Area B are just a bit further than an excursion length of each other, indicating that water that exits one flooded area would typically take at least two typical tidal cycles to enter into another flooded area. The outlets from Area A to Marina del Rey and the outlets from Area B to Ballona Creek are separated by approximately three times the excursion distance and pass through a portion of Santa Monica Bay. This indicates that Area A and Area B are not well connected by Alternatives 1-4. Only Alternative 5 would closely connect Area A and Area B.

3.3.7 Flooding

Increasing tidal inundation within the Ballona wetlands may also affect the potential for flooding. Potential changes to the flood hazard as a result of the alternatives were evaluated.

Flood hazard was considered to arise from two sources – stormwater discharge from the Ballona Creek watershed and elevated ocean water levels in Santa Monica Bay. The watershed of Marina del Rey is small and its stormwater contribution is not considered a significant flood hazard. Flood events are typically characterized by their likelihood of occurrence, where the likelihood is expressed as a return interval. For this study, the selected stormwater discharge event has a return interval of 50 years or a 2% chance of occurring in any one year. The hydrograph of this 50-year stormwater discharge, which relates the rate at which water enters Ballona Creek as a function of time, was developed by the U. S. Army Corps of Engineers (2008). This hydrograph was developed by combining: (1) modeling of the transformation of rainfall into runoff and (2) frequency analysis of past discharge events.

The second source of flood hazard, elevated ocean water levels, arises from meteorological events acting at the regional or global scale. Regional meteorological events which elevate water levels include low atmospheric pressure associated with storm systems and wind setup. El Niño is the global meteorological event which leads to elevated ocean water levels along the entire western coastline. Since a detailed frequency analysis of elevated ocean water levels has not yet been conducted, this study relied upon an event selection approach to identify typical increases in ocean water level. Water levels at the Port of Los Angeles during 12 large storm events increased an average of 1.1 ft above expected water levels (USACE Hydrology Report).

These sources of water, stormwater discharge and elevated ocean water levels, interact with the ground surface elevation to determine the depth and spatial extent of flooding. Because of the existing levees which bound Ballona Creek, flooding is also a function of hydraulic connection. By adding tidal connections, the restoration alternatives alter the potential for flooding while decreasing the peak water levels within Ballona Creek. Within the flooded areas, flood exposure increases because of additional conveyance through the new tidal connections. However, the exposure within these flooded areas can be managed to acceptable levels by configuring the tidal connections and/or the flood hazard to infrastructure can be mitigated by structural means. The input of flood waters into the flooded areas acts to reduce the flood hazard within Ballona Creek itself. Because the flooded areas provide additional storage for flood waters, flood peak water levels along Ballona Creek, downstream of the tidal connection, are reduced.

Infrastructure that is exposed to flood hazard as a result of its location within or adjacent to the project area can be protected in several ways. The infrastructure itself can be raised above peak flood levels. For instance, roadways which cross the project site could be raised on structures or earthwork to elevate them above anticipated flood levels. Flood risk for infrastructure adjacent to the project area can be mitigated by constructing new levees or improving existing levees to constrain the flooded area extent.

Alternatives 1 and 2, which have muted tidal systems, have flood peaks at or below the closure elevation. If the rate at which the water level rises is rapid then the gate may close when elevations within the site are lower. For those alternatives that allow a full tide, flood peaks in the wetland channels are generally about a foot lower than in Ballona Creek. For instance, with the 50-year storm, Ballona Creek has a flood elevation of about 8.9 ft NAVD; for the same storm conditions the southeast wetland in Area B records 7.1 ft NAVD, and the southwest marsh was 7.6 ft NAVD.

Flood peaks also lower along Ballona Creek. At the seaward end of the channel, the existing peak flood elevation is predicted to be 8.9 ft NAVD. Predictions under Alternatives 1 and 2 have similar elevations as existing conditions. Alternatives 3 and 4 exhibit a 0.5 ft reduction in peak levels because of storage in the restored wetlands. Alternative 5 has slightly less of a reduction of 0.3 ft, due in part to the channel configuration and roughness of the vegetated floodplain.

3.3.8 Tables

Table 3-3. Inundation Regime of the SRT Gates in Area B, Showing Percentage of Time Tidal Water at or Above a Given Elevation

Elevation	% of time tides at or above given elevation				
ft NAVD	Santa Monica Bay (open ocean)	SRT closes at 3.6 ft NAVD	SRT closes at 4.9 ft NAVD	SRT closes at 6.6 ft NAVD	
7.5	0%				Inundation muted
7.0	1%				
6.5	4%				
6.0	8%				
5.5	14%			0%	
5.0	19%			4%	
4.5	28%		0%	16%	
4.0	38%	0%	6%	29%	
3.5	51%	23%	42%	44%	
3.0	65%	56%	58%	57%	
2.5	74%	69%	72%	70%	
2.0	80%	76%	78%	77%	Inundation similar
1.5	85%	82%	83%	82%	
1.0	90%	87%	88%	87%	
0.5	95%	100%	91%	91%	
0.0	98%	100%	97%	97%	
-0.25	100%	100%	100%	100%	

Note: all these examples use the existing 39 ft^2 culvert; with the gate set to close at 6.6ft NAVD the tide range is damped due to the lack of capacity of the culvert.

Table 3-4. Habitat Zonation in Terms of Inundation Regime and Elevation for Full and Muted Tidal Regimes

Habitat type	Inundation regime	Elevation range, ft NAVD			
	%r	Santa Monica Bay (open ocean)	SRT closes at 3.6 ft NAVD	SRT closes at 4.9 ft NAVD	SRT closes at 6.6 ft NAVD
Salt pan	14-28%	4.5-5.5	3.5-3.6	3.8-3.9	4.0-4.6
Transition Zone	14-28%	4.5-5.5	3.5-3.6	3.8-3.9	4.0-4.6
High Marsh	28-50%	3.5-4.5	3.2-3.5	3.3-3.8	3.3-4.0
Mid Marsh	50-74%	2.5-3.5	2.2-3.2	2.4-3.3	2.2-3.3
Low Marsh	74-90%	1.0-2.5	0.7-2.2	0.7-2.4	0.7-2.2
Intertidal Channel /Mudflat	90-100%	-3.0-1.0	-0.1-0.7	-0.1-0.7	-0.1-0.7
Subtidal	100%	-5.0- -3.0			

Table 3-5. Variation of Tidal Prism for Area B Southwest Wetland

	Ballona Creek tidal prism,
	ac-ft
Ballona Creek only	235
Alt 1 and 2 Area B SRT	267
Alt 3 and 4 Area B breached	386

Table 3-6. Variation of Tidal Prism for Area B Southeast Wetland

	Ballona Creek tidal prism,
	ac-ft
Ballona Creek only	235
Alt 1 Area B add muted tidal HW and tp	250
Alt 2, 3, 4 Area B fully tidal	390

Table 3-7. Variation of Tidal Prism for Area A

	Basin H tidal prism,
	ac-ft
Existing	9
Alt 2 Area A	36
Alt 3 Area A	69
Alt 4 Area A subtidal	345

Table 3-8. Channel Network Characteristics

Alt	Area	Channel length, ft			Order, no. of channels				
		Subtidal	**Intertidal**	**Total**	**1**	**2**	**3**	**4**	**5**
2	Area B East	1,530	13,730	15,260	43	12	4	1	
	Area A and C	1,820	14,730	16,550	43	12	4	1	
	Total	**3,350**	**28,460**	**31,810**	**86**	**24**	**8**	**2**	**0**
3	Area B East	1,530	20,270	21,800	67	20	6	1	
	Area B West	8,010	42,070	50,080	150	43	12	4	1
	Area A and C	4,770	27,030	31,800	150	43	12	4	1
	Total	**14,310**	**89,370**	**103,680**	**367**	**106**	**30**	**9**	**2**
4	Area B East	1,530	20,270	21,800	67	20	6	1	
	Area B West	8,010	42,070	50,080	150	43	12	4	1
	Area A (5 sub watersheds)	0	10,850	10,850	60	20	5		
	Total	**9,540**	**73,190**	**82,730**	**277**	**83**	**23**	**5**	**1**
5	**Total**	**17,810**	**164,650**	**182,460**	**678**	**198**	**58**	**14**	**2**

3.4 SEDIMENT AND WATER QUALITY

Water and sediment quality are key to the proper functioning of wetland systems. Contaminants associated with poor sediment and water quality can have an effect on the health of wetland plant and animal communities and to the long-term sustainability of any restoration efforts. Accumulated contaminants may also pose a human health risk. A healthy wetland depends on the continuing flow of non-impacted tidal waters and sediment into and out of the restored areas.

Contaminants that have been detected in the water column in Ballona Creek above the water quality criteria include copper, lead, zinc, bacteria indicators, polyaromatic hydrocarbons (PAHs), and several pesticides. These contaminants are generally associated with urban runoff that may contain heavy metals, PAHs and pesticides. These constituents generally are adsorbed to, and carried by, fine-grained soils (clays) and organic materials. These materials then settle out when the water flow velocity decreases such as in a wetland. Continuous flushing through adequate circulation and channel flows would reduce the accumulation of impacted sediments; in a muted tidal system there may be periods of high water slack where increased sedimentation may occur.

Evaluation of sediments in both the Ballona tidal prism and in Marina del Rey has indicated benthic impacts and in some cases toxicity responses to aquatic organism. As indicated by the toxicity testing and benthic studies, these constituents may have negative impacts to the benthic and aquatic organisms within the wetland. Certain metals such as selenium and mercury can bio-accumulate in the wetland environment and are carried up the food-chain. Organic compounds such as PAHs and pesticides such as DDT can also bio-accumulate in organisms in the wetlands resulting in a long-term impact.

Through the Total Maximum Daily Load program, pollutant load reduction is required to reduce these impacts to the benthic and aquatic communities. TMDL implementation is, however, in its initial phases which include developing an implementation plan and identifying source of pollutants. Due to the challenges of reducing pollutant loads from highly urbanized watersheds, improvements in water quality and significant reduction in potential impacts may take twenty years or more. Therefore, alternative for the wetland restoration need to consider the potential impacts from storm flows within this projected timeframe.

Water quality in Ballona Creek may improve as a result of efforts to meet TMDL targets. The need for restricted wet weather flows would diminish compared to the importance of water quality within the wetlands achieved through adequate circulation and residence time that would require less restriction of flow in and out of the wetland

Alternatives are compared by evaluating the sediment and water quality issues associated with different sources of tidal and fresh water flows, which include Ballona Creek, tidal waters and urban storm water runoff. These issues form the criteria for which the alternatives can be assessed to assure a healthy and sustainable wetland.

3.4.1 Ballona Creek Flows

Historical and current water quality data indicate that dry weather flows from Ballona Creek exceed water quality objectives for bacteria indicators, metals, and other constituents. Dry weather flows may result in pollutant loading to the restored areas. Any alternative that increases the connection of the creek to the wetlands, through larger culverts and breaches, may increase this loading.

Storm water flows frequently exceed water quality objectives for bacteria, metals, PAHs, and pesticides in Ballona Creek. Alternatives that allow for the use of flood gates can prevent the inflow of contaminated storm water into the wetlands and reduce pollutant loading. Restricted connections, for example culverts, may reduce inflow from the Creek but would also restrict drainage leading to ponding of polluted waters on the wetlands. Unrestricted storm flows from Ballona Creek, through larger breaches and levee removal, would allow the greatest exchange of water between the Creek and wetlands. Compared to muted tidal systems this would maximize the area exposed to pollutants but this may be mitigated by the improved circulation and flushing of the system.

3.4.2 Tidal Water from Ballona Estuary and Marina del Rey

In general the oceanic water quality is better than in Ballona Creek or Marina Del Rey. In Ballona Creek the tidal influence extends up to Centinela Creek and water quality reduces further away from the ocean as a result of less mixing (a function of tide and fresh water flow). Water in Marina del Rey also exceeds the water quality objectives for bacteria indicators, metals and other constituents. However, the magnitude and frequency of these exceedances are lower in comparison to Ballona Creek. The main channel of Marina del Rey has better water quality than the back basins due to greater circulation, proximity to the ocean, and less direct input from urban runoff.

Accessing the cleaner oceanic water is dependent upon the location of the tidal connection and the excursion length of the waters in the wetlands. Alternatives that have inlets or breaches closer to the ocean would provide water of higher quality to the restored areas. Alternatives that have greater excursion lengths, through larger tidal prisms, would draw from more distant, higher quality waters. Water quality within the wetlands, compared with the muted tidal systems, would also be improved by adequate circulation and lower residence time.

3.4.3 Suspended Sediment Loading

Suspended sediment and organic matter in urban runoff attract and provide the mechanism to transport constituents such as heavy metals (copper, lead, zinc), bacteria, pesticides, PAHs and other organic compounds to receiving waters. These sediments then settle out as velocity decreases when storm flows meet tidal waters or enter into the wetlands.

Historical and current data indicate long term accumulation of these constituents in sediments in Ballona estuary and at the tide gates into Area B; sediment testing has indicated toxic effects on aquatic organisms. Suspended sediments from Ballona Creek and from local resuspension during storms, may continue to enter the wetlands and impact sediment quality.

Marina del Rey also has impacted sediments in the main channel and in several of the back basins. The sources of the impacted sediments may include the Ballona estuary, resuspension of coastal sediments during storms, storm water discharges directly into Marina del Rey and human activities within the Marina.

Alternatives that restrict flows into the wetlands during and, for a period, after storm events may reduce the supply of sediment to the wetlands but increase the potential for settling of finer material due to longer slack periods. In the long term, restricted flow and import of sediment would limit sediment cycling. This may further reduce the already limited sediment supply from the urbanized watershed.

Other storm water inflows are at the ends of Falmouth and Pershing Drives and along Lincoln Boulevard and Marina Freeway. Continued loading of these constituents into the existing wetland areas has resulted in localized impacts to sediment. All the alternatives include storm water treatment wetlands to reduce the pollutant loading. Treatment wetlands can be effective in removing heavy metals, sediment and organic compounds that adsorb to fine-grain soil particles and organic matter. The effectiveness of these systems depends on the retention time that flows entering the wetlands and the maintenance of the plants and sediments. These wetlands may only be able to reduce loads from a portion of storm water flows due to the constraints of size, through flow, and number of inflow locations.

3.4.4 Sediment Impacts

Within the project area there are contaminated soils in the creek and wetland channels. Grading of the site for an alternative may make these contaminants bioavailable. All the alternatives would alter the local flow patterns within the wetlands, either by altering the path or velocity of the flow. As a result there would be localized accretion and erosion of the existing sediment as the channels adapt to the new flow regime. This may result in the mobilization of contaminated soils which may be deposited within the site or transported out to the Creek or Marina del Rey.

Culverts and other constrictions should be sized to reduce the flow velocity below that for significant erosion. Alternatives may also include structures that reduce the velocity at locations of high flow.

3.5 SUSTAINABILITY AND MAINTENANCE

All natural systems have a certain amount of variation or trends that occur over different time scales. In a tidal wetland, these variations may include floods or droughts over the short term or changes in climate over the long term. These variations can cause stress to the system, which may be anticipated and accommodated within the design of a restoration project. Climate change, for example, would affect not only sea level but also temperature and precipitation.

In addition to long term changes, there would also be individual events that would stress the system. Variations in timing and frequency of storms are difficult to predict, as is the accidental release of contaminants. The uncertainty in the timing and magnitude of these stressors makes the operation and maintenance (O&M) of the system to unexpected changes important.

3.5.1 Long-term Sustainability - Sensitivity to Climate Change

Long-term sustainability of the restored wetlands is evaluated as the sensitivity to climate change and other long-term trends, including sea level rise and also changing rainfall patterns and sediment supply within the watershed.

Tidal wetlands exist within a very narrow vertical range, set primarily by the tidal frame. A small change in the tidal frame due to sea level rise would result in movement of the vertical distribution of tidal habitats. The response of tidal wetland to sea level rise depends primarily on:

1. sediment supply to the wetland and the associated rate of wetland accretion, and
2. the availability of space for the transgression of wetland habitats to higher elevations.

If sediment is readily available, vertical accretion may keep pace with sea level rise and the spatial distribution of tidal habitats may not change significantly. If sediment supply is low, as in Ballona Creek, accretion rates may be slower than sea level rise and habitats would transgress landward. In Alternatives 2, 3, 4 and 5, tidal wetlands would be graded to elevations that support the desired vegetation, as it is assumed accretion rates would be slow.

As sea level rises, habitats that are higher in the tidal frame would be converted to habitats that are lower in the tidal frame (e.g., high marsh is converted to low marsh, low marsh is converted to mudflat, and mudflat is converted to open water). If the transitional zone has a shallow slope, higher tide levels due to sea level rise would inundate transitional and upland habitats and convert these areas to high marsh. The space provided by shallow upland slopes allows tidal habitat to transgress up the slope with sea level rise, thereby maintaining similar acreages of habitat. If the transitional slope is steep, higher elevation habitat acreages would decrease as open water and lower elevation habitats transgress landward.

The tidal wetland habitats in Alternatives 2, 3, 4 and 5 include broad transitional slopes (1:50 to 1:70) that allow habitat transgression and can accommodate 2 to 3 feet of sea level rise. These shallow slopes would also provide valuable interim transitional habitat and act as a buffer from the surrounding urban activity. Where space is constrained and shallow slopes are not feasible, particularly where wetlands are located close to levees or roads, the transgression process would still occur but the higher elevation marsh habitat would be compressed against the slope of the levee into a narrow horizontal band. There may be loss of some wetland in the future due to the steep transitional slopes in these locations.

Alternatives 1 and 2, which include culverts or gates, allow some control of the water surface elevation. In these alternatives, a muted tidal regime would be implemented that limits the maximum water surface elevation. The result would likely be a vertical and horizontal compression of the higher elevation habitats (high marsh and transition zones). The culverts and gates would be designed to accommodate expected sea level rise.

Current assessments of climate change in California do not indicate a clear trend or significant change in precipitation patterns. Higher temperatures are expected to cause a significant shift from snow to rain in the mountains, but coastal California is relatively unaffected by snow. Significant changes in precipitation and streamflow in coastal watersheds are therefore not currently predicted. There is the potential for decreased precipitation and more severe droughts. Small changes in water balance for sensitive habitats, such as seasonal wetlands and brackish marsh, may result in temporary or permanent changes in the salinity regime of these areas. Those areas that are already fully tidal wetlands may not be directly affected but they may still be influenced by changes in occasional freshwater inputs. In this respect, wetland areas connected to Ballona Creek and its watershed would be more sensitive than those connected to Marina del Rey.

3.5.2 Operations and Maintenance (O&M)

The alternatives require varying levels of ongoing operations and maintenance (O&M). Fully tidal wetlands in Alternatives 3, 4, and 5 would be designed to be self-maintaining and are expected to require little O&M. Muted tidal wetlands in Alternatives 2 and 3 would require regular and ongoing O&M of tide gates.

In addition to routine O&M for typical conditions, there would always be unforeseen or difficult to predict events – a large flood, the accidental release of a pollutant, the failure of a mechanical structure. Ideally the alternatives should be flexible enough to accommodate such unknowns and allow the opportunity for intervention. The muted tidal wetlands in Alternatives 1 and 2 provide the ability to occasionally close off the wetlands from its main tidal source, which could prevent high flows or contaminants from entering the site. A flood or tide gate may be added to a culvert with relative ease; however, it is much more difficult to close off the breaches and lowered levees in Alternatives 3, 4, and 5 from Ballona Creek. On the landward side, preventing flows from entering the site is more difficult due to the number of potential inflows and the difficulty of rerouting the flows to the ocean. For fully tidal wetlands in Alternatives 3, 4, and 5, the breaches may allow better flushing of contaminants entering from either the creek or adjacent land.

If controls are used as part of the management of the alternative, planning should include system response if the control fails. For instance, if a tide gate fails to operate then the impact it would have on the wetlands would differ depending on whether it failed open or shut, at high or low water. Ideally the tide gate should not be the only protection against excessive water levels, there should be redundant measures such as additional ebb culvert barrels and landward levees.

Another consideration is the reversibility of an alternative. All alternatives would have an adaptive management plan in which it may be desirable to manipulate conditions. Changing the operation of an existing gate has less risk than changing the tidal inundation by removing a section of the levee. If conditions change and the system does not respond as required then the ability to revert to the former state may be desirable. Another example may be the enhancement of existing uplands, where changes envisioned in Alternative 1 and 2 are mainly related to management rather than structural changes and could more easily be reversed.

3.5.3 Vectors

Mosquitoes occur in wetland ecosystems where certain species can be vectors for viral diseases such as forms of encephalitis and more recently West Nile Virus. Understanding the life cycles and habitat requirements of the species that can be disease vectors is important in their control. Mosquitoes breed in standing water. Mosquitoes rarely occur in significant numbers in areas of tidal wetlands that are regularly inundated and drained over the tide cycle. Problems can occur in areas of tidal wetlands that are not well drained, such as ponds and pans that are infrequently or seasonally inundated, densely vegetated areas that pond water between tides, or locations where tidal drainage has been interrupted. Maintenance (e.g., spraying) may be required to address vector issues for poorly drained areas of tidal marsh.

For muted tidal wetlands, the designs should provide the ability to drain areas of standing water when required. This could be accomplished by operating gated culverts to drain the wetland on an occasional basis. Open areas of standing water should be large enough to allow wind waves to disturb the surface and dense vegetation around the edges should be avoided.

Additionally, wide buffers between wetlands and residential areas can reduce the likelihood of vector issues. The design of the alternatives should provide access points for mosquito surveillance and control.

3.5.4 Invasives

Biological invasions by exotics represent one of the most serious threats to ecosystem integrity and functioning. Invaders can detrimentally alter habitats, eat native species, and act as disease agents. Millions of dollars are spent annually in combating exotic plant pests just within southern California. Managing exotic species is complicated, as invaders are living organisms that can adapt to their new environments and have diverse, cascading effects. Invasive species may become established in restored upland and wetland habitats, requiring costly removal and maintenance efforts.

Salt marshes in southern California have been relatively free from invasions of wetland plants. Some localized exceptions include a mangrove (*Avicennia marina*) intentionally introduced into Mission Bay, San Diego, a sea lavender (*Limonium ramosissimum provinciale*) in Carpinteria salt marsh in Santa Barbara and *Tamarix* which has invaded the high marsh at Tijuana Estuary in San Diego County.

Upland area in southern California have some particularly troublesome plant invaders including giant reed (*Arundo donax*), which forms dense stands in riparian, brackish and fresh water wetlands, and salt cedar (*Tamarix* spp.), which have invaded riparian habitats, uplands, transition zones and high salt marsh. The major invaders at Ballona include , wattle (*Acacia* spp.), myoporum (*Myoporum laetum*), Russian thistle (*Salsola tragus*) mustard (*Brassica* spp.), garland daisy (*Chrysanthemum coronarium*), wild radish (*Raphanus sativus*), castor bean (*Ricinis communis*), pampas grass (*Cortaderia jubata*), fennel (Foeniculum *vulgare*), brazillian pepper tree (*Schinus terebinthifolia*), slender fan pam (*Washingtonia robusta*), non-native spurge (*Euphorbia* spp.), multiple varieties of ice plant (*Aizoaceae*) and non-native grasses have invaded disturbed upland areas and continues to spread.

Important vertebrate invaders that may affect restoration efforts include cowbirds, which are nest parasites that affect the endangered Least Bell's Vireo, and predatory red fox and house cats. These primarily upland invaders can also enter the wetland areas, impacting the native species. Estuarine and marine invaders include the clam-smothering mussel (*Muscalista senhousia*) and the carnivorous yellowfin goby (*Acanthogobius flavimanus*), the "killer" alga *Caulerpa taxifolia*, the salt-marsh destroying crustacean *Sphaeroma quoyanum*, and the mud-flat invading cordgrass *Spartina alterniflora*.

Alternatives with greater area of upland habitats would have greater impacts from invasive species and provide more opportunities for them to impact the adjacent wetland habitats. Alternatives 3, 4 and 5 provide the greatest area of contiguous wetland habitat (see Table 3-3), while Alternative 5 provides a significantly smaller edge to area ratio (Table 3-4).

3.6 PUBLIC ACCESS, RECREATION AND SAFETY

The goal of the public access plan is to provide "enhanced access to and within the Ballona Ecosystem consistent with ecosystem preservation and restoration values in a safe, consistent, coherent and functional manner," as per project objectives in the Ballona Wetland Restoration Plan Goals and Objectives (Appendix A). Public access features would be developed in concert with habitat restoration efforts to ensure maximum resource protection while providing a valuable recreational experience for the community. Providing public access and interpretive features about habitat restoration in turn provides increased public education, awareness, and support of local biological and physical resources present within the Ballona Wetlands. Providing strategically-placed public access features and limiting the intensity and duration of recreational use at the Ballona Wetlands would reduce impacts to the wetlands and enhance opportunities to involve the public in restoration and monitoring efforts.

The proposed public access and recreation features include a system of trails and overlooks, gateway entrances, interpretive stations, pedestrian bridges, bicycle parking, parking areas, boardwalks, vehicular pullouts, and visitor center. These would provide a diversity of public access and recreation opportunities for a wide range of users. The goal for the future design of these features would be to integrate all aspects of the project into a coherent system of restoration and public access that provides a clear sense of place within the context of the Ballona Wetlands and surrounding landscape.

The California Fish and Game Commission has designated the majority of the project area as a State Ecological Reserve. The purpose of the designation is to provide protection for rare, threatened or endangered native species. Public entry and recreational use of ecological reserves is subject to general rules and regulations to ensure that recreation is compatible with the primary purpose of resource protection.

In order to protect natural resources on the site and limit impact to wetland areas, a controlled and appropriate level of access to the Ecological Reserve would be provided as part of restoration. The public access strategy would focus on managing and concentrating recreation use within the site. The restoration and public access design would accommodate an appropriate level of fishing, boating, walking, and other activities consistent with the Ecological Reserve designation and ecosystem restoration values:

- **Walking**. Currently, access to the Ecological Reserve for walking or hiking is authorized on a case-by-case basis, and the site is not yet open to the general public. However, there is a public trail and self-guided interpretive tour located along the perimeter of the Freshwater Marsh. Walking or hiking would likely be the predominant recreational use of the site.

- **Biking**. Several local and regional bicycle routes are located near the Ballona Wetlands. No formal off-road or trail bicycle paths exist within the wetlands. The Ecological Reserve designation permits biking only on the designated bicycle path located on the north bank of Ballona Creek. Bicycle use is not permitted within the Ecological Reserve or Freshwater Marsh area.

- **Fishing**. Fishing currently occurs on both sides of Ballona Creek and from the downstream pedestrian bridge. The Ecological Reserve designation permits fishing with barbless hooks from the shoreline of Ballona Creek or from boats within the Ballona Creek channel. Fishing within the wetland area is restricted and by permit only.

- **Boating**. The Ballona Creek channel is currently used for both motorized and non-motorized boating. The University of California Los Angeles and Loyola Marymount University rowing teams use the Ballona Creek channel for crew practice. The Ecological Reserve designation permits boating within the Ballona Creek channel. Boating within the wetland area, however, is restricted and by permit only.

- **Other Recreational Uses**. Playa Vista Little League currently plays baseball on three fields located within the Ecological Reserve (Area C).

Public access and recreation features would provide a variety of settings, including access to the estuarine environment and retreat from urbanized areas, and would provide recreation opportunities for a variety of visitors. Access would be designed to be as barrier-free as possible to provide access for visitors of varying abilities and to comply with the Americans with Disabilities Act. In some locations, trails may be designed to accommodate vehicular use in order to provide access for security or maintenance. Raised boardwalks would be strategically located to maximize interpretive and educational opportunities related to the site and ongoing restoration activities. Exact trail locations and characteristics would be further developed when the preferred alternative is identified.

Table 3-9 details the number, length and location of public access features.

The Ballona Wetlands are also an important crossroad within the regional trail network. Both the coastal South Bay Bicycle Trail and the Ballona Creek Bicycle Trail run along the boundary of the site. Running north/south, the South Bay Bicycle Trail is a 22-mile paved trail that runs from Will Rogers State Beach in the north to Torrance County Beach in the south. Running east/west, the Ballona Creek Bicycle Trail runs along the south boundary of Area A and concludes in Culver City. The project is an opportunity to increase regional connectivity by developing an integrated trail network within the project site that connects to the surrounding regional trail network. The Alternatives would both preserve and enhance regional connectivity through connections of loop trails within the project area to the regional network. These connections would provide regional and local trail users with a range of opportunities and destinations.

Providing public access and interpretive features regarding habitat restoration in turn provide increased public education, awareness, and support of local biological and physical resources present within the Ballona Wetlands. Interpretive stations would be developed at strategic locations such as at gateway entrances, overlooks, or along the trail network within the project area. Educational signage and interpretive panels would facilitate a greater understanding and appreciation of the landscape. A potential visitor center and other opportunities for outdoor education and interpretation would provide a rich diversity of public access and recreation opportunities for a wide range of users. The goal for the future design of these features would be to integrate all aspects of the project into a coherent system of restoration and public access that provides a clear sense of place within the context of the Ballona Wetlands and surrounding landscape.

The prehistoric resources within and near the Ballona project area, including LAN-54, contain human remains and other materials that are of extremely high heritage value and sensitivity to the contemporary Gabrielino/Tongva Native American groups. Efforts to enhance cultural awareness of these resources and Native American lifeways in general should therefore be closely coordinated with the California Native American Heritage Commission and those groups identified as having specific concerns for the Ballona area.

As outlined in the Ballona Wetland Early Action Plan, interpretive panels would highlight habitat characteristics and diversity, watershed history, and Native American site usage through clear, consistent and attractive displays (Conservancy 2007). Overlooks or viewing platforms would be located at vista points where important features of the landscape can be viewed and/or opportunities for wildlife viewing and birding exist. Associated interpretive information would be provided at these facilities based on the opportunities provided at the facility sites.

Public access within Ballona Wetland would be developed in a manner that is “safe, consistent, coherent and functional” for the safety of the public, long-term management, and maintenance of the site. The separation of incompatible uses, such as bikers and walkers or bikers and cars is important for public safety and security in the area. The Ballona Wetlands are located in a densely population area surrounded by busy roads and popular regional bike paths. The Ecological Reserve designation provides clear guidance on allowable recreational uses within the site.

The most common unauthorized uses within the project area are BMX biking, dog walking, homeless encampments, dumping, and off-trail walking. Unauthorized use of the site can have an adverse impact on the landscape. Therefore, controlling these uses is critical to successful habitat restoration. Wetland restoration would inherently preclude access to portions of the site by creating deepwater and wetland habitat.

Lincoln Boulevard, Jefferson Boulevard, and Culver Boulevard, as well as street ends to the west and north, provide site access for automobiles. Current on-site parking includes an unimproved lot behind Gordon’s Market in Area B, paved on-street parking along Jefferson Boulevard at the Freshwater Marsh, and a paved parking lot at the Little League baseball fields in Area C. Safe traffic access would be provided by designating parking areas, creating roadside pullouts to provide formalized automobile access and viewing locations, and discouraging unauthorized roadside parking.

3.6.1 Tables

Table 3-9. Public Access Features Comparison

Public Access & Recreational Features	Alternative 1 (length/ number)	Alternative 2 (length/ number)	Alternative 3 (length/ number)	Alternative 4 (length/ number)	Alternative 5 (length/ number)
Trails					
Area A: Trails	8,800 feet	8,000 feet	9,450 feet	3,550 feet	4,450 feet
Area B: Trails	29,600 feet	29,600 feet	27,000 feet	27,000 feet	16,200 feet
Area C: Trails	7,200 feet	6,700 feet	7,150 feet	6,550 feet	2,250 feet
Boardwalks	1,900 feet	1,450 feet	1,350 feet	3,650 feet	3,850 feet
Access Points & Overlooks					
Gateway Entrances	11	11	11	10	7
Overlooks	4	6	9	9	10
Parking and Pullouts					
Formal Parking Areas	4	4	4	4	4
Vehicular Pullouts	0	0	2	2	2
Pedestrian Crossings					
Pedestrian Creek Bridge Crossing	1	1	1	1	1
Pedestrian Road Crossing	2	2	1	1	5

3.7 PHASING AND COSTS

This section describes the probable construction costs for the five selected alternatives as described in Chapter 2. In determining an opinion of probable construction costs appropriate to conceptual level design, several assumptions were required. These assumptions included:

- construction methods
- unit costs
- project sequencing and phasing
- permitting
- property acquisition

Table 3-10 is included to illustrate the level of accuracy and amount of contingency which is typically included in cost estimation for construction projects at various levels of design. This table is from the Cost Estimate Classification System, developed by the Association for the Advancement of Cost Estimating (AACE, 1997). As shown in the table, a particularly wide range in accuracy is assumed inherent for project design at the conceptual level. In addition, contingency is a large percentage of the estimated project costs, decreasing as the level of design is increased.

The “estimates of probable costs” are summarized in Table 3-11. Appendix D contains detailed cost estimates for each alternative by area and supporting information. It is important to note that these are large scale construction projects and that the alternatives involve significant intervention, and hence would require further detailed analysis and engineering design that would likely lead to additional refinements. Consequently, at this conceptual design phase, a cost contingency of 35% is included. We anticipate that actual construction costs could be reduced significantly through more detailed engineering. This is particularly true of the unit costs identified for fill placement; if a major fill element is included in the project, there is an opportunity to develop a construction methodology with a lower cost. Also, land costs are not included. At this stage, it is anticipated that all construction can be accomplished on publicly-owned land, and land and easement purchase costs are therefore not included. Also, costs associated with environmental restrictions of construction including timing and phasing are not explicitly treated.

These estimates are subject to refinement and revisions as the design is developed in future stages of the project. The cost tables summarize the cost of construction, and do not include estimated project costs for additional studies, permitting, detailed design, construction observation, monitoring and ongoing maintenance. Estimated costs are presented in 2008 dollars, and would need to be adjusted to account for price escalation for implementation in future years. This opinion of probable construction costs is based on: PWA’s prior experience, prices from similar projects, and consultation with contractors and others involved in comparable projects.

Note these estimates of probable construction costs and the actual costs at the time of construction may vary. The cost of construction would be impacted by the availability of construction equipment and crews and fluctuation of supply prices at the time the work is bid. PWA makes no warranty, expressed or implied, as to the accuracy of such opinions as compared to bids or actual costs.

3.7.1 Notes on Cost Estimate Assumptions

Quantities were estimated conservatively (high). For the grading of the subtidal, mudflats and marsh plain, it is assumed the grading was to the desired elevation and volumes were calculated using the "average end area method." For channels, it is assumed that only the largest channels (order 3, 4 and 5) would be excavated, and that these channels would be excavated to their modeled, equilibrium dimensions. Quantities of material used in levees were increased to account for settlement.

Appendix D (Table D-2) includes the unit costs and assumptions used in the cost estimate. The cost of excavation is the most expensive item in Alternatives 2 to 5. The cost used for excavation is $15/CY, which may be high. The use of scrapers or other efficient construction methods may have a lower unit cost. However, in this case, over-excavation and/or ripping of the soil may be required to give a suitable substrate for wetland restoration. This additional work would increase costs. Therefore, lower unit costs are not recommended for use in the cost estimate without further analysis of engineering and constructability considerations.

Onsite trucking and placement of excavated material is included as a separate item in the cost estimate. The cost estimate assumes that as much material as possible is reused within the same area to construct levees. Even so, each alternative generates more material than can be reused on site. There is no requirement to move material from one area to another, with the exception of Alternative 1. In Alternative 1, material excavated in Area A would be trucked to Area B and used as fill for levee construction along the daylighted culvert. It is assumed that the excess quantity from each area will be placed on site in stockpiles, at least until the material is disposed of off site. Table 3-12 lists the volume of excess material to be stockpiled (Appendix D, Table D-4 includes a rough calculation of possible stockpile areas).

Options for disposal may include:

Option 1 / 2. Remove sediment, barge sediment to the Port of Los Angeles (POLA), and unload dredged material at POLA (Option 1) or dispose material at a confined disposal facility (CDF) at POLA (Option 2).

Option 3. Remove sediment, barge sediment to POLA, and truck to landfill for beneficial use as landfill cover.

Option 4. Remove sediment, barge sediment to POLA, and dispose contaminated material at a hazardous waste landfill. The level and extent of on-site contamination is presently unknown.

Option 5. Remove sediment, barge sediment offshore, and dispose sediment offshore (Offshore Disposal).

Option 6. Remove sediment and dispose sediment on a nearby beach (Beach Disposal).

POLA identified and evaluated disposal Options 1 to 4. A preliminary draft cost estimate table prepared for POLA by Weston (Weston, undated) for these options was provided. There are uncertainties associated with the preliminary draft table and conceptual-level cost estimates. Disposal costs were not estimated for this report. The POLA/Weston cost estimate information was used to estimate the costs for Options 1 to 3. Mobilization (8%) and a 35% contingency were added to the disposal cost estimates for consistency with the estimates in this report and to account for uncertainties. Cost estimates for Option 4 are not included because information on contamination is not currently available.

For offshore disposal (Option 5) and beach disposal (Option 6), a range of costs is included in the estimate. On the lower end of the range, the costs for offshore disposal (Option 5) and beach disposal (Option 6) may be as low as the costs for disposal at POLA (Option 1 / 2). The upper end of the range for offshore disposal (Option 5) may be as high as the unit cost for dredging and offshore disposal at Upper Newport Bay provided by the SCC (G. Gauthier, SCC, pers. comm.) This unit cost is $28 per cubic meter for dredging and disposal about three to five miles offshore (S. Brodeur, County of Orange, pers. comm.). For beach disposal (Option 6), the upper end of the unit cost may be about $10/CY higher than the costs for Option 1 / 2. The cost estimates for disposal options should be updated at the next opportunity. Table 3-13 summarizes the disposal option cost estimates for each alternative.

3.7.2 Phasing

Areas A and C and Area B are not hydraulically connected in Alternatives 1 to 4 and so their construction may be phased in either order. In addition, it would be possible to construct Area A prior to Area C in each of these alternatives. Since each area generates more than enough material to construct levees, there is no need to stockpile material for use in later phases.

Alternative 5 is shown as being constructed in three phases (see Figure 2-9). A breakdown of the cost estimate between phases is included in Table 3-11. Excavation of Area A and removal of the Ballona Creek levees downstream of Lincoln Boulevard would occur first. This would require the construction of a temporary levee across the northern part of Area B and adjacent to Culver Drive. This temporary levee would increase the costs of phasing Alternative 5 compared to the cost estimated for Alternative 5 without phasing. The second phase would consist of restoring the remaining portion of Area B once the first phase habitat had been successfully established. Finally, Area C would be restored in the third phase. The advantage of phasing would be to spread costs over a longer period of time and take advantage of the timing of other projects, such as the widening of Lincoln Boulevard. The project could be stopped at the end of any of the phases and still leave a functioning system.

3.7.3 Tables

Table 3-10. Levels of Cost Estimate Accuracy and Contingency for Different Levels of Design

Design Completion Level	Cost Estimate Accuracy	Contingency
Conceptual (order of magnitude costs)	-30% to +50%	35–50%
Preliminary (30%)	-15% to +30%	20-25%
40 to 70% complete	-15% to +30%	15-20%
70 to 100% complete	-5% to +15%	10-15%

Table 3-11. Summary of Engineer's Estimates[1] for Alternatives 1 to 5 (cost in Millions of Dollars)

Alternative	Area A	Area B	Area C	Total
1	$4.0	$2.6	--	**$6.6**
2	$42.6	$16.0	$3.3	**$61.8**
3	$69.3	$55.5	$5.2	**$130.0**
4	$108.4	$55.5	$5.2	**$169.0**
5	$99.8	$59.0	$50.4	**$209.3**
	Phase 1	**Phase 2**	**Phase 3**	
5 [2]	$110.4	$48.8	$50.5	$209.7

Notes:

1 - Estimated construction costs include a 35% contingency

2 - The cost estimate for phasing Alternative 5 is higher due to the construction of a temporary levee

Table 3-12. Estimated Volumes of Excess Material to Be Stockpiled.

	Stockpile Volume (ac-ft)			
	Area A	**Area B**	**Area C**	**Total**
Alternative 1	50	-	-	**50**
Alternative 2	590	120	60	**770**
Alternative 3	1,040	600	90	**1,730**
Alternative 4	1,700	600	90	**2,390**
Alternative 5	1,650	760	840	**3,250**
	Phase 1	**Phase 2**	**Phase 3**	
Alternative 5	1,790	570	830	**3,190**

Table 3-13. Summary of Estimated Costs[1] for Disposal Options. Costs in Millions of Dollars

							Alt 5 with Phasing [2]			
		Alt 1	**Alt 2**	**Alt 3**	**Alt 4**	**Alt 5**	**Phase 1**	**Phase 2**	**Phase 3**	**Total [2]**
On-Site Work		**$6.6**	**$61.8**	**$130.0**	**$169.0**	**$209.3**	$110.4	$48.8	$50.5	**$209.7**
Disposal Volume (CY)		**86,400**	**1,241,440**	**2,789,580**	**3,853,140**	**5,231,600**	2,889,960	923,500	1,344,600	**5,158,060**
Off-Site Disposal Options										
Option 1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**	**$1.3**	**$19.1**	**$43.0**	**$59.4**	**$81.0**	$44.5	$14.2	$20.7	**$81.0**
Option 3	**Beneficial Use - Landfill Cover**	**$4.2**	**$59.7**	**$134.1**	**$185.2**	**$252.6**	$138.9	$44.4	$64.6	**$252.6**
Option 4	**Disposal at Hazardous Waste Landfill [3]**									
Option 5	**Offshore Disposal (low end of range)**	**$1.3**	**$19.1**	**$43.0**	**$59.4**	**$81.0**	$44.5	$14.2	$20.7	**$81.0**
	Offshore Disposal (high end of range)	**$3.6**	**$51.0**	**$114.6**	**$158.3**	**$216.**	$118.7	$37.9	$55.2	**$216.0**
Option 6	**Beach Disposal (low end of range)**	**$1.3**	**$19.1**	**$43.0**	**$59.4**	**$81.0**	$44.5	$14.2	$20.7	**$81.0**
	Beach Disposal (high end of range)	**$2.7**	**$38.3**	**$86.0**	**$118.7**	**$162.**	$89.1	$28.5	$41.4	**$162.0**

Notes

1 - Estimated construction costs include a 35% contingency

2 - The cost estimate for phasing Alternative 5 is higher due to the construction of a temporary levee

3 - Estimate not included for Beneficial Use - Landfill Cover, contamintant report pending

4. SUMMARY

1. The project goal is to create functional estuarine habitat, including shallow subtidal, mudflats, fully tidal wetlands, salt pan and transitional habitats. Extensive enhancement of muted tidal wetlands or upland habitat, such as coastal sage scrub, grassland and saline seasonal marsh, does not achieve the project goal. However, upland habitat may provide some support for functioning estuarine habitat. Alternatives 3, 4 and 5 create the largest areas of fully tidal estuarine habitat while Alternatives 1 and 2 have larger areas of upland and muted tidal habitat. As discussed in Section 3.1, tidal estuarine habitats would benefit vascular and non-vascular plants, small mammals, a diverse community of aquatic invertebrates and many bird species known to utilize other southern California wetlands. Alternatives 4 and 5 create large areas of shallow subtidal habitat adjacent to mudflat. This would provide spawning and nursery habitat for pelagic and demersal fish species; these may disperse to the adjacent nearshore habitat and to other regional wetlands.

2. Transitional habitats, between tidal wetlands and upland, support a unique assemblage of vascular plant species and provide additional support for terrestrial species such as snakes, lizards, small mammals and birds. Transitional habitats also provide refuge for wildlife during periods of high water, serve as buffers against human activity, and allow for transgression of wetland habitats with rising sea levels. Alternatives 3, 4 and 5 provide the widest and largest area of transitional habitat. Muted tidal systems, as in Alternatives 1 and 2, have a reduced tidal range and therefore a compressed vertical range of habitats, limiting the area of transitional habitat that can be created.

3. Upland areas would support populations of vascular plants and provide foraging and nesting habitat for a number of bird species. Upland areas would also provide breeding and foraging habitat for insect pollinators, butterflies and moths, birds, herpetofauna and some mammals. All alternatives provide some upland habitat; however, there is a trade-off between the acreage of estuarine habitat and upland habitat. Alternatives 1 and 2 have the most upland habitat and the least change to the existing habitat mix. Freshwater seasonal wetlands, including vernal pool habitat, would benefit specific vascular and non-vascular plants, aquatic invertebrates and herpetofauna uniquely adapted to this environment, Alternatives 2, 3 and 4 create vernal pools.

4. Alternatives with larger, contiguous, areas of wetland habitat are more likely to sustain populations of associated species. Alternatives 3, 4 and 5 have larger areas of contiguous wetlands with fewer roads, wider transitions and more channels. These alternatives would have a higher quality of wetland habitat because they would be more remote from noise, lights, cars, and other human impacts. Alternatives with larger areas of contiguous wetland would also have fewer impacts from, and require less active management for, invasive plant and animal species.

5. Fully tidal systems allow for greater tidal circulation and reduced residence time. This would lead to a more rapid exchange of water with the ocean, and positive effects on exchange of gases, nutrients, fish larvae, sedimentation and improved water quality. Alternatives 1 and 2 have large areas of muted tidal wetland; Alternatives 3, 4 and 5 create fully tidal wetlands. The large intertidal areas of Alternative 2, 3 and 5 would have the shortest residence times, completely draining on most tidal cycles. Alternative 4 has a substantial subtidal volume, which would flush over several tidal cycles.

6. A complex tidal channel system allows water, sediment and nutrients to reach all parts of the wetland and provides diverse habitats. The complexity of the channel network depends on the area of the wetland and its tidal prism. Alternatives 3, 4 and 5 have large tidal prisms and would support an extensive and complex channel network with a large range of channels sizes.

7. The higher quality sources of tidal water are the ocean and Marina del Rey. The ability to bring this water into the wetlands would depend on the location of the tidal connection and the tidal excursion length. Alternatives 2, 3 and 4 improve tidal connections between Area A and higher quality water in Marina del Rey; this would also benefit habitat connectivity for fish species. All alternatives have some connection to Ballona Creek, which has poorer water quality. Longer excursion lengths increase the mixing of water on each tidal cycle, improving water quality. Alternatives 3, 4 and 5, with the largest tidal prism, have excursion lengths extending to the ocean.

8. The form of the tidal connection would affect the connectivity and function of habitat by influencing the movement of sediment, seeds, gases, nutrients, fish and fish larvae. Tide gates in Alternatives 1 and 2 would control water surface elevations within the wetlands but would limit connectivity with Ballona Creek and Marina del Rey, reducing diversity, and limiting primary productivity. Gates can also control pollutant loading, especially during storm events, although muted tidal systems would have a longer residence time allowing greater settling of pollutants. Gates would require regular maintenance and management as failure could impact habitat and cause flooding. Fixed structures, such as gates and culverts, need to accommodate both scour and sea level rise in their design.

Breaches in Alternatives 3 and 4 allow for full tidal range, movement of larger fish and greater seed dispersal. Open breaches would allow greater tidal circulation, reduced residence times and would be able to adapt to rising sea levels. Levee removal in Alternative 5 has the advantages of breaches and increases the interaction between the wetlands and the Creek - creating gradients of inundation and salinity across the site, letting the morphology evolve and allowing for periodic disturbance by flooding and scouring.

9. All of the alternatives would maintain the existing level of flood protection. Alternatives 1 and 2 have muted tidal systems, which would maintain the existing flood levels. These

alternatives rely on tide gates. Alternatives 3, 4 and 5 can accommodate higher flood levels by the construction of new levees and provide additional flood storage, reducing peak flood elevations.

10. All the alternatives would include principles of adaptive management in their Operation and Maintenance strategy. Alternative 1 has little change from the present situation and the risk associated with implementation is low. The restoration of wetlands in Alternative 2, 3 and 4 could be undertaken in distinct hydrologic areas which would allow for adaptive management and experimentation. Alternative 5 restores a large, contiguous area of habitat connecting a number of existing hydrologic units with Ballona Creek. This alternative makes the greatest change to the site, would be the hardest to reverse and consequently has the most risk. This risk may be mitigated to an extent by phasing the implementation.

The following tables have been developed from the above summary. They indicate favorable characteristics in terms of habitat, hydrology and public access. Check marks indicate which alternatives have these characteristics and the number of check marks indicates the relative degree. The number in brackets refers to the relevant summary paragraph above.

4.1 TABLES

Table 4-1. Summary of Habitat Characteristics

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Large areas of fully tidal estuarine habitat (1)		√	√√	√√√	√√√
Large areas of mudflat (1)			√	√√	√√
Large areas of shallow subtidal habitat, adjacent to mudflats (1)				√√	√√
Extensive channel network (6)	√	√	√√	√√	√√√
Wide transitional habitat (2)		√	√√	√√	√√
Large areas of enhanced upland habitats (3)	√√	√√	√	√	
Allows for dynamic interaction between Ballona Creek and the Wetlands					√
Larger and more hydraulic connections between wetland habitats, Ballona Creek and the ocean (5, 7, 8)		√	√√	√√	√√√
Hydraulic connection to Marina del Rey (7)		√	√	√√	
Fewer culverts and tide gates; more breaches and levee removal (7, 8)			√	√	√√
Larger contiguous areas of estuarine habitat with fewer roads and more channels (4)			√	√	√√

Table 4-2. Summary of Hydrology, Sediment and Water Quality Characteristics

	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Full tidal range (1)		√	√√	√√√	√√√
Large channel network (6)		√	√√	√√	√√√
Daylights culverts, creates breaches (8)	√	√	√√	√√	√√
Large tidal prism (5, 7)		√	√√	√√√	√√√√
Short residence time (5)		√√	√√	√	√√√
Long excursion length (7)		√	√√	√√√	√√√
Control of flows by gates (8)	√	√			
Maintains existing flood levels (9)	√	√			
Increase in flood storage (9)			√√	√√√	√√√
Stormwater wetlands	√	√	√	√	√
Hydraulic connection to Marina del Rey (7)		√	√	√√	

4.2 RANKING OF ALTERNATIVES

Ranking is based upon the ability of each alternative to meet the project goals: the creation of functioning estuarine habitats, tidal circulation, connectivity of habitat areas, ability to address sediment and water quality, sustainability and maintenance. The alternatives are ranked from 1 to 5, with 1 being the highest rank.

In order to protect natural resources on the site and limit impact to wetland areas, a controlled and appropriate level of access to the Ecological Reserve would be provided as part of restoration. The alternatives are not ranked according to public access; each alternative can be modified to accommodate varying degrees of access as described in the feasibility analysis.

Alternative 1 – Rank 5

Alternative 1 is ranked the lowest because this alternative:

- does not achieve the project goals of creating a functional estuarine habitat;
- maintains existing upland habitat and does not provide fully tidal habitat;
- does not address existing problems of invasive species, limited buffers, poor tidal circulation, poor connectivity between habitat areas, and supports only a limited number of targeted wetland species;
- has upland areas that would require continuous management for a muted tidal system, invasive species and human impacts; and
- accommodates sea level rise through tidal muting.

Alternative 2 – Rank 4

Alternative 2 is ranked 4th because this alternative:

- creates fully tidal areas with better connections to Marina Del Rey although existing muted tidal areas remain;
- maintains significant upland areas;
- does not take advantage of whole site;
- does not address existing problems of invasive species, limited buffers, tidal circulation restricted by levees, poor connectivity between habitat areas;
- has upland areas that would require continuous management for a muted tidal system, invasive species and human impacts; and
- accommodates sea level rise through tidal muting.

Alternative 3 – Rank 3

Alternative 3 is ranked 3rd because this alternative:

- creates fully tidal areas across the whole site;

- creates complex channel networks;
- improves tidal circulation with breaches and larger connection to Marina del Rey water;
- creates large contiguous areas of habitat and large buffer areas;
- has poor connectivity between habitat areas across the site; and
- accommodates sea level rise through transgression.

Alternative 4 – Rank 2

Alternative 4 is ranked 2rd because this alternative:

- creates fully tidal areas across the whole site;
- creates complex channel networks;
- improves tidal circulation with breaches and larger connection to Marina del Rey water;
- creates large contiguous areas of habitat and large buffer areas;
- has poor connectivity between habitat areas across the site;
- includes subtidal habitat adjacent to wetlands using Marina Del Rey water ;
- has longer residence time in subtidal areas; and
- accommodates sea level rise through transgression.

Alternative 5 – Rank 1

Alternative 5 is ranked the highest because this alternative:

- is the most likely to create a functional estuarine habitat as per the project goals;
- creates the largest complex channel network;
- improves tidal circulation through a direct connection to Ballona Creek;
- has the largest tidal prism, lowest residence time, and greatest tidal excursion;
- creates the largest contiguous area of wetland;
- has the greatest connectivity across the site;
- allows interaction between the wetlands and the Creek;
- restores gradients in salinity and inundation;
- allows periodic disturbance by flooding and scouring; and
- accommodates sea level rise through transgression.

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APPENDIX A.
GOALS AND OBJECTIVES, OPPORTUNITIES AND CONSTRAINTS

Appendix A

Ballona Wetlands Restoration Plan
Goals and Objectives,
Opportunities & Constraints

The purpose of this document is to identify key characteristics of the project area that present opportunities for achieving the restoration planning goals and objectives as well as those that may limit (or place constraints on) the achievement of those goals and objectives. The ideas listed below tend to be generalized, this document is an effort to take information about the existing conditions of the area and assess what that information tells us about achieving the project's goals and objectives.

This table does not evaluate the relative importance of specific opportunities or constraints and there are internal inconsistencies among the opportunities and constraints identified. Inherent in some of the opportunities are preferences, priorities and approaches to wetland restoration and because of these differences, some conflict with one another. The purpose of this document is not to resolve these potential conflicts, but rather to be sure there is a common understanding of the project area's potential for achieving the fullest range of goals.

Goal 1: Ecosystem Restoration: Restore, enhance, and create estuarine habitat and processes in the Ballona Ecosystem to support a natural range of habitat and functions, especially as related to estuarine dependent plants and animals.

Sub-goal 1. Habitat: Preserve, restore, enhance, and create a variety of functional wetland, estuarine and other habitats representative of the Ballona Ecosystem.

Objectives:

a. Support existing and future habitat based on identified regional needs

b. Create spatial connectivity within the site

c. Create appropriate edge habitat and connectivity to adjacent areas of the Ballona Ecosystem

d. Provide landscape-level function at a regional scale addressing habitat/landscape patches, corridors, connectivity and mosaics landscapes. Provide habitat for migratory birds, fish nurseries, etc.

Opportunities	Constraints
Preserve, restore, enhance, and create multiple habitats historically associated with both the Ballona Wetlands and the region.	Because the size of the site is limited, it may not be possible to incorporate large enough patches of all historic habitat types to ensure their viability.
Restore and create fully tidal wetland habitat	Habitats are fragmented by the existing roads, infrastructure and surrounding development
Preserve and enhance seasonal ponding areas	Existing habitats on site could be displaced by future enhancement, such as the restoration of tidal inundation
Create regional habitat linkages and corridors	Site has been filled, existing soil types may not be appropriate for reestablishment of all historic habitats
Incorporate adjacent upland habitats along with transitional habitats linking wetlands and uplands.	
Restore diverse habitats based upon gradients of elevation, hydroperiod and salinity	

Sub-goal 2. Biodiversity: Preserve and increase the native biodiversity of the Ballona Ecosystem. Identify and protect multiple levels of diversity (e.g. species, habitats, biogeographic provinces and trophic structure).

Objectives:

a. *Increase diversity and populations of rare and endangered plant and animal species.*

b. *Establish and maintain diverse native plant communities, including vascular plants, algae, and diatoms.*

c. *Support a diverse complement of species including: birds, fish, amphibians, reptiles, native aquatic and terrestrial invertebrates.*

Opportunities	Constraints
Restore biodiversity historically associated with the region, including common, rare and locally extirpated species.	Implementation of restoration efforts will entail impacts to existing species to some degree and may need to be mitigated in some way
Strategically design habitat to ensure recruitment and survival of targeted species	Site may too small and isolated to support some species
Restore microhabitats that support various life stages of species	May become a biological sink as a result of invaders, predators or other impacts
	Restricted tidal connection could limit the species of fish that can be established

Sub-goal 3. Physical/Chemical Processes: Maintain and establish physical and chemical processes consistent with the restoration goals.

Objectives:

a. *Improve tidal circulation and enlarge the amount of area that is tidally inundated.*

b. *Manage surface and subsurface freshwater inflows to support desired on-site habitats.*

c. *Establish and maintain a sediment transport regime that supports the desired wetland functions.*

d. *Re-establish a dynamic range of hydrologic conditions (intensity and duration) to support natural ecosystem processes.*

e. *Establish and maintain biogeochemical processes representative of natural wetland ecosystems.*

Opportunities	Constraints
Increase tidal flow into the site	Flood conveyance in Ballona Creek Channel needs to be maintained
Improve tidal connectivity within the site by enlarging existing channels and culverts, and creating new channel networks	Existing tidal connections are insufficient to create and maintain a significant area of natural tidal wetland
Improve management of tide gates to create a muted tidal system with long-term management of water levels	Elevations are too high, fill disposal will be difficult
Change the roads and berms to improve habitat connections, reduce flood hazards and accommodate sea-level rise	Existing infrastructure may limit hydrologic connections within the site
Include distributary channels in the bluff deltas for coarse sediment distribution where feasible	Urban watershed negatively impacts sediment supply, water quality and hydrograph of potential freshwater sources
Restore a more natural tidal slough system linking freshwater areas to tidal marsh	Natural channel formation may be limited due to lack of tidal scour, high elevations, soil type and absence of antecedent channel network
Enhance historic Centinela Creek in Area B by increasing freshwater flows.	Limited supply of fine sediments to the site may limit march evolution over time
Reduce current flooding problems around the project area	Low-lying properties around the periphery of the site may need to be protected from flooding
Daylight outlet culvert of the Freshwater Marsh	The upstream reach of Centinela Creek has been diverted.

Physical/Chemical Processes, continued

Opportunities	Constraints
Modify Ballona Creek levees by realignment or changing the form of the bank	
Coordinate the management of tide gates in the Ballona Ecosystem (Del Rey Lagoon, Ballona Lagoon & Ballona Wetlands)	

Sub-goal 4. Sustainability: Facilitate the conservation and restoration of natural resources in a manner that maintains and improves the ecological integrity, function, diversity and productivity for future generations.

Objectives:

a. *Accommodate potential sea level rise for transitional habitat provide appropriate elevations to accommodate habitat shifts*
b. *Use self-sustaining, low maintenance systems where possible*
c. *Minimize future adverse effects of nuisance species, including non-native, invasive species, feral predators and disease vectors.*
d. *Protect the wetlands from adverse impacts caused by contaminants in influent water or sediment.*
e. *Plan for the longterm management of the site*

Opportunities	**Constraints**
Accommodate rising sea level by using site slope to allow habitat migration	Future development of surrounding areas
Provide sufficient tidal flow to maintain channel system	Maintenance and management resources have not been identified
Incorporate principles of adaptive management in restoration design to phase implementation and test different methods	Some sources of water and sediment to the site may be contaminated, those contaminants may accumulate in the restoration area
Utilize (or employ) existing organizations to maintain and implement stewardship activities at the site	Accumulation of contaminants or pollutants on the site: including trash and aerial deposition
Use low maintenance processes to improve water quality of urban runoff entering the wetlands	Site vulnerable to invasive species, onsite and from local area
Design site to minimize the impacts of streetlights, traffic noise and other urban characteristics on habitat values	Rising sea level may inundate low lying areas
Reduce management costs associated with tide gates	Infrastructure, such as gas facilities, needs to be maintained

Goal 2: Social and Socioeconomic Values: Create opportunities for aesthetic, cultural, recreation, research and educational use of the Ballona Ecosystem that are compatible with the environmentally sensitive resources of the area.

Sub-goal 1. Public Access: Design enhanced access to and within the Ballona Ecosystem consistent with ecosystem preservation and restoration values in a safe, consistent, coherent and functional manner.

Objectives:

a. *Develop gateway entrances that attract, welcome and inform ecosystem visitors.*
b. *Phase-out inappropriate or uncontrolled access points.*
c. *Create public outreach, education and interpretive opportunities for visitors, organizations and institutions.*
d. *Develop appropriate signage that enhances visitor understanding of wetland restoration efforts; increase public awareness of local biological and physical resources present within Ballona Wetlands.*
e. *Develop overlooks and connections accessible to pedestrian, bike and bus users and provide the appropriate signage to facilitate such access.*
f. *Provide potential opportunities for the public to participate in restoration and monitoring efforts.*

Opportunities	Constraints
Develop parking areas and designated entry points for the public on currently disturbed or developed areas.	Informal access points and associated unauthorized and uncontrolled uses
Develop interpretative components to educate the public on the values of wetland functions and habitat, build on existing educational programs	Public access areas reduce the area available for restoration
Design access with buffers between people and sensitive habitat areas	
Install facilities to serve visitors of the site	
Improve overlook points. For example, potential to use sediment material onsite to create high points	
Install consistent signage	

Public Access, continued

Opportunities	Constraints
Provide access that serves people with disabilities	
Incorporate educational and stewardship activities into the Little League program	

Sub-goal 2. Cultural Access and Preservation: Initiate formal and informal consultation with representatives of the Gabrielino/Tongva Tribal Council to develop guidelines that contribute to the preservation of sacred and cultural sites.

Opportunities	Constraints
Provide access for cultural use of the site by native people	Protection of cultural resources on site may constrain site design
Preserve cultural resources onsite	
Educate the public regarding archaeological and historic resources	

Sub-goal 3. Recreational Use: Design site to accommodate an appropriate level of fishing, boating, walking, and other activities consistent with the Ecological Reserve Designation and ecosystem restoration values.

Objectives:

a. *Provide public trails and viewing areas around the perimeter of the wetlands with interpretive displays at selected locations.*

b. *Concentrate potentially incompatible human activities in non-sensitive areas*

Opportunities	Constraints
Develop a recreational plan compatible with the Ecological Reserve designation	Existing unauthorized uses, such as BMX use and dog walking, may be incompatible with Ecological Reserve designation
Integrate existing trails, features and disturbed areas into the designated trail network.	
Integrate trail network with local and regional trails, bikeways and transportation systems	

Sub-goal 4. Public Safety and Security: Design public access so that the wetlands are a safe place to visit.

Objectives:

a. Design access to minimize maintenance costs

b. Provide access points at locations responsive to the needs of law enforcement.

c. Create and maintain access points in a manner that minimizes safety concerns and hazards.

Opportunities	Constraints
Provide for a safe visitor experience through site design	Major roadways cross the site, fast moving traffic, limited places for parking
Consolidate Gas Company facilities, separate from habitat areas and public access	Poorly secured site, hard to control all unauthorized access in an urban setting
Improve traffic-related safety concerns through crosswalks, walkways and safe parking areas	Unknown extent of methane or other potentially harmful substances
Improve emergency access to the site	Need to protect public health by limiting disease vectors (such as mosquitos)

APPENDIX B.
HABITAT DESCRIPTIONS FOR RESTORATION ALTERNATIVES

Draft

BALLONA WETLAND RESTORATION PROJECT: HABITAT DESCRIPTIONS FOR RESTORATION ALTERNATIVES

Prepared by Wayne R. Ferren Jr., John C. Calloway, Joy B. Zedler, and the Ballona Wetland Restoration Science Advisory Committee

I. INTRODUCTION

The Ballona Wetlands Restoration Project seeks to restore ecosystem structure, function, and processes at Ballona Wetlands, in particular those related to the support of biodiversity. A method of organizing biological diversity information for the Ballona Wetland Restoration Project is to group plants and animals by the "habitat" in which they are most likely to be sustained under improved conditions. One measure of progress toward achieving habitat restoration goals, therefore, is a determination of whether or not these targeted organisms are supported by the manipulated habitats to a measurable and acceptable level of sustained occurrence. Performance criteria can be established to measure establishment of species populations in these habitats. Physical parameters of the environmental also can be monitored and compared against data from reference sites or expected conditions to determine if the restored areas are performing within a range of anticipated values.

The following are generalized groups of habitats (organized by category and type) with information regarding characteristics such as structural feature, ecosystem function, and landscape process as well as dominant or characteristic plant species, characteristic animal species, and presumed extirpated or rare or endangered species that could be candidates for translocation and recovery experiments or goals within the Ballona Ecosystem.

The categories and subcategories of habitats are arranged from estuarine deepwater habitats and wetlands to palustrine wetlands, followed by uplands within the Ballona Ecosystem and within the estuarine category from subtidal (deepwater) and intertidal open water and non-vegetated types of habitats to vegetated types, generally going from lower elevation and hence more frequently flooded types to less frequently flooded types, an important distinction when assessing habitat characteristics. Habitat restoration design as it relates to the potential for significant sea level rise due to global climate change is an important consideration for the Ballona Wetland Restoration Science Advisory Committee during the evaluation of restoration alternatives for the Ballona Ecosystem.

II. LIST OF HABITAT CATEGORIES AND TYPES

Habitat Category I – Estuarine Open Water: Non-vegetated Habitats and Flooded Substrates:

1. Deepwater Habitats (mud and sand substrates) – Open Water Subtidal Conditions

2. Deepwater Subtidal and Wetland Intertidal Channels (cobble/gravel and riprap substrates) – Open Water Subtidal, Intertidal, and High Tide Conditions

3. Intertidal Wetland Habitats (sand and mud substrates) – Intertidal and High Tide Conditions

Habitat Category II - Estuarine Non-vegetated Intertidal Wetland Habitats

4. Intertidal Margins, Beds, Banks, and Benches (mud and sand substrates) - Low Tide Conditions

5. Intertidal Channels (cobble/gravel and riprap substrates) - Low Tide Condition

6. Mudflats

7. Hyperhaline Salt Flats

Habitat Category III - Estuarine Vegetated Wetlands:

8. Aquatic Bed Wetlands

9. Cordgrass (Low) Marsh

10. Marsh Plain (Middle Marsh)

11. High Marsh (clay/mud or sand/loam substrates)

12. High Marsh Transition Zone (including Euryhaline and Hyperhaline Habitats)

13. Brackish Marsh (an associated Open Water Habitat)

Habitat Category IV - Palustrine Nontidal Wetlands:

14. Transitional Emergent Wetlands (delta distributaries and margins of estuaries)

15. Freshwater Marsh

16. Seasonal Palustrine Wetlands (including Haline Vernal Wetlands)

17. Palustrine Scrub/Shrub Wetland (= DFG "Riparian Scrub")

18. Palustrine Forested Wetland (= DFG "Riparian Woodland"?)

Habitat Category V - Upland Habitats:

19. Grasslands (= DFG Non-native Herbaceous Vegetation)

20. Coastal Scrub (including Coastal Bluff Scrub)

21. Coastal Dune Scrub and Dune Herbs (including Foredunes)

22. Forests, Woodlands, Groves, and Tree Rows (including DFG "Eucalyptus Grove")

III. HABITAT DESCRIPTIONS

Habitat Category I – Estuarine Open Water: Non-vegetated Habitats and Flooded Substrates:

In the estuarine system, deepwater habitats are characterized by the subtidal water regime and wetlands are characterized by various non-storm-influenced intertidal water regimes including irregularly exposed, regularly flooded, and irregularly flooded regimes.

1. Deepwater Habitats (mud and sand substrates) – Open Water Subtidal Conditions

Narrative (refer to other open water habitats for additional information): Subtidal deepwater habitats include channels, bays, basins, and other features, which at extreme low water do not drain with the outgoing tides. The subtidal estuarine water regime results in permanently flooded habitats and permanent bodies of open water. These habitats are generally considered truly aquatic systems and are adjacent to and down-slope from tidal estuarine wetlands. Estuaries with extensive deepwater habitat areas often support adjacent areas of intertidal mudflat and low marsh wetland habitats.

The "plants" of channels and creeks, both intertidal and subtidal, are generally nonvascular taxa, but under brackish conditions may include various aquatic bed and emergent vascular species. The non-vascular plants include phytoplankton (e.g., diatoms) and macroalgae, which, along with the detritus from decomposed Cordgrass (*Spartina foliosa*), are often direct links in the estuarine food chain (i.e., are directly consumed by higher order consumers). Benthic invertebrates are the most visible consumers of detritus, algae and plankton. Crabs and snails graze on detritus and macroalgae, while bivalve mollusks filter feed on phytoplankton. Polychaete worms inhabit the fine sediments of tidal creeks, while fish exploit the water column and substrate surface.

Fish use of subtidal habitats can be categorized by various functional groups or guilds including, for example, (1) adult and juvenile marine fish, such as Leopard Sharks (*Triakis semifasciata*), Grey Smoothhounds (*Mustelus californicus)*, and Stripped Mullet (*Mugil cephalus*) that enter estuaries with incoming tides to forage in estuaries, (2) adult marine fish such as Round Rays that feed and mate in estuaries; (3) marine fish such as California Halibut (*Paralichthys californicus*) that use flooded estuarine habitats especially channels as nursery habitat for young-of-the-year juvenile populations; (4) estuarine restricted fish such as Long-jawed Mudsuckers (*Gillichthys mirabilis*) that spend their entire life cycle in estuaries; (5) estuarine fish such as Tidewater Gobies (*Eucyclobius newberryi*) that are restricted to particular types of estuaries with brackish water but that survive under marine conditions during floods and return to estuaries under reduced runoff conditions; (6) anadromous fish such a Steelhead Trout (*Oncorhynchus mykiss*) that live under marine conditions as adults but enter estuaries to spawn either in estuaries or in rivers and streams on adjacent watersheds. In general most estuaries do not support all of the fish guilds, but collectively, southern California estuaries as a whole provide functions for each guild.

Estuarine open water habitats such as those provided by permanently flooded conditions are important foraging areas for birds from other habitats. Of note is the endangered California Least Tern (*Sterna antillarum browni*), which breeds on sandy habitats adjacent to marine and estuarine wetlands and forages on small fish, primarily Top Smelt *(Atherinops affinis)* and Northern Anchovy *(Engraulis mordax)* in the relatively shallow water of estuaries. Shallow water habitat also is important for foraging by wading birds [e.g., Snowy and Great Egrets (*Egretta thula*, *Casmerodias albus*) and Green, Black-crown Night, and Great Blue Herons (*Butorides virescens*, *Nycticorax nycticorax*, *Ardea herodias*], wading shore birds [e.g., Willet (*Catoptrophorus semipalmatus*)], diving birds including grebes, mergansers, and many ducks. The endangered Brown Pelican (*Pelecanus occidentalis*) is a frequent forager in estuarine open water habitats such as those provided by permanently, semi-permanently flooded, and intertidal water regimes. Open waters also provide low-tide refuges for species that move on to the mudflat and marsh plain during high tide.

Structural features: bays, lagoons, channels.

Deepwater habitats: Estuarine Unconsolidated Bottom and Rocky Bottom, and Estuarine Streambed Deepwater Habitats.

Physical processes: estuarine hydrology including tidal hydraulics; fluvial hydrology in river and creek mouth estuaries; marine and shoreline processes associated with estuary mouth dynamics; sediment transport; biogeochemistry.

Water regime/hydrology: subtidal, permanently flooded (i.e., deepwater habitats).

Salinity: haline to mixohaline.

Dominant/characteristic plant(s): diatoms, algae.

Associated plant(s): *Zostera marina*, *Potamogeton pectinatus, Ruppia maritima*, *Ruppia chirrosa* in various types of Estuarine Aquatic Bed Deepwater Habitat.

Characteristic animals: perhaps over 35 species of fish depending on type of estuary and guild of fishes present; suites of benthic and epibenthic invertebrates including various mollusks, crustaceans, worms, etc.; wading birds; dabbling and diving waterfowl; foraging Osprey.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; resident and migratory bird resting and foraging habitat, source populations of marsh-plain fish species (e.g., California Killifish, Long-jaw Mudsuckers); nutrient removal (denitrification at anoxic-soil/oxic-water interface; also P removal with sediment deposition); maintain predictable environment by maintaining hydrological connectivity and reducing extremes of drought (hypersalinity) and/or freshwater flooding (hyposalinity).

Recovery opportunities: foraging habitat for California Least Tern (*Sterna antillarum browni*), California Brown Pelican (*Pelicanus occidentalis californicus*), and Osprey (*Pandion haliaetus*); flat fish nursery habitat including California Halibut (*Paralichthys californicus*), Starry Flounder (*Platichthys stellatus*), and Diamond Turbot (*Hypsopsetta guttulata*).

Management Issues: water quality.

2. Deepwater Subtidal and Wetland Intertidal Channels (cobble/gravel and riprap substrates) – Open Water Subtidal, Intertidal, and High Tide Conditions

Narrative (refer to other open water habitats for additional information): Estuarine channels and creeks play a critical role in salt marshes as they convey tidal waters and associated nutrients and dissolved gases. They also support a complex assemblage of plants and animals, and are particularly diverse when cobble beds provide surfaces for attachment by some invertebrates (e.g., mussels, oysters, barnacles, and limpets) and protective habitats for others (e.g., crabs, gobies). This substrate differences separates this habitat type (#2) from type #3 (sand and mud substrates).

Estuarine channels and creeks are subjected to a wide variety of environmental conditions including fluctuations in salinity and depth of tidal inundation. Typically, tidal flushing is greatest at the tidal inlet and decreases with distance from the inlet. This general gradient, in turn influences, water movement, salinity, temperature, nutrients, and dissolved gases. These environmental factors influence the species composition, distribution, and population dynamics of the channel fauna.

Structural features: marine cobble deltas, cobble channel beds and bars, riprap.

Deepwater Habitats and Wetlands: Estuarine Streambed and Unconsolidated Shore and Bottom (cobble/gravel) Wetlands and Estuarine Rocky Shore and Rocky Bottom (boulder) Wetlands and Estuarine Deepwater Habitats.

Physical processes: estuarine hydrology including tidal hydraulics; fluvial hydrology in river and creek mouth estuaries; marine and shoreline processes associated with estuary mouth dynamics; sediment transport; biogeochemistry.

Water regime/hydrology: subtidal, permanently flooded (i.e., deepwater habitats); intertidal irregularly exposed, regularly flooded, irregularly flooded.

Salinity: haline and mixohaline.

Dominant/characteristic plant(s): micro-algae (e.g., diatoms, cyanobacteria); macro-algae (e.g., *Ulva* and *Enteromorpha*).

Associated plant(s): none.

Characteristic animals: oysters; mussels; crustaceans including Shore, Mud, and Fiddler Crabs; possibly over 70 species of invertebrates in cobble beds; wading birds; dabbling and diving waterfowl; foraging Osprey. Many estuarine fish species also use these channels depending on the type of estuary and habitat.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; biofiltration (e.g., bivalve filtration from mussels, oysters, etc.), nutrient cycling/biogeochemistry; N and P removal as above; carbon removal by shell forming mollusks.

Recovery opportunities: *Ostreola conchaphila* (native oyster) on cobble-gravel and other hard substrates; foraging habitat for California Least Tern, California Brown Pelican, and Osprey.

Management issues: water quality including sedimentation; loss of habitat due to dredging in some estuaries; expansion of habitat in other estuaries due to ongoing accretion of marine deltas.

3. Intertidal Wetland Habitats (sand and mud substrates) – Intertidal and High Tide Conditions

Narrative (refer to other open water habitats for additional information): Intertidal channels and creeks play a critical role in salt marshes as they convey tidal waters and associated nutrients and dissolved gases. They also support a complex assemblage of plants and animals. Estuarine channels and creeks are subjected to a wide variety of environmental conditions. Typically, tidal flushing is greatest at the tidal inlet and decreases with distance from the inlet. This general gradient, in turn influences, water movement, salinity, temperature, nutrients, and dissolved gases. These environmental factors influence the species composition, distribution, and population dynamics of the channel fauna.

Structural features: intertidal channels, creeks, basins, banks, benches, marsh plain, as well as margins of deepwater habitats in bays, lagoons and subtidal channels, natural creek levees and back-levee depressions (pools).

Wetlands: Estuarine Unconsolidated Bottom, Unconsolidated Shore, Streambed, Aquatic Bed, and Emergent wetlands.

Physical processes: estuarine hydrology including tidal hydraulics; fluvial processes in tidal river and stream channels; marine and shoreline processes in estuary mouths; sediment transport; biogeochemistry.

Water regime/hydrology: intertidal **–** semi-permanently flooded, irregularly exposed, regularly flooded, irregularly flooded.

Salinity: haline or mixohaline.

Dominant/characteristic plant(s): diatoms.

Associated plant(s): none or *Spartina foliosa* and *Sarcocornia pacifica* (*Salicornia virginica*), and other species as appropriate on flooded habitat margins and the marsh plain; channel banks provide substrate for germination of *Ulva* spp. spores, which then grow into blades that break free and become highly productive floating mats.

Characteristic animals: perhaps over 35 species of fish depending on type of estuary and habitat; suite of benthic and epibenthic invertebrates including Ce*rithidea californica* (California Horn Snail) and various clam genera including *Tagelus, Macoma*, *Protothaca*; wading birds including egrets and herons; dabbling and diving waterfowl; and foraging Osprey.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; resident and migratory bird resting and foraging habitat, source populations of marsh-plain fish species (e.g., killifish, mudsuckers); nutrient cycling/biogeochemistry; N and P removal.

Recovery opportunities: flat fish habitat including California Halibut, Starry Flounder, and Diamond Turbot; foraging habitat for California Least Tern, Brown Pelican, and Osprey.

Management issues: water quality including sedimentation; loss of habitat due to dredging in some estuaries; expansion of habitat in other estuaries due to ongoing accretion of marine deltas.

Habitat Category II
Estuarine Non-vegetated Intertidal Wetland Habitats

4. Intertidal Margins, Beds, Banks, and Benches (mud and sand substrates) - Low Tide Conditions

Narrative: Within the intertidal wetland portion of estuaries and in addition to mudflat features for those estuaries that support flats, other non-vegetated structures, including channel beds, banks and benches, often occur that can have similar functions to mudflats exposed at low tide conditions. These structures are group together here when lacking aquatic bed or emergent wetland vegetation cover.

Structural features: bay and lagoon margins and beds, bottoms, banks, and benches of estuarine channels and creeks.

Wetlands: Estuarine Streambed, Unconsolidated Shore, and Unconsolidated Bottom Wetlands.

Physical Processes: estuarine hydrology including tidal hydraulics; biogeochemistry.

Water regime/hydrology: irregularly exposed, regularly flooded.

Salinity: haline and mixohaline.

Dominant/characteristic plant(s): diatoms.

Associated plant(s): none or *Spartina foliosa*, *Sarcocornia pacifica* (*Salicornia virginica*) on margins; channel banks provide substrate for germination of *Ulva* spp. spores, which then grow into blades that break free and become highly productive floating mats.

Characteristic animals: suite of benthic and epibenthic invertebrates including C*erithidea californica* (California Horn Snail) and various clam genera including *Tagelus, Macoma, Protothaca*; wading and shore birds (foraging); polychaetes; oligochaetes.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; biofiltration, food chain support and nutrient cycling, N and P removal, C removal by bivalves.

Recovery opportunities: channel bench and similar habitat for Fiddler Crabs (*Uca crenulata*).

Management issues: water quality and sedimentation issues.

5. Intertidal Channels (cobble/gravel and riprap substrates) - Low Tide Conditions

Narrative: Estuarine channels and creeks play a critical role in salt marshes as they convey tidal waters and associated nutrients and dissolved gases. They also support a complex assemblage of plants and animals, and are particularly diverse when cobble beds provide surfaces for attachment by some invertebrates (e.g., mussels, oysters, barnacles, and limpets) and protective habitats for others (e.g., crabs, gobies). Estuarine channels and creeks are subjected to a wide variety of environmental conditions including fluctuations in salinity and depth of tidal inundation. Typically, tidal flushing is greatest at the tidal inlet and decreases with distance from the inlet. This general gradient, in turn influences, water movement, salinity, temperature, nutrients, and dissolved gases. These environmental factors influence the species composition, distribution, and population dynamics of the channel fauna.

Structural features: marine cobble deltas, cobble channel beds and bars, riprap.

Wetlands: Estuarine Unconsolidated Shore and Bottom (cobble/gravel) and Estuarine Rocky Shore and Rocky Bottom (boulder).

Physical processes: estuarine hydrology including tidal hydraulics; fluvial hydrology in river and creek mouth estuaries; marine and shoreline processes associated with estuary mouth dynamics; biogeochemistry.

Water regime/hydrology: intertidal irregularly exposed, regularly flooded, irregularly flooded.

Salinity: haline and mixohaline.

Dominant/characteristic plant(s): micro-algae (diatoms, cyanobacteria); macro-algae.

Associated plant(s): none.

Characteristic animals: oysters and mussels (hard substrates) crustaceans including Shore, Mud, and Fiddler Crabs; possibly over 70 species of invertebrates in cobble beds.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; low tide resting habitat for resident and migratory birds and foraging habitat for shorebirds and clapper rail; biofiltration (by bivalves), nutrient cycling/biogeochemistry; food chain support.

Recovery opportunities: *Ostreola conchaphila* (native oyster), shore bird feeding habitat.

Management issues: water quality including sedimentation**.**

6. Mudflats

Narrative: Extensive mudflats generally occur in estuaries that have gradually sloping shorelines and are sufficiently large enough to support a extensive open water and low marsh habitats or that are flooded for long periods due to closure of the estuary mouth or reduced tidal flow, presenting development of a vegetated marsh plain. Many estuaries that lack extensive mudflat habitat support functions for shore bird foraging and maintenance of invertebrate biodiversity because tidal channel beds and banks that are exposed at low tide provide similar habitat areas.

Structural features: down slope from low marsh and the marsh plain.

Wetlands: Estuarine Unconsolidated Shore and Unconsolidated Bottom Wetlands, and Estuarine Aquatic Bed Wetland (Irregularly Exposed).

Physical processes: extended periods of inundation prevent vascular plant growth.

Water regime/hydrology: regularly (daily) flooded by high tides.

Salinity: haline.

Dominant/characteristic plant(s): micro-algae, especially diatoms (over 100 species identified at some estuaries in s. CA).

Associated plant(s): at lowest tides, Eelgrass (*Zostera marina*) may be exposed (Estuarine Aquatic Bed Wetland, Irregularly Exposed) if present in estuary; macroalgae (e.g., *Ulva* spp.).

Characteristic animals: invertebrates: crabs, shrimp, clams, etc. (some are listed above regarding intertidal creeks] and shorebirds.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; nitrogen fixation by microalgae, sediment accumulation (and P removal), nutrient cycling, denitrification, invertebrate habitat, shorebird foraging.

Recovery opportunities: shorebird feeding habitat.

Management issues: mudflat is a very limited in most southern California estuaries. Sedimentation elevates the mudflat to levels that can support vascular plants; once vascular plants are established, the habitat is less suitable for shorebird feeding.

7. Hyperhaline Salt Flats

Narrative: Whereas intertidal mudflats occur at low elevations, permanently hypersaline salt flats are an important part of continuum from upland to low marsh. Salt flats but generally form only when the elevational gradient of the marsh plain is sufficient low for this evaporate zone to form at the higher levels of infrequent tidal inundation. As with restoration of all tide influenced habitats, establishment of hyperhaline salt flat and adjacent euryhaline marsh habitats require careful consideration of elevation, frequency and duration of inundation, and substrate texture. Salt flats alternate between flooded and drought conditions, which prevent most plants from occurring or from developing closed canopies if they are present. The open flat, with an occasional subshrub (e.g., *Arthrocnemum* (*Salicornia*) *subterminale*), offers certain shore birds a rare habitat that allows both feeding and refuge from predators.

Structural features: shallow depressions of upper marsh plain, banks, upper tidal deltas

Wetlands: Estuarine Unconsolidated Shore (Irregularly Flooded)

Physical processes: Estuarine processes including tidal hydraulics; geochemical processes including formation of evaporate deposits; salt concentration so that soils prevent invasion by exotic plants.

Water regime/hydrology: irregularly flooded by tides; < 25% of high tide.

Salinity: hyperhaline **-** 200 g/L or more in dry season.

Dominant/characteristic plant(s): none; scattered *Arthrocnemum subterminale.*

Associated plant(s): none.

Characteristic animals: Staphylinid beetles; shorebirds use these areas as refugia.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; resting and foraging areas for migratory birds, especially during high tides when other habitats are inundated.

Recovery opportunities: Tiger beetles (?); Elegant Tern (*Sterna elegans*) roosting habitat.

Management issues: Naturally occurring salt flat habitats, such as along the margins of estuarine deltas, were often some of the first areas filled in and developed in southern California estuaries. The Ballona Ecosystem supports habitat on dredge spoil in areas that were previously lower elevation habitats on the marsh plain. Preservation of salt plat habitat and functions may require relocation of the habitat if existing conditions are altered as part of a restoration plan.

Habitat Category III
Estuarine vegetated wetlands:

8. Aquatic Bed Wetlands

Narrative: This habitat category as described herein includes a number of different types depending on the structure of the habitat and the dominant organism, such as algae, bluegreen algae, vascular plants, etc. For example, nutrient-rich, estuarine channels are likely to be dominated by floating *Enteromorpha intestinalis* whereas nutrient-rich, exposed mud flats may be characterized by *Enteromorpha clathrata.* Lagoons, channels, and flooded marsh depressions with haline salinities may support dense, submersed colonies of *Ruppia maritima,* whereas similar areas that are mixohaline are likely to be characterized by *Ruppia cirrhosa* and other vascular aquatic-bed species.

Structural features: depressions in marsh plain, intertidal and subtidal channels, lagoons, and bays; haline vernal wetlands.

Wetlands: Estuarine Aquatic Bed Algal; Estuarine Aquatic Bed Rooted Vascular.

Physical processes: Estuarine processes including hydraulics.

Water regime/hydrology: variable depending on class of wetland and type of estuarine system; includes permanently flooded, semi-permanently flooded; intermittently exposed, regularly flooded, irregularly flooded.

Salinity: haline; mixo-haline.

Dominant/characteristic plant(s): Algae – various species represented including Enteromorpha, *Ulva*, *Porphyra*, etc, but many examples are not large enough or provide a dense enough cover to warrant distinction as a wetland type; Rooted vascular plants – various species depending on conditions, including *Ruppia maritima* (haline or euryhaline) and *Potamogeton pectinatus*, *Ruppia cirrhosa*, and *Zannichellia palustris* (mixohaline). Floating vascular plants – e.g., *Lemna gibba* (mixohaline).

Associated plant(s): as noted above or various emergent species in adjacent wetlands.

Characteristic animals: food and habitat for aquatic invertebrate species and for small fish species, including Tidewater Goby (*Eucyclogobius newberryi*) under mixohaline conditions.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; food chain support for waterfowl such as dabbling ducks; bio-assimilation of nutrient pollution; nutrient cycling/biogeochemistry; N and P removal.

Recovery opportunities: Mixohaline (i.e., brackish) environments that support *Ruppia cirrhosa* are frequently habitat for populations of Tidewater Goby (*Eucyclogobius newberryi)*, a federal endangered and state fish of concern.

Management issues: water quality.

9. Cordgrass (Low) Marsh

Narrative: Low salt marsh is regularly and daily inundated by tides and is dominated by California Cordgrass (*Spartina foliosa*) that forms dense monotypic stands, primarily along channel edges and adjacent to mudflats. At its lower elevation, cordgrass intergrades with mudflat habitat; at its upper elevation it intergrades with a mosaic of mid-marsh species. California Cordgrass is a highly productive species. It decomposes to form the base of the detrital food chain that supports many lower order estuarine consumers. The tall canopy provides cover for birds such as Curlew and Pintail Duck, which forage during migration.

Many of the animals of the low marsh are adapted to periods of frequent inundation. These include California horn snail, Lined Shore Crab *(Pachygrapsus crassipes)*, Yellow Shore Crab *(Hemigrapsus oregonensis)*, and Fiddler Crab *(Uca crenulata)*. The best-studied animal of the low marsh is the federal and state-endangered Light-footed Clapper Rail (*Rallus longirostrus levipes*). This species generally nests in the cordgrass that grows in the low marsh and feeds on fishes and crustaceans in adjacent tidal creeks. It also nests in pickleweed on the marsh plain and in bulrushes in brackish marsh vegetation.

Structural features: lower edge of the marsh plain, tidal channel margins

Wetlands: Estuarine Emergent Persistent Wetland (Regularly Flooded)

Physical processes: Estuarine processes including tidal hydraulics; sediment accumulation.

Water regime/hydrology: regular (daily) flooding by tides

Salinity: hypersaline and saline to brackish

Dominant/characteristic plant(s): *Spartina foliosa;* also patches of *Batis maritima.*

Associated plant(s): *Salicornia bigelovii.*

Characteristic animals: *Pachygrapsus crassipes; Hemigrapsus oregonensis; Uca crenulata;* California Horn Snail (*Cerithidea californica).*

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; sediment accumulation and reduced erosion along channel edges; nutrient cycling/biogeochemistry; N and P removal; C sequestration; high rates of primary productivity and food web support; invertebrate habitat; fish habitat when flooded by tide water.

Recovery opportunities: *Spartina foliosa* (where it previously existed or to compensate for areas where its population is declining); Light-footed Clapper Rail (Fed. & State endangered bird).

Management issues: potential impacts from native and introduced predators of marsh nesting birds (Light-footed Clapper Rail); excessive sedimentation.

10. Marsh Plain (Middle Marsh)

Narrative: Intermediate elevations within the salt marsh are inundated irregularly by tides but at a greater frequency than are higher elevations. As a result, the plant species that inhabit this elevation are adapted to occasional prolonged inundation. The dominant plant is Pickleweed [*Sarcocornia pacifica* (*Salicornia virginica*)] a perennial with the broadest elevation range of all salt marsh species. Other common mid-marsh species include Saltwort (*Batis maritima*), Arrow-grass (*Triglochin concinnum*), Estero Sea-blite (*Suaeda esteroa*), and Jaumea (*Jaumea carnosa*). An important feature of the marsh plain is its topographic heterogeneity, which includes creeks, creek banks, levees, and shallow depressions. The creeks provide habitat for Longjaw Mudsucker (*Gillichthys mirabilis*);

creek levees tend to support more plant species than the plain (e.g., Estero Sea-blite is especially abundant near creeks), and the shallow depressions (5-10 cm) tend to reduce biomass of perennial pickleweed. When this dominant is subdued, the annual pickleweed (*Salicornia bigelovii*) can establish and persist. Deeper depressions (≥10 cm) retain tidal water and become feeding oases for the California Killifish (*Fungulus parvipinnus*); shallow depressions develop algal growths that support dense populations of invertebrates that are suitable prey for fish.

The animals of the mid-marsh are abundant and diverse. Food is abundant in the form of algae and vascular plant detritus. Animals that feed directly on algae include Ephydrid flies, amphipods, and snails such as the Olive Snail (*Melampus olivaceus*) in marsh vegetation and California Horn Snail (*Cerithidea californica*) in open flats and channels. A variety of birds forage in the mid-marsh, especially during higher tides when mudflats are under water, including Willet *(Catotrophorus semipalmatus)*, Marbled Godwit *(Limosa fedoa)*, Long-billed Curlew *(Numenius americanus)*, Great Blue Heron *(Ardea herodias)*, and Great Egret *(Ardea alba)*. The state endangered Belding's Savannah Sparrow *(Passerculus sandwichensis beldingii)* inhabits the marsh plain where it prefers to nest in pickleweed in mid and high marsh conditions.

Structural features: mid-marsh plain, rivulets, tidal pools, creek-side levees and back-levee depressions.

Wetlands: Estuarine Emergent Persistent Wetland (Irregularly Flooded).

Physical processes: estuarine processes including tidal hydraulics and maintenance of sediment and elevation.

Water regime/hydrology: irregularly flooded by tides (ca. 50% of high tides).

Salinity: saline to hypersaline.

Dominant/characteristic plant(s): *Sarcocornia pacifica* (*Salicornia virginica*).

Associated plant(s): *Frankenia salina*, *Jaumea carnosa*, *Distichlis spicata*, *Suaeda esteroa, Triglochin concinna.*

Characteristic animals: *Fundulus parvipinnis* (California Killifish); *Melampus* olivaceus; polychaetes; oligochaetes.

Ecosystem functions: plant diversity support (the mash plain is potentially diverse in native halophytes), habitat for rare, endangered, and special interest species; insect support, nutrient cycling/biogeochemistry; N and P removal; primary productivity and detrital food web support.

Recovery opportunities: Belding's Savannah Sparrow (State endangered bird); Long-billed Curlew (*Numenius americanus*); Estero Seep-weed (*Suaeda esteroa*); Northern Harrier (*Circus cyaneus*).

Management issues: sedimentation (increase in elevation and loss of shallow depressions that form pools and create feeding oases, or erosion (decrease in elevation); potential impacts to marsh nesting birds (Belding's Savannah Sparrow).

11. High Marsh (clay/mud or sand/loam substrates)

Narrative: High marsh habitats are irregularly to intermittently inundated by tidal water and generally range from saline to hypersaline conditions. Plants that comprise the high marsh include the Parish's Glasswort [*Arthrocnemum subterminale* (*Salicornia subterminalis*)], Shoregrass (*Monanthochloe littoralis)*, Alkali Heath (*Frankenia salina*), and Sea Lavender *(Limonium californicum)*. The vegetation varies depending on the drainage and density of the soil (i.e., ratio of clay to sand), which often is correlated with salinity. Vegetation in dense, hypersaline (salinity greater than seawater) or euryhaline (fluctuating salinity, seasonal hypersalinity) is quite different than loose, sandy soils. The endangered Salt Marsh Bird's Beak *(Cordylanthus maritimus* spp. *maritimus)* occurs in high marsh and is more abundant in sandy soils. Likely the open canopies of sandy areas allow seeds to germinate after rainfall while also offering roots for this hemiparasite to parasitize. High marsh vegetation provides habitat for Belding's Savannah Sparrow, staphylinid beetles, the snail *Assiminea transluscens*, and other estuarine restricted species.

Structural features: upper marsh plain, slopes of berms and banks; upper tidal deltas.

Wetlands: Estuarine Emergent Persistent Wetland (Irregularly Flooded).

Physical processes: Estuarine processes including tidal hydraulics; also Aeolian-influenced processes if adjacent to dune systems, or fluvial-influenced if on a delta.

Water regime/hydrology: Irregularly flooded by tides (< 50% of high tides.

Salinity: saline, hyperhaline, euryhaline.

Dominant/characteristic plant(s): *Arthrocnemum subterminale*; *Monanthochloe littoralis.*

Associated plant(s): *Sarcocornia pacifica, Limonium californicum, Distichlis spicata, Spergularia macrotheca, Atriplex watsonii, Frankenia salina*

Characteristic animals: *Asiminea transluscens* (snail); Belding's Savannah Sparrow; Cottontail; Ground Squirrels.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; high tide refuge for Light-footed Clapper Rail and Belding's Savannah Sparrow.

Recovery opportunities: Light-footed Clapper Rail (Fed. & State endangered bird); Belding's Savannah Sparrow (State endangered bird); Northern harrier (*Circus cyaneus*) foraging habitat; *Cordylanthus maritimus* ssp. *maritimus* (Fed. & State endangered plant)

Management issues: Loss of historic habitat due to filling and development. Vulnerable to invasion by many introduced invasive plant species including introduced species of *Limonium* (Sea Lavender), are less likely to invade lower elevations habitats, and introduced grass species such as Rabbit's Foot Grass (*Polypogon monspeliensis*), Sicklegrass (*Parapholis incurva*), Italian Ryegrass (*Lolium multiflorum*) because it is rarely tidal and can have very low salinities at least seasonally.

12. High Marsh Transition Zone (including Euryhaline and Hyperhaline Habitats)

Narrative: The transition zone represents that area where the halophytic and hydrophytic salt marsh vegetation overlaps with upland communities. Storm-surge high tides may flood habitats transitional to upland habitats, including various palustrine wetlands adjacent to high marsh estuarine wetlands; however, they are generally considered to be located beyond the limits of estuarine wetlands, but within the more broadly defined "estuarine" ecosystem (e.g., the Ballona Ecosystem). At relatively undisturbed southern California estuaries, examples of Estuarine Scrub Shrub Wetland may occur in the transition zone and may include Boxthorn *(Lycium californicum)*, Bush Seepweed *(Suaeda nigra)*, Coast Golden Bush (*Isocoma menziesii*), Parish's Glasswort (*Arthrocnemum subterminale*), and Quail Bush (*Atriplex lentiformis*). These overlap with the highest elevation salt marsh species including, for example, Saltgrass *(Distichlis spicata)*, Alkali Weed *(Cressa truxillensis)*, and Shoregrass *(Monanthochloe littoralis)*. *Lycium* is a common perch for birds and various small mammals burrow under it. The fact that it is deciduous shrub that greens up whenever there is water available makes it an indicator of sewage spills or other off-season sources of water.

The animals of the higher elevations of the transition zone are primarily terrestrial species. Those associated with shrubby uplands such as portions of the transition zone include, for example, various species of snakes, lizards, small mammals and birds. Herpetofauna may include California Kingsnake *(Lampropeltis getulus californiae)*, San

Diego Gopher Snake *(Pituophus melanoleucus annectens)* and side-blotched lizard *(Uta stansburiana)*. Common mammals of the shrub-dominated uplands include Western Harvest Mouse *(Reithrodontomys megalotis)*, Deer Mouse *(Peromyscus maniculatus)*, Pocket Gopher (*Thomomys* sp.), Opossum *(Didelphis virginianus)*, Striped Skunk (*Mephitis mephitis)*, and California Ground Squirrel *(Spermophilus beechyi)*. The small mammals are preyed upon by a variety of birds including Short-eared Owl *(Asio flammeus)*, Northern Harrier *(Circus cyaneus)*, and White-tailed Kite *(Elaneus caeruleus)*. Ground-nesting bees that pollinate Salt Marsh Bird's-Beak (*Cordylanthus maritimus* spp. *maritimus*) live above the high tide in this habitat. Boxthorn (*Lycium californicum*) offers a tall perch site for various birds, and its thorns can deter human intrusion.

One of the more interesting habitats is the euryhaline zone with fluctuating salinities between wet season low salinities and dry season hypersaline conditions. The habitat is characterized by winter annual plant species such as Salt Marsh Daisy (*Lasthenia glabrata* ssp. *coulteri*), Salt Marsh Sand-sperry (*Spergularia marina*), Toad Rush (*Juncus bufonius*), and Hutchinsia (*Hutchinsia procumbens*), which are adapted to the fluctuating salinities. The euryhaline zone is generally located upslope from hyperhaline salt flats and down-slope from nontidal palustrine wetland or grassland habitats and is perhaps the habitat most representative of Mediterranean climate estuarine wetlands.

The transition zone may also include nontidal palustrine habitats both salt influenced and non-saline types. Seeps from perched water tables on deltas and the toe of slopes and along dune transitions often support a variety of palustrine emergent and scrub-shrub types. Characteristic non-saline or slightly brackish species may include shrubs such as Mule Fat (*Baccharis salicifolia*) and herbaceous species such as spiny-rush (*Juncus acutus*), Willow-Dock (*Rumex salicifolia)*, and Alkali Ryegrass (*Leymus triticoides*). Seasonal palustrine wetlands also occur in this area, especially in low-gradient deltaic deposits and may include salt-influenced types supporting a variety of native annual species such as Alkali Barley (*Hordeum depressum*). Belding's Savannah Sparrows use the taller shrubs of this habitat during the non-nesting season.

Structural features: alluvial plain, upper deltas, banks.

Wetlands: Estuarine Emergent Persistent and Nonpersistent Wetland (Irregularly Flooded); Estuarine Scrub Shrub Wetland (Broadleaved Deciduous and Evergreen).

Physical processes: estuarine processes including tidal hydraulics; fluvial-influenced if on a delta; geochemical processes including formation of evaporate deposits.

Water regime/hydrology: (irregularly flooded by tides; i.e., < 20% of tides); and adjacent storm-tide influenced wetlands, palustrine wetlands, and uplands.

Salinity: fluctuating from mixohaline and saline to hyperhaline (more saline than sea water) and euryhaline (fluctuating salinity) and upslope to potentially non-haline.

Dominant/characteristic plant(s): *Arthrocnemum subterminale, Monanthochloe littoralis, Lycium californicum.*

Associated plant(s): winter annuals including *Spergularia marina*, *Juncus bufonius, Hordeum depressum, Lasthenia glabrata* ssp. *coulteri, Hutchinsia procumbens.*

Characteristic animals: (see animals discussed above regarding the high marsh habitat).

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; foraging areas for upland animals; resting areas for migratory birds; high tide refuge for Light-footed Clapper Rail; pollination support.

Recovery opportunities: *Lasthenia glabrata coulteri* (CNPS rare); *Hutchinsia procumbens* (locally extirpated); Tiger beetles (?); Northern Harrier (*Circus cyaneus*) foraging areas.

Management issues: Loss of historic habitat due to filling and development. Vulnerable to colonization by many introduced invasive plant species. This transitional habitat [and the high marsh as noted above] is highly susceptible to invasive species such as Rabbit's Foot Grass (*Polypogon monspeliensis*), Sicklegrass (*Parapholis incurva*), Italian Ryegrass (*Lolium multiflorum*), and other grasses because it is rarely tidal and can have very low salinities at least seasonally, especially during unusually wet winters and in areas that receive substantial anthropogenic freshwater inputs.

13. Brackish Marsh (and associated Open Water Habitat)

Narrative: Sites where freshwater mixes with saline seawater produce brackish conditions with intermediate salinities. This phenomenon is less frequent in southern California where many estuaries are less influenced by runoff from rainfall than in more northerly latitudes. In southern California, brackish sites vary seasonally, with dilution during the wet season and concentration of salts during the dry season. Local influence from seeps and springs and seasonally impounded stream and river-mouths can produce brackish environments that support emergent vegetation characterized, for example, by Prairie Bulrush [*Bolboschoenus* (*Scirpus*) *maritimus*], and Southern Cattail (*Typha domingensis*), and aquatic bed species including (*Potamogeton pectinatus)* and Ditchgrass (*Ruppia* spp.). The biggest difference in plant composition between brackish and salt marshes is often at the lower elevations in the marsh -- higher elevation areas of Mediterranean-climate brackish marshes tend to be similar to the mid-marsh plain or high marsh habitats of salt marshes. Tidewater Goby (*Eucyclogobius newberryi),* a Federal listed endangered species, occurs in systems or habitats within systems characterized by brackish water conditions.

Structural features: channels, depressions, basins, seeps and springs.

Wetlands: Estuarine Emergent Persistent and Nonpersistent Wetland (Semi-permanently Flooded); estuarine Aquatic Bed Wetland (Floating and Rooted Vascular; Algal).

Physical processes: Estuarine processes including tidal hydraulics; also fluvial-influenced if associated with a river channel and artesian-influenced if associated with seeps or springs from groundwater.

Water regime/hydrology: Tidally influenced with a wide range of tidal inundation frequencies depending on elevation and distance from the tidal inlet; seasonal dilution from surface water (runoff).

Salinity: brackish (mixohaline).

Dominant/characteristic plant(s): Prairie Bulrush [*Bolboschoenus* (*Scirpus*) *maritimus*]*;* California Bulrush, Tule [*Schoenoplectus* (*Scirpus*) *californicus*]; American Bulrush [*Schoenoplectus* (*Scirpus*) *americanus*]; Southern Cattail (*Typha domingensis*).

Associated plant(s): Salt Marsh Bulrush [*Bolboschoenus* (*Scirpus*) *robustus*] (unknown from Ballona?); Spiny Rush (*Juncus acutus*).

Characteristic animals: rails; bittern; wrens, Redwing Blackbird.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; biofiltration of freshwater runoff; nutrient cycling/biogeochemistry; N and P removal; C sequestration; sediment accumulation; very high rates of primary productivity in the lower portions of brackish and freshwater marsh areas; food web support.

Recovery opportunities: Light-footed Clapper Rail (Fed. & State endangered); Tidewater Goby (threatened); Brackish Water Snail (*Tyonia imitator*).

Management issues: Influence of stormwater runoff on formation of and impacts to brackish marshes; water quality; excessive sedimentation from upstream disturbances.

Habitat Category IV
Palustrine Nontidal Wetlands:

14. Transitional Emergent Wetlands (delta distributaries and margins of estuaries)

Narrative: The toe of slopes along estuary margins often provide opportunities for the formation of fresh or brackish water seeps and springs, including examples with well-developed dune fields containing freshwater lenses, deltas of rivers with shallow aquifers, and alluvial fans with artesian wells. These features can be the sites of estuarine brackish marshes and palustrine freshwater marshes. They also can support the development of palustrine emergent wetlands that are transitional in nature and similar to habitat type No 12 – High Marsh Transition Zone, but are distinctly palustrine and adjacent to estuarine habitats within coastal ecosystems.

Structural features: margins of dunes, deltas, banks, bluffs, alluvial fans and plains.

Wetlands: Palustrine Emergent Persistent Wetland.

Physical processes: Fluvial and/or groundwater hydrology.

Water regime/hydrology: (Permanently?), seasonally, temporarily, or intermittently saturated; temporarily or intermittently flooded.

Salinity: Freshwater to euryhaline. Due to brackish nature of water, salt spray, or rare storm-tide influences, or even concentration of salts by plants, soil salinity may increase during dry periods and may include formation of surface precipitates.

Dominant/characteristic Plant(s): Alkali Ryegrass (*Leymus triticoides*); Saltgrass (*Distichlis spicata*); Western Goldenrod (*Euthamia occidentalis*); Salt Marsh Baccharis (*Baccharis douglasii*).

Associated plant(s): Alkali Barley (*Hordeum depressum);* Seaside Heliotope (*Heliotropium curassavicum);* Coast Golden Bush (*Isocoma menziesii);* Western Sea-Purslane (*Sesuvium verrucosum);* Common Sedge (*Carex praegracilis*); Yerba Mansa (*Anemopsis californica*); Baltic Rush (*Juncus balticus*); Small-leaved (Petunia parvifolia); Sticky Conyza (*Conyza coulteri*).

Characteristic animals: small mammals including voles, harvest mice, field mice, gophers; herpetofauna.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; hydrology (seasonally saturated, temporarily flooded).

Recovery opportunities: foraging habitat for White-tailed Kite and other raptors; potential habitat for Ventura Marsh Milk-vetch (*Astragalus pycnostachys* var. *lanosissimus* - Fed and State listed endangered plant); Wandering Skipper (butterfly); Southern Salt Marsh Shrew (*Sorex ornatus salicornicus*).

Management issues: invasion by Giant reed (*Arundo donax*) and Myoporum (*Myoporum laetum*).

15. Freshwater Marsh

Narrative: Freshwater marshes occur in saturated, organic rich or sometime mineral soils. The dominant plants are generally emergent monocots such as cattails (*Typha* spp.) and bulrushes [e.g., *Schoenoplectus (Scirpus) californicus*], although aquatic-bed species, such as pondweeds (*Potamegeton* spp.), may also be common. Redwing Blackbirds (*Agelaius phoeniceus*) and Marsh Wrens (*Cistithorus palustris*) commonly breed in the tall, dense vegetation. Common mammals include Raccoon (*Procyon lotor*), Striped Skunk and Opossum. Freshwater marsh habitat may also support the Light-footed Clapper Rail, although this is not considered optimal breeding or foraging habitat. These marshes may provide refugia for rails and other bird species during extreme high tides and rive floods. Creation and maintenance of freshwater marsh habitat is dependent upon a continual source of freshwater. Some coastal wetland restoration plans have incorporated freshwater and brackish marshes due to historical evidence of springs adjacent to intertidal areas

Structural features: river and stream channels; ponds; seeps and springs

Wetlands: Riverine Nonpersistent Emergent Wetland; Palustrine Emergent Persistent Wetland (Permanently or Semi-permanently Flooded, Irregularly Exposed).

Physical processes: Fluvial and/or groundwater.

Water regime/hydrology: Permanently flooded; intermittently flooded; seasonally flooded; permanently and seasonally saturated.

Salinity: fresh water to slightly brackish (groundwater conditions).

Dominant/characteristic Plant(s): Broadleaved Cattail (*Typha latifolia*); Bur-reed (*Sparganium eurycarpum*); California Bulrush (*Schoenoplectus californicus*); Southern Cattail (*Typha domingensis*).

Associated plant(s) - Representative: Basket Rush (*Juncus textilis*); Spiny Rush (*Juncus acutus*); Spike-rush (*Eleocharis spp*.), Hooker's Evening Primrose (*Oenothera elata* ssp. *hookeri*); Horsetails – Common Scouring Rush (*Equisetum hyemale* ssp. *affine*), Smooth Scouring Rush (*E. levigatum*), Giant Horsetail (*E. telmateia*); Western Goldenrod (*Euthamia occidentalis*); Willow Dock (*Rumex salicifolius* vars. *crassus*); Willow Herb (*Epilobium ciliatum* ssp. *ciliatum*); Yerba Mansa (*Anemopsis californica*); American Bulrush (*Schoenoplectus americanus*); Three-square Bulrush (*Schoenoplectus pungens*); Cinquefoil (*Potentilla anserina*); Monkey-flower (*Mimulus guttatus*).

Characteristic animals: Western Pond Turtle, Red-legged Frog; rails, waterfowl, Red-winged Blackbird (*Agelaius phoeniceus*); many passerine birds.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; nutrient cycling/biogeochemistry; N and P removal; C sequestration; sediment accumulation; high rates of primary productivity; habitat for breeding birds.

Recovery opportunities: Western Pond Turtle (*Clemmys marmorata*); California Red-Legged Frog (*Rana aurora draytonii*); Light-footed Clapper Rail and other rail species known to use freshwater marshes adjacent to estuaries in southern California; Least Bittern (*Ixobrychus exilis*); Northern Harrier (*Circus cyaneus*); Spiny Rush (*Juncus acutus*).

Management issues: excessive sedimentation; subject to shrub invasion (e.g., willow invasion). Sites that are less frequently flooded can have substantial problems with non-native grasses such as Rabbitsfoot Grass. Also, Giant Reed and Pampas Grass are large perennial grasses that can be problematic.

16. Seasonal Palustrine Wetlands (including Haline Vernal Wetlands)

Narrative: Seasonal wetlands are non-tidal wetlands and transitional habitats that are flooded to varying degrees by seasonal rainfall and runoff. If there are sufficient salts in the soil, the seasonal wetland may support plant species more typical of coastal salt marsh, such as Pickleweed [*Sarcocornia pacifica* (*Salicornia virginica*)], Saltgrass (*Distichlis spicata*), and Alkali Weed (*Cressa truxillensis*). If the soils do not contain salts or alkaline substances, the seasonal wetlands may support freshwater marsh species and a mixture of weedy opportunists. "Vernal pools" and saline vernal wetlands of transition zones can occur on alluvial and deltaic deposits adjacent to estuarine habitats and are known to support special concern plants and invertebrate animals (e.g., fairy shrimp species).

Seasonal wetlands can be important to a number of bird species that feed on the insects, algae and aquatic invertebrates that develop in these temporary habitats. Amphibians, such as western toad (*Bufo boreas*) and Pacific Tree Frog (*Pseudacris regilla*) have been noted to breed in this habitat. These areas also attract mammals, such as Coyote, Raccoon, Striped Skunk and Opossum. In areas where water pools deeply enough, waterfowl species such as Mallard (*Anas platyrhynchos*), Cinnamon Teal (*Anas cyanoptera*) and American Coot (*Fulica Americana*) have been observed. Seasonal wetlands may also used by shorebirds such as Killdeer (*Charadrius vociferus*) and Black-necked Stilts (*Himantopus mexicanus*).

Structural features: depressions in deltas and fill deposits often associated with other palustrine wetlands adjacent to estuarine wetlands

Wetlands: Palustrine Emergent Wetland, persistent and non-persistent types, seasonally flooded and generally euryhaline

Physical processes: natural examples influenced by fluvial and coastal (storm) processes and anthropogenic effects from disturbances including infilling, dredging, grading, etc.

Water regime/hydrology: Seasonally flooded

Salinity: Fresh water or euryhaline (low salinity when flooded and higher salinity when dry)

Dominant/characteristic Plant(s): Haline vernal wetland examples – Alkali Barley (*Hordeum depressum*); Pickleweed (*Sarcocornia pacifica*); Salt Marsh Daisy (*Lasthenia glabrata* ssp. *coulteri*); Salt Marsh Sand-Sperry (*Spergularia marina*); Toad Rush (*Juncus bufonius* ssp. *halophilus*?). Freshwater examples – Meadow Barley (*Hordeum brachyantherum* ssp. *brachyantherum).*

Associated plant(s): Alkali Mallow (*Malvella leprosa*); Alkali Weed (*Cressa truxillensis*); Sea-Purslane (*Sesuvium verrucosum*); Horned Sea-blite (*Suaeda calceoliformis*); Seaside Heliotrope (*Heliotropium curassavicum*); Slim Aster (*Symphyotrichum subulatum*); Sticky Conyza (*Conyza coulteri*).

Characteristic animals: planktonic (e.g., rotifers, crustaceans including copepods, cladocerans) and macroscopic (e.g., aquatic insect larvae) invertebrates.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; shorebird foraging habitat.

Recovery opportunities: Silver Scale (*Atriplex argentea* var. *mohavensis*) (extirpated?); Hutchinsia (*Hutchinsia procumbens*) (extirpated?); Southern Tarweed (*Centromadia. parryi* ssp. *australis*); fairy shrimp species?

Management issues: impacts (e.g., cover and thatch) from introduced annual weeds including Brass Buttons (*Cotula coronopifolia*), Mediterranean Barley (*Hordeum marinum*), Italian Ryegrass (*Lolium multiflorum*), Rabbitsfoot Grass (*Polypogon monspeliensis*), and Sicklegrass (*Parapholis incurva*).

17. Palustrine Scrub/Shrub Wetland (= DFG "Riparian Scrub")

Narrative: Willow scrub is characterized by dense broad-leafed, winter-deciduous riparian thickets dominated by several willow shrub and tree species (*Salix* spp.). Riparian trees also may occur with the association and may include, for example, scattered Fremont's Cottonwood (*Populus fremontii*), and Western Sycamore (*Platanus racemosa*). Riparian woodland also may occur in small groves or in riverine corridors that drain into estuaries. As with other riparian habitats, riparian scrub supports a diverse assemblage of wildlife species, especially passerine bird species. The endangered Least Bell's Vireo (*Vireo bellii pusillus*) and Southwestern Willow Flycatcher (*Epidonax traillii extimus*) as well as other sensitive species, such as Yellow Warbler (*Dendroica petechia brewsteri*) and Yellow-breasted Chat (*Icteria virens*) all depend on riparian woodlands for breeding. Mammal assemblages are similar to those found in freshwater marsh habitats as the two often intergrade. In an undisturbed estuarine system, willow scrub habitat would generally occur upstream of tidal influence as willows are very sensitive to salt. Like freshwater marsh, this habitat is dependent upon a constant source of freshwater.

Structural features: bluff and dune seeps or spring, floodplains.

Wetlands: Palustrine Scrub/Shrub Wetland (Broadleaved Deciduous and Evergreen).

Physical processes: fluvial and/or groundwater hydrology; sediment transport.

Water regime/hydrology: seasonally and permanently saturated; temporarily flooded; phreatophytic.

Salinity: fresh water.

Dominant/characteristic Plant(s): Arroyo Willow (*Salix lasiolepis*); Mule Fat (*Baccharis salicifolia*); Sandbar Willow (*Salix exigua*).

Associated plant(s): Basket Rush (*Juncus textlis*); California Rose (*Rosa californica*); Coyote Brush (*Baccharis pilularis*); Salt Marsh Baccharis (*Baccharis douglasii*); American Dogwood (*Cornus sericea* ssp. *occidentalis*)?; Hoary Nettle (*Urtica dioica* ssp. *holosericea*).

Characteristic animals: resident and migratory passerine birds, such as Common Yellowthroat (*Geothlypis trichas*) and Blue grosbeack (*Guiraca caerulea*), and those listed herein (habitat no. 18); herpetofauna and mammals of various guilds.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; refuges for estuarine wildlife species and wildlife corridors linking upland sites with coastal wetlands.

Recovery opportunities: Least Bell's Vireo (*Vireo bellii pusillus*) and Southwestern Willow Flycatcher (*Epidonax traillii extimus*) as well as other sensitive species, such as Yellow Warbler (*Dendroica petechia brewsteri*) and Yellow-breasted Chat (*Icteria virens*).

Management issues: Impacts from invasive plant species including Giant reed (*Arundo donax*), Pampas Grass (*Cortaderia selloana*); Myoporum (*Myoporum laetum*).

18. Palustrine Forested Wetland (= DFG "Riparian Woodland"?)

Narrative: Palustrine Forested Wetland as discussed herein is generally characterized by isolated stands of trees or tall shrubs that occur at seeps, toe-of-slopes, ponded areas, along streams and rivers, and at other sites with shallow water tables. Arroyo Willow (*Salix lasiolepis*) is the most common representative but other native species such as additional willow species, Black Cottonwood (*Populus balsamifera* ssp. *trichocarpa*), and Western Sycamore (*Platanus racemosa*) are also represented. Riparian corridors along streams and rivers are no longer well developed due to impacts from urbanization, but portions of the original drainage of Centinela Creek still support riparian vegetation. In the riparian setting, trees in upland and wetland habitats may be included in mapped examples of this vegetation where the distinction among hydric (i.e., wetland), mesic, and xeric (i.e., upland) types of riparian vegetation are often not distinguished. A number of exotic species also may be represented including Myoporum (*Myoporum laetum*) and various species of *Eucalyptus,* especially Blue Gum (*Eucalyptus globulus*).

Structural features: bluff seeps, floodplains, margins of dunes and dune swales.

Wetlands: Palustrine Forested Broadleaved Deciduous Wetland.

Physical processes: fluvial and/or groundwater hydrology; sediment transport.

Water regime/hydrology: permanently, seasonally, temporarily, or intermittently flooded; permanently, seasonally saturated; phreatophytic.

Salinity: freshwater.

Dominant/characteristic Plant(s): Black Cottonwood (*Populus balsamifera* ssp. *trichocarpa*); Western Sycamore (*Platanus racemosa*); Arroyo (*Salix lasiolepis*).

Associated plant(s): Blue Elderberry (*Sambucus mexicana*); Coast Live Oak (*Quercus agrifolia*); White Alder (*Alnus rhombifolia*); Red Willow (*Salix laevigata*); Shining Willow (*Salix lucida* ssp. *lasiandra*); Black Willow (*Salix goodingii*); California Walnut (*Juglans californica*); various riparian shrubs and vine species and herbaceous plants including Stinging Nettle (*Urtica dioica* ssp,. *holosericea*).

Characteristic animals: Passerine birds including resident and migratory birds such as those sensitive species listed below; herpetofauna; shelter and corridor for mammals including raccoon, skunk, and coyote.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; breeding bird habitat.

Recovery opportunities: Southwestern Willow Flycatcher (*Empidomax trallii extimus*); Least Bell's Vireo (*Vireo belli pusillus*); Western Yellow Warbler (*Dendroica petechia brewsteri*); Yellow-breasted Chat (*Icteria virens*).

Management issues: vulnerable to invasion by Giant Reed (*Arundo donax*) and various exotic vines (e.g. Cape Ivy), shrubs (Tamarisk), and tree species (e.g., *Eucalytus* spp.); restore connectivity of stands when appropriate and feasible.

Habitat Category V
Upland Habitats:

19. Grasslands (= DFG Non-native Herbaceous Vegetation)

Narrative: Grasslands are illustrated on historic maps of the Ballona region and are likely to have occurred on alluvial deposits on the periphery of the coastal wetland ecosystem, mixed with various forms of coastal scrub. DFG recently used the designation "non-native herbaceous" for the category of vegetation that represents the existing conditions of "grassland", "meadow", or "prairie" vegetation within the Ballona Ecosystem. In a restored state, the vegetation could include native grass species and a diverse number of native herbaceous and sub-shrub species as noted above, with small colonies and scattered individuals of coastal scrub species to provide perches and shelter for animals that characterize grassland and adjacent scrub and wetland habitats.

Structural features: upland alluvial deposits, graded spoil deposits,

Physical processes: potentially a fire-maintained community.

Dominant/characteristic Plant(s): in an upland context - California Barley (*Hordeum brachyantherum* ssp. *californicum*); Purple Needlegrass (*Nassella pulchra*); Salt Grass (*Distichlis spicata*); Alkali Ryegrass (*Leymus triticoides*).

Associated plant(s): Alkali Heath (*Frankenia salina*); Coast Golden Bush (*Isocoma menziesii*); Common Tarweed (*Dienandra fasciculata*); Telegraph Weed (*Heterotheca grandiflora*); Deerweed (*Lotus scoparius*), Spanish Clover (*Lotus purshianus*), Owl's Clover (*Castilleja exerta*); White Cudweed (*Gnaphalium canescens*); Common Verbena (*Verbena lasiostachys*); California Poppy (*Eschschulzia californica*); Pitseed Goosefoot (*Chenopodium berlandieri*); Arroyo Lupine (*Lupinus succulentus*); Bicolor Lupine (*Lupinus bicolor* var. *microphyllus*); Fascicled Milkweed (*Asclepias fasciculata*); Bush Aster (*Lessingia filaginifolia*); Fiddleneck (*Amsinckia menziesii*); Western Ragweed (*Ambrosia psilostachya*); Gum Plant (*Grindelia robusta*); California Goldenrod (*Solidago californica*); Popcorn Flower (*Cryptantha inermedia*); Miniature Sun Cup (*Camissonia micrantha*); Rattlesnake Weed (*Euphorbia albomarginata*); Pygmy Stonecrop (*Crassula connata*).

Characteristic animals: resident and migratory grassland bird species including Horned Lark; herpetofauna including lizards and snakes, such as California King Snake and Gopher Snake; and small mammals including voles, mice, shrews, and moles.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; host plants for butterfly larvae including the Wandering Skipper Monarch (*Danaus plexippus*) butterflies; habitat for native small mammals; foraging habitat for raptors such as White-tailed Kite and Northern Harrier and egrets (Great Egret) and herons (Great Blue Heron).

Recovery opportunities: South Coast Marsh Vole (*Microtus californicus stephensi*); San Diego Black-tailed Jackrabbit (*Lepus californicus bennettii*); California Horned Lark (*Eremophila alpestris*); White-tailed Kite (*Elanus caeruleus*); Northern Harrier (*Circus cyaneus*).

Management issues: Maintenance of grassland habitat to prevent it becoming coastal scrub (using fire, grazing, or mowing techniques?); control of invasive plant species.

20. Coastal Scrub (including Coastal Bluff Scrub)

Narrative: The general category "coastal scrub" includes a number of shrub-dominated plant communities in the context of a variety of land forms. Coyote Brush and California Sage Brush form colonies on alluvial and disturbed soils and can occur within the context of grassland and other herbaceous vegetation. Upland delta scrub can be quite rich in shrub species and occurs in alluvium adjacent to wetland forms of delta scrub often dominated by Mulefat (*Baccharis salicifolia*). Coastal Bluff Scrub is limited to coastal bluffs where salt tolerant species including Wooly Sea-Blite (*Suaeda taxifolia*) and Quail Bush (*Atriplex lentiformis*) are characteristic but occurs in different forms depending on proximity to salt spray. Within the bluff community, sparsely-vegetated areas or areas with low vegetation also can support a wide variety of herbaceous species, some of which are also associated with coastal dunes. Coastal Dune Scrub is treated separately herein. No Maritime Chaparral occurs in the Ballona Ecosystem.

Other forms of upland coastal scrub include, for example, Delta Scrub and Baccharis Scrub, which can be transitional to wetland scrub types.

A variety of terrestrial animals, including amphibians, reptiles, mammals and birds are supported by coastal scrub habitat. For instance, Coastal Sage Scrub is the preferred breeding habitat of the coastal California Gnatcatcher (*Pilioptila californica californica*).

Structural features: alluvial deposits, berms and banks; coastal bluffs.

Physical processes: fluvial, erosional, (and anthropogenic).

Dominant/characteristic Plant(s): Coyote Brush (*Baccharis pilularis*); California Sagebrush (*Artemisia californica*); *Mugwort (Artemisia douglasiana***);** Quail Bush (*Atriplex lentiformis*); Douglas' Nightshade (*Solanum douglasii*); Lemonade Berry (*Rhus integrifolia*); Seacliff or Dune Buckwheat (*Eriogonum parvifolium*).

Associated plant(s): Laurel Sumac (*Malosma laurina*); Cliff Aster (*Malacothris saxatilis*); Deerweed (*Lotus scoparius*); Black Sage (*Salvia mellifera*); Wild Morning-glory (*Calystegia macrostegia*); Melic Grass (*Melica imperfecta*); Foothill Needlegrass (*Nassella lepida*); California Brome (*Bromus carinatus*); Mock Heather (*Ericameria ericoides*); Bladderpod (*Isomeris arboreus)*; Elderberry (*Sambucus mexicanus*); Wild Cucumber (*Marah macrocarpus*); Giant Ryegrass (*Leymus condenstatus*); California Encelia (*Encelia californica*); Suffrutescent Wallflower (*Erysimum insulare* ssp *suffrutescens*); Coastal Prickly Pear (*Opuntia littoralis*); California Buckwheat (*Eriogonum fasciculaum*); Milk Vetch (*Astragalus trichopodus*); Branching Phacelia (*Phacelia ramosissima* var.

austrolittoralis); Bush Mallow (*Malacothamnus fasciculatus*); Lewis' Evening Primrose (*Camissonia lewisii*); Toyon (*Heteromeles arbutifolia*); Chaparral Nightshade (*Solanus xanti*); Wooly Sea-blite (*Suaeda taxifolia*).

Characteristic animals: Loggerhead Shrike (Lanius ludovicianus) perching; California Gnat Catcher (*Polioptila californica californica*) endangered; resident and migratory passerine birds including Luzuli Bunting (*Passerina amoena*) and Blue Grosbeak (*Guiraca caerulea*); small mammals.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; breeding bird habitat; refuge for resident estuarine birds.

Recovery opportunities: Pacific Pocket Mouse (*Perognathus longimembris pacificus*); Loggerhead Shrike (*Lanius ludovicianus*) perching; California Gnat Catcher (*Polioptila californica californica*) breeding habitat; Suffrutescent Wallflower (*Erysimum insulare* ssp. *suffrutescens*); Lewis' Evening Primrose (*Camissonia lewisii*); Coastal Dunes Milkvetch (*Astragalis tener* var. *titi*).

Management issues: plan for connectivity among sites; invasive species such as Pampas Grass.

21. Coastal Dune Scrub and Dune Herbs (including Foredunes)

Narrative: Dune habitat represents a form of transition zone between the land and the sea and includes Coastal Dune Scrub and Dune Herb vegetation. Coastal dune habitats have been largely lost due to development in southern California. Prior to development, plant species such as dune lupine (*Lupinus chamissonis*), Mock Heather (*Ericameria ericoides*), dune primrose *(Camissonia cheiranthifolia)*, sand verbena *(Abronia maritima)* and dune ragweed *(Ambrosia chamissonis)* stabilized the loose sand, and the dunes where thereby anchored. Following human disturbance, many of the native plants were eliminated and exotics, such as sour-fig *(Carporotus edulis)* and sea rocket *(Cakile maritima)* invaded or were planted.

Dunes are important habitats for several species of rare insects including Globose Dune Beetle *(Coelus globosus)*, the Sandy Beach Tiger Beetle *(Coelus hiticollis gravida)*, and Sand Dune Tiger Beetle *(C. latesignata latesignata)*. The San Diego Horned Lizard and Silvery Legless Lizard *(Anniella pulchra pulchra)* were once common; the later still occurs within the Ballona Ecosystem. The endangered California Least Tern *(Sterna antillarum browni)* and Western Snowy Plover *(Charadrius alexandrinus nivosus)* are associated with dune habitat but generally nest in the upper beach environment, which is no longer connected to the dunes.

Structural features: coastal dunes

Physical processes: aeolian transport and deposition of sands; storm influenced.

Dominant/characteristic Plant(s): Dune Lupine **(***Lupinus chamissonis*); Dune Buckwheat **(***Eriogonum parvifolium***)**; Beach Bur (*Ambrosia chamissonis*); Beach Evening Primerose (*Camissonia cheiranthifolia*); Common Sand Verbena (*Abronia umbellata*).

Associated plant(s): California Croton (*Croton californicus*), Tall Stephanomeria (*Stephanomeria virgata*), Mock Heather (*Ericameria ericoides*), Yellow Pincushion (*Chaenactis glabriuscula*), California Sun Cup (*Camissonia bistorta*), Lewis' Evening Primrose (*Camissonia lewisii*), Miniature Sun Cup (*Camissonia micrantha*), Coastal Dunes Milkvetch (*Astragalis tener* var. *titi*).

Characteristic animals: Silvery Legless Lizard (*Anniella pulchra pulchra*); Globose Dune Beetle (*Coelus globosus*); Ciliated Dune Beetle.

Ecosystem functions: maintenance of biodiversity; habitat for rare, endangered, and special interest species; source of freshwater seeps along interface with salt marsh habitat.

Recovery or protection opportunities: Silvery Legless Lizard (*Anniella pulchra pulchra*); El Segundo Blue Butterfly (*Euphilotes battoides allyni*); Dorothy's El Segunda Dune Weevil (*Trigonoscuta dorothea dorothea*); Globose Dune Beetle (*Coelus globosus*); Lande's El Segundo Dune Weevil (*Onychobaris langei*); Suffrutescent Wallflower (*Erysimum insulare* ssp. *suffutescens*); Beach Spectaclepod (*Dithyrea maritima*), Lewis' Evening Primrose (*Camissonia lewisii*)

Management issues: Remnant dunes are disjunct from coastal processes that formed them hence no natural disturbance regime, and beach related habitats are missing from the complex. Vulnerable to introduced invasive plant species.

22. Forests, woodlands, groves, and tree rows (including DFG "Eucalyptus Grove")

Narrative: Oak woodlands, characterized by Coast Live Oak (*Quercus agrifolia*), are characteristic along slopes, bluffs, and banks adjacent to various estuaries in southern California but may not have been located within or in proximity to the Ballona Ecosystem. Nonetheless, Coast Live Oaks may have been in the more xeric portions of riparian forests that included stands of Western Sycamore (*Platanus racemosa*). Current conditions include a number of groves and stands of planted or naturalized, largely exotic trees (e.g., Blue Gum, *Eucalyptus globulus*) within the Ballona Ecosystem. Some of these sites have important ecosystem functions such as nesting areas for great Blue Herons, whereas others (e.g., Myoporum and Acacia) may be less important depending on the site and role in the ecosystem.

Structural features: cultivated areas; roadsides; yards; banks and bluffs.

Physical processes:

Dominant/characteristic Plant(s): *Eucalyptus* spp.; Myoporum (*Myoporum laetum*).

Associated plant(s): numerous species of planted and naturalized trees including Acacia (*Acacia baileyana*); California Walnut (*Juglans californica*); Peruvian and Brazilian Pepper Trees (*Schinus molle* and *S. terebinthifolia*); Canary Island Date Palm (*Phoenix canariensis*); Slender Fan Palm (*Washingtonia robusta*); Carob (*Ceratonia siliquia*); Sweet Gum (*Liquidambar styraciflua*); Olive (*Olea europea*); Velvet Ash (*Fraxinus velutina*); Fremont Cottonwood (*Populus fremontii*); Chinese Elm (*Ulmus parvifolia*).

Characteristic animals: resident and migratory passerine birds; roosting and possibly nesting raptors; roosting and nesting herons.

Ecosystem functions: habitat for rare, endangered, and special interest species; perches for raptors.

Recovery opportunities: Preservation/expansion of Great Blue Heron rookery; potential for Monarch Butterfly over-wintering habitat in groves of Blue Gum (*Eucalyptus globulus*).

Management issues: Monarch Butterflies use exotic Eucalyptus trees as winter roosts. Need to retain butterfly habitat (if Eucalyptus trees are targeted as butterfly habitat at Ballona), while not encouraging spread of exotic tree species.

APPENDIX C.
HYDRODYNAMIC MODELING

APPENDIX C – NUMERICAL MODELING OF BALLONA WETLAND RESTORATION ALTERNATIVES TECHNICAL APPENDIX

Hydrodynamic modeling was conducted in support of the development and evaluation of restoration alternatives for the Ballona Wetlands Restoration Project. The Environmental Fluid Dynamics Code (EFDC) hydrodynamic model was selected because of its capacity to model the relevant physical processes, its compliance with regulatory standards, and its availability in the public domain at no cost.

This appendix documents the development, calibration, and alternative implementation of the EFDC model. It also provides supporting documentation for specific model results discussed in the Feasibility Report. This appendix is not a stand-alone report and should be reviewed in conjunction with Section 3.3 (Hydrology) of the Feasibility Report.

Because the EFDC model uses metric units, some of the model results in this appendix are presented using metric units. However, the discussion in the Feasibility Report uses English units to follow local convention. As a result, this appendix presents some results in metric units and some in English units.

Sections C-1 and C-2 were prepared as stand-alone memos. Section C-1 discusses the EFDC model development and calibration. Section C-2 discusses the representation of marsh channel networks within the model. Section C-3 shows overview plots of model bathymetry for each alternative. Section C-4 provides supporting documentation for model results discussed in Section 3.3 (Hydrology) of the Feasibility Study.

C-1. LOWER BALLONA CREEK MODELING – EFDC MODEL DEVELOPMENT AND CALIBRATION

1. INTRODUCTION

This section presents the calibration process for the Environmental Fluid Dynamics Code (EFDC) hydrodynamic model developed for the Ballona Creek Wetland Restoration Project. The EFDC model was configured such that predicted water levels accurately replicate observed water levels from a two-week calibration period. Typically, predicted water levels agree to within 5 cm of the observed water levels. Having calibrated the EFDC model, it is ready to characterize the hydrologic response of the proposed restoration actions for feasibility assessment purposes.

This section includes details of the model development and calibration. The section on model development describes the EFDC model in general and summarizes how the model was configured to represent the Lower Ballona Wetland system. The section on calibration describes the calibration approach and compares model predictions and field observations.

2. MODEL DEVELOPMENT

The EFDC model was chosen to simulate the Lower Ballona Wetland system after discussion between the Project Management Team, the Science Advisory Committee and the LA District, Corps of Engineers. Benefits of this model include its capacity to model the relevant physical processes, its compliance with regulatory standards, and its availability in the public domain at no cost.

After briefly describing EFDC's general characteristics, this section describes the application of the model to the Lower Ballona Wetland system, including the model's domain, boundary conditions, initial conditions and model execution. The linked Lower Ballona Wetland system includes lower Ballona Creek; Ballona Wetland Restoration Areas A, B, and C; Marina Del Rey; Del Rey Lagoon; Ballona Lagoon; the Grand Canal; and a portion of Santa Monica Bay. The uncertainties with respect to the model predictions are discussed.

2.1. MODEL DESCRIPTION

EFDC is a numerical model designed for simulating flows in open water systems. The model was originally developed at the Virginia Institute of Marine Science and receives continuing support from the U.S. EPA. A complete description of the model assumptions, governing equations and approximations, including the space discretization, time integration, and numerical solution methods is presented in Hamrick (1992). Tetra Tech (2002) provides guidance in using the model as well as references to successful applications of EFDC for a variety of tidally-influenced systems.

The physical processes represented in the model include important aspects of the Lower Ballona Wetland system:

- unsteady tidal flow,

- boundary wetting and drying, and
- hydraulic control structures.

EFDC solves the physical equations for fluid flow on a staggered, finite-difference grid. The modeling domain is defined by a curvilinear flexible mesh, enabling the grid to follow dominant terrain features. At present, the model has been configured to predict two-dimensional (2D) depth-averaged flow. Although not implemented for this study, the model can be extended to simulate three-dimensional (3D) flows and the transport of salt, sediment, and/or contaminants.

2.2. MODEL DOMAIN

The model domain defines the portion of the physical environment that is included in the model. Its extent should include the system's relevant components and processes between these components. Additionally, the boundaries of the system should be sufficiently far from the region of interest such that boundary conditions do not overly constrain flow in the region of interest. When constructing the model's horizontal grid that defines the domain, these factors must be balanced against model execution time. The vertical component of the model domain is defined by the system's bathymetry. Further information about the physical setting within the model domain can be found in PWA (2006).

2.2.1. Model extent

The model domain extends from where Ballona Creek passes under Sawtelle Boulevard to Santa Monica Bay, as shown in Figure 1. The upstream boundary is beyond the range of tidal influence and coincides with a discharge monitoring station. Placing the downstream boundary within Santa Monica Bay provides ample distance and tidal volume between the specified tidal boundary condition and the region of interest. Between the upstream and downstream boundaries, the model domain includes:

- lower Ballona Creek;
- Ballona Wetland Restoration Areas A, B and C;
- Marina Del Rey, including Oxford Basin;
- Del Rey Lagoon;
- Ballona Lagoon, including the Grand Canal downstream of Washington Boulevard; and
- a portion of Santa Monica Bay roughly 1.3 km by 2.5 km.

2.2.2. Horizontal grid generation

EFDC employs a curvilinear orthogonal grid to represent the physical domain. The grid is analogous to a rubber sheet of graph paper. Its curvilinear aspect allows the grid to be stretched and transformed so that it aligns with the major topographic features of the model domain. However, orthogonality requirements dictate that the grid maintains nearly perpendicular intersections at cell boundaries.

The grid generation tools available within the EFDC modeling environment are somewhat limited in their functionality. Instead, DELFT3D's grid generation software (WL | Delft Hydraulics, 2006b) was used to create the grid. DELFT3D's graphical user interface provides robust tools for grid orthogonalization, manipulation, and merging. After creating the grid with the DELFT3D software, the grid files were converted to EFDC format using MatLab programs. The grid cell sizes average 10 m across in most of the model domain, resulting in approximately 42,000 active cells within the domain.

2.2.3. Bathymetry

The bathymetry, or spatial map of surface elevations, is represented in the model as a single elevation value at the center of each grid cell. Multiple sources of bathymetric data were compiled to cover the entire model domain. The sources of bathymetry data for each region are listed below:

- *Ballona Creek:* Channel centerline elevations and width from the channel's design drawings (Los Angeles County Flood Control District, 1959).

- *Ballona Wetland Areas A, B and C*: Ground surface elevations from the R.J. Lung & Associates aerial survey in April 1998, supplemented with spot elevations, marsh channel cross sections, and culvert invert elevations collected by PWA in 2006.

- *Marina Del Rey*: Elevations in the main stem of the marina from unpublished USACE dredging surveys in March 2006 and elevations in the mooring basins extrapolated from the adjacent main channel elevations.

- *Del Rey Lagoon:* Spot elevations from bathymetric survey drawings (City of Los Angeles, 2003) interpolated across the lagoon.

- *Ballona Lagoon and the Grand Canal*: Elevations from cross section surveys (Coastal Frontiers Corporation, 1989) and Ballona Lagoon Enhancement Project design drawings (City of Los Angeles, 1997).

- *Santa Monica Bay*: Bathymetric survey data from the National Oceanic and Atmospheric Administration (1997).

All elevation data were converted to the same horizontal datum (UTM Zone 10N) and vertical datum (NAVD88) using Corpscon software (U.S. Army Corps of Engineers, 2004). The data sets were then imported into the DELFT3D bathymetry generation software (WL | Delft Hydraulics, 2006a) and smoothly interpolated at the boundaries between data sets. The compiled bathymetric surface was converted into EFDC-specific input files using the EFDC_Explorer graphical user interface (Criag, 2004). To refine features such as wetland channels and elevated road bed that have widths on the order of the 10 m grid cell size, a MatLab program was used to inscribe these features into the bathymetry. This procedure ensures that these features are hydraulically contiguous, but yields a stair-step appearance as the features traverse diagonally across the grid. The compiled bathymetry for the model extent is shown in Figure 1. Figure 2 displays a portion of the bathymetry within the western portion of Area B that includes wetland channels and road bed. This figure demonstrates the implementation of these features as contiguous sets of grid cells.

2.3. BOUNDARY AND INITIAL CONDITIONS

Boundary and initial conditions describe the external forcing applied to the model and starting values for the predicted variables, respectively. Boundary conditions consist of:

- the tidal boundary within Santa Monica Bay,
- the freshwater inflows from the Ballona Creek watershed,
- culvert discharges, and
- bed roughness.

Initial conditions must be specified for the water surface elevation and velocity field when the model begins a simulation.

2.3.1. Tidal boundary

Comparison between the NOAA continuous tide gauge station at the Port of Los Angeles (Station ID 9410660) and water surface measurements in Ballona Creek collected by Nearshore and Wetland Surveys (2006) show good agreement with minimal amplitude differences or phase lag. For example, observations in Ballona Creek (Nearshore and Wetland Surveys, 2006) and at the Port of Los Angeles are shown in Figure 3. Because of the agreement between the two data sets, the Port of Los Angeles water surface elevation data was applied as the open tidal boundary condition at the model's western edge in Santa Monica Bay. This tide station is well established and it can provide boundary condition data for a wide range of time periods. The northern and southern boundaries of the model grid in Santa Monica Bay are linked by a periodic boundary condition. This type of boundary condition minimizes the influence of these boundaries on model results.

2.3.2. Freshwater inflow

The primary freshwater inflow into the Lower Ballona system comes from Ballona Creek itself. The upstream model boundary coincides with the County of Los Angeles, Department of Public Work's discharge station at Sawtelle Blvd (Station ID F38C-R). Observations from this station were used as a discharge boundary condition into the model.

2.3.3. Culvert and gate discharges

Culverts and gates regulate flow into and out of the Area B wetland, Fiji Ditch, Del Rey Lagoon, and Ballona Lagoon. Culvert flow is represented in the model as water-level-dependent discharge between a pair of grid cells. Discharges through all but one culvert are implemented in the EFDC model through an input file that specifies the discharge as a function of the difference in water levels at the ends of each culvert.

A slightly more complex specification was used for the gate that conveys water from Ballona Creek to the Area B wetland. Flow through this gate is governed by a self-regulating tide gate that closes automatically once the water level in Ballona Creek reaches a predetermined level. For this culvert, the discharge was modeled as a function of both the upstream and downstream water levels and the discharge was set to zero when the upstream water level in Ballona Creek equal or exceeds the water level which triggers gate closure.

Observed water levels within the Area B wetland (Nearshore and Wetland Surveys, 2006) slowly increase even after the self-regulating tide gate has closed. This increase may result from leakage through either of the tide gates and/or seepage from the headlands to the south of the wetland. The exact source remains a point of discussion. To replicate these slowly increasing water levels, a constant discharge of 0.16 m^3/s was added as a source to the wetland. This rate was estimated from the observed rate of water level increase after the self-regulating tide gate has closed (Figure 5) and the area of inundated wetland during higher high water. If future investigation clarifies and quantifies the source of this water level increase, it can be more explicitly included in the model.

2.3.4. Bed roughness

Bed roughness relates the flow velocity to the frictional loss of momentum as the flow moves over the bed. EFDC parameterizes the bed friction's effect on flow through a roughness height, z_0, based on the assumption of a logarithmic velocity profile. A typical, constant z_0 value of 0.002 m was applied across the entire domain (Blumberg and Mellor, 1987). Sensitivity analysis of water levels to variations in z_0 confirms that water levels are relatively insensitive to this parameter.

2.3.5. Initial conditions

Model start times were selected to coincide with slack tide when current speeds can be initialized to zero. Initial water levels throughout the model domain were set to a uniform value equal to the open boundary condition. The model was spun up for four days of simulation time to remove initial transients from the model results and enable water levels and velocities to equilibrate to the prescribed boundary conditions.

2.4. MODEL EXECUTION

For the model configuration described above, model testing indicates that stable and accurate predictions are achieved with a time step of two seconds. With this time step, simulations execute on a 3.6 GHz PC workstation at speeds approximately eight times faster than real time.

2.5. MODEL UNCERTAINTY

EFDC is a widely used modeling tool for estuarine simulations and has been validated in numerous studies (Tetra Tech, 2002). However, numerical models inherently rely on approximations that introduce sources of uncertainty in the model results. Uncertainties may be present both spatially and temporally, and may result from a variety of factors, including:

- physical characteristics of the model domain,
- specification of boundary conditions, or
- limitations in the model's numerical formulation.

For the specific application of a hydrodynamic model of the Lower Ballona system, it is important to assess the modeling uncertainties and assumptions made in applying the model to understand the extent to which these uncertainties affect model predictions.

The largest uncertainties affecting model performance for the Lower Ballona model are the accuracy and resolution of available bathymetry and the grid resolution used in the model to resolve this bathymetry. To the extent possible, the model has made use of the most recent and best available bathymetric data and datum conversion tools (Section 2.2.3). However, when the bathymetric data is sampled onto the model grid, additional filtering of the bathymetric data occurs which limits the capacity of the model to resolve small-scale bathymetric features. The grid resolution for the model was selected to be as fine as possible, subject to the computation time restraints. The nominal grid cell size of 10 m prevents the model from accurately resolving the bathymetry in the smallest channels. However, since the volume of these small channels represents a small fraction of the overall domain, their exclusion is not likely to significantly alter the model's predictions.

The model solves the 2D depth-averaged approximation of the hydrodynamic flow equations. The use of 2D simulations significantly reduces the computational time required for the model simulations but also introduces additional model uncertainty in the hydrodynamic predictions. This uncertainty is constrained because the wetland's shallow depths and limited freshwater inputs minimize the impact of 3D flow effects.

Model uncertainties are also introduced through the specification of boundary conditions and model parameterizations, such as bed roughness. Additionally, any field data used either to force the model or to calibrate the model has some associated uncertainty due to instrument calibration and errors, instrument location, field corrections, and data noise.

3. MODEL CALIBRATION

The model was calibrated to observed water levels, primarily by adjustment of culverts and gate discharge rates. As presently calibrated, the model predicts water levels to within 5 cm of observations for nearly all of the calibration period. The sections below describe the calibration approach, summarize the observation data, compare predicted and observed water levels, and outline future refinements to the model.

3.1. CALIBRATION APPROACH

Calibrating a model involves adjusting model parameters or model formulation in order to match model predictions and field observations at known locations. Initially, the calibration process can verify that each of the specified model inputs and boundary conditions are working properly. Subsequent iterations of the calibration process enhance agreement between model predictions and observations. The model is run for a known set of input conditions, and its output is compared to a known set of observations. The discrepancies between the model predictions and the observation data help determine which aspects of the model are not adequately capturing the physical processes. This may lead to adjusting some model parameters to improve agreement between predictions and observations.

Adjustments to model parameters are made until the model's response to the specified inputs replicates the field measurements as closely as possible. The goal of the calibration process is to identify the areas and processes of highest interest, and maximize the model's predictive capability in those areas, while ensuring reasonable behavior in the rest of the model predictions.

The model was calibrated to optimize agreement between observations and predictions of water levels. Calibration to water levels indicates that the model is correctly predicting the volumes of water that are exchanged between each region of the model. Calibration of Ballona Creek water levels required no adjustments to model parameters beyond the model setup described above in Section 0. To calibrate water levels at the other four observation stations, all of which are upstream of culverts, a coefficient scaling the discharge through the culverts was adjusted. Comparison between this calibrated discharge and the discharge estimated by the U.S. Geological Survey Culvert Analysis Program (CAP; Fulford, 1998) exhibit good agreement.

3.2. OBSERVATION DATA

The water level observations used for calibration were collected by PWA and Nearshore and Wetland Surveys (2006) in July and August, 2006. A representative spring-neap cycle from July 5 to July 20 was selected from this observation record as the calibration period to simulate. The five locations at which water levels were observed are shown in Figure 1. In addition to water levels in Ballona Creek, which is directly exposed to the tidal action, the other four stations are located in regions where the tidal flows are controlled by flow through gates and culverts.

3.3. WATER LEVEL COMPARISON

Time series of predicted water levels at five stations and the corresponding observed water levels are plotted in Figure 4 to Figure 8. For most of the two-week simulation period, these time series demonstrate agreement within 5 cm between the model predictions and observations. Differences larger than 5 cm between predictions and observations are typically caused by mechanisms beyond the scope of the model that are insignificant in comparison to the changes expected from restoration. Explanation for these larger differences between observations and predictions are discussed below:

- During several of the lowest tides in the middle of the simulation period, the observations bottom out at constant values that are above the predicted values (Figure 4 to Figure 7). This is because the instruments were mounted such that water levels during these lowest tides fell below their sensors and exposed the sensors to the atmosphere during these periods.
- As discussed above in Section 2.3.3, an unknown water source causes water levels to rise in the Area B wetland after the tide gates between Ballona Creek and the wetland close. The observed water levels consist of a rapidly rising section while the tide gate is open and then a slowly rising section once the tide gate closes (Figure 5). In the absence of data, the unknown source was modeled as a constant discharge to the wetland. This approximation of the source is sufficient to

reproduce the typical rising water levels during high tides. However, the source's actual discharge rate probably varies in time, causing the differences between the observed and the modeled water levels.

- In Fiji Ditch (Figure 6), high frequency oscillations in the water level observations are consistent with the 6 to 8 second water level oscillations observed visually during instrument installation. It is hypothesized that these water level oscillations result from ocean swell that propagates through the marina and culvert. The model does not include the physical processes which create this type of water level oscillation since this process does not transport significant amounts of water.
- Below 0.25 m NAVD, predicted water levels in Del Rey Lagoon fall more rapidly than observed water levels (Figure 7). This difference may be the result of the representation of the lagoon's bathymetry in the model, which was created by interpolation from relatively few spot elevations. Since the predictions at all other times and locations otherwise demonstrate good agreement with the observed water levels and the lagoon is only a small feature located outside the project area, the current implementation is sufficient for assessment of the restoration alternatives. If specific questions regarding circulation within the lagoon are of interest, the model's representation of the lagoon's bathymetry should be improved.
- The tide gates regulating flow into Ballona Lagoon (Figure 8) are manually adjusted to restrict flow during spring tides, e.g. from July 7 to July 14. This operational practice prevents flooding upstream of the gates. Since records of the actual gate settings are not maintained (Mariposa Landscaping, personal communication), no attempt was made to model the Lagoon's water levels during this period. Hence, during the spring tides, the predicted water level continues to span nearly the full range of water levels in Ballona Creek while the observed water level within Ballona Lagoon was muted.

3.4. FUTURE WORK

Although the model is sufficiently calibrated to provide a feasibility assessment of the proposed restoration alternatives, additional calibration should be conducted for future stages of alternative design or evaluation of more complex processes, such as sediment transport or water quality. These additional steps include:

- Calibration to observed current velocity data
- Calibration to observed salinity data
- Validation to water levels during high Ballona Creek discharge

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5. FIGURES

Source: R.J. Lung & Associates aerial survey (1998) and PWA (2006) channel cross sections

figure 1
Lower Ballona Modeling

Model Bathymetry, Full Extent

PWA Ref# 1793.01

PWA

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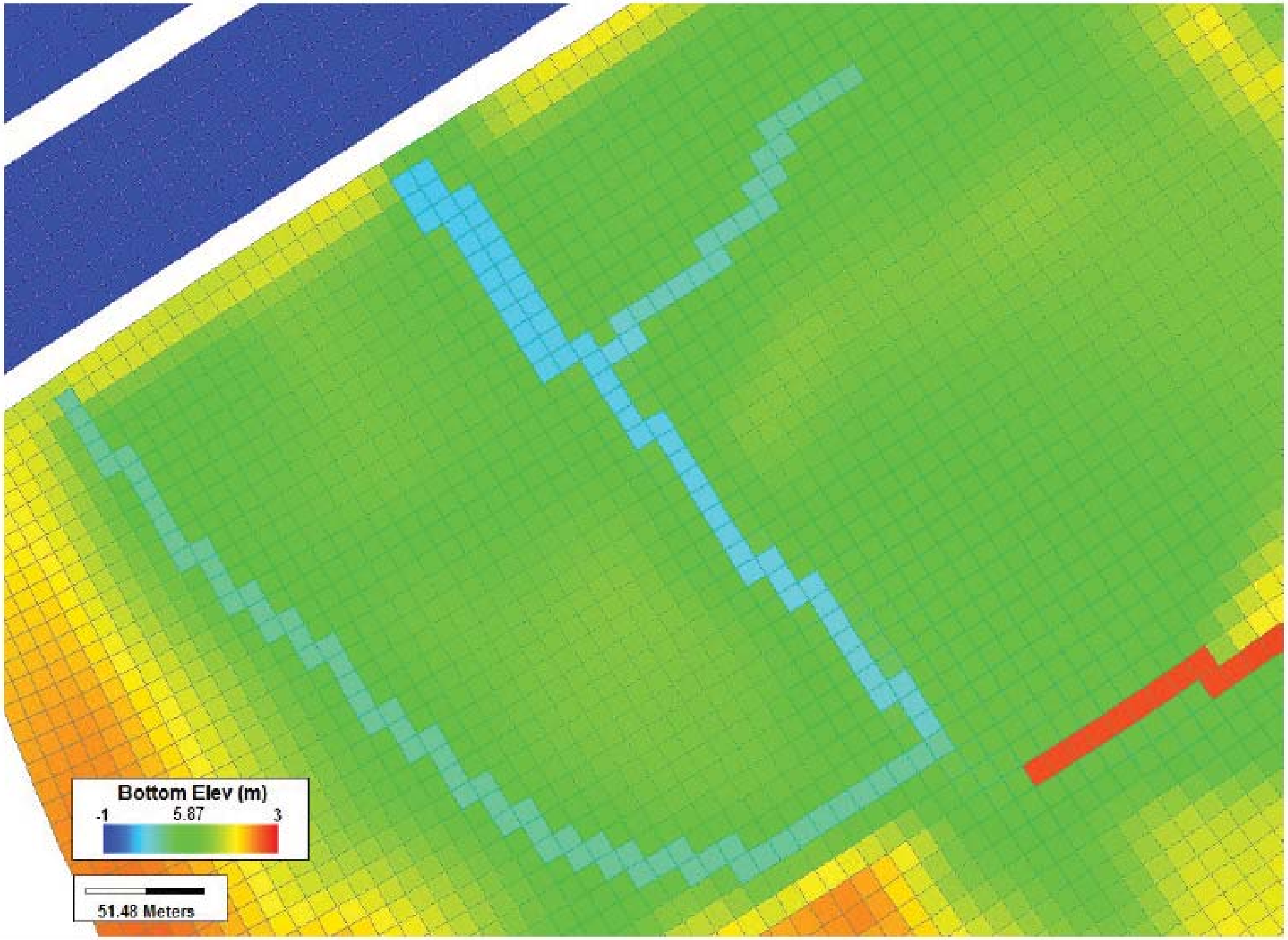


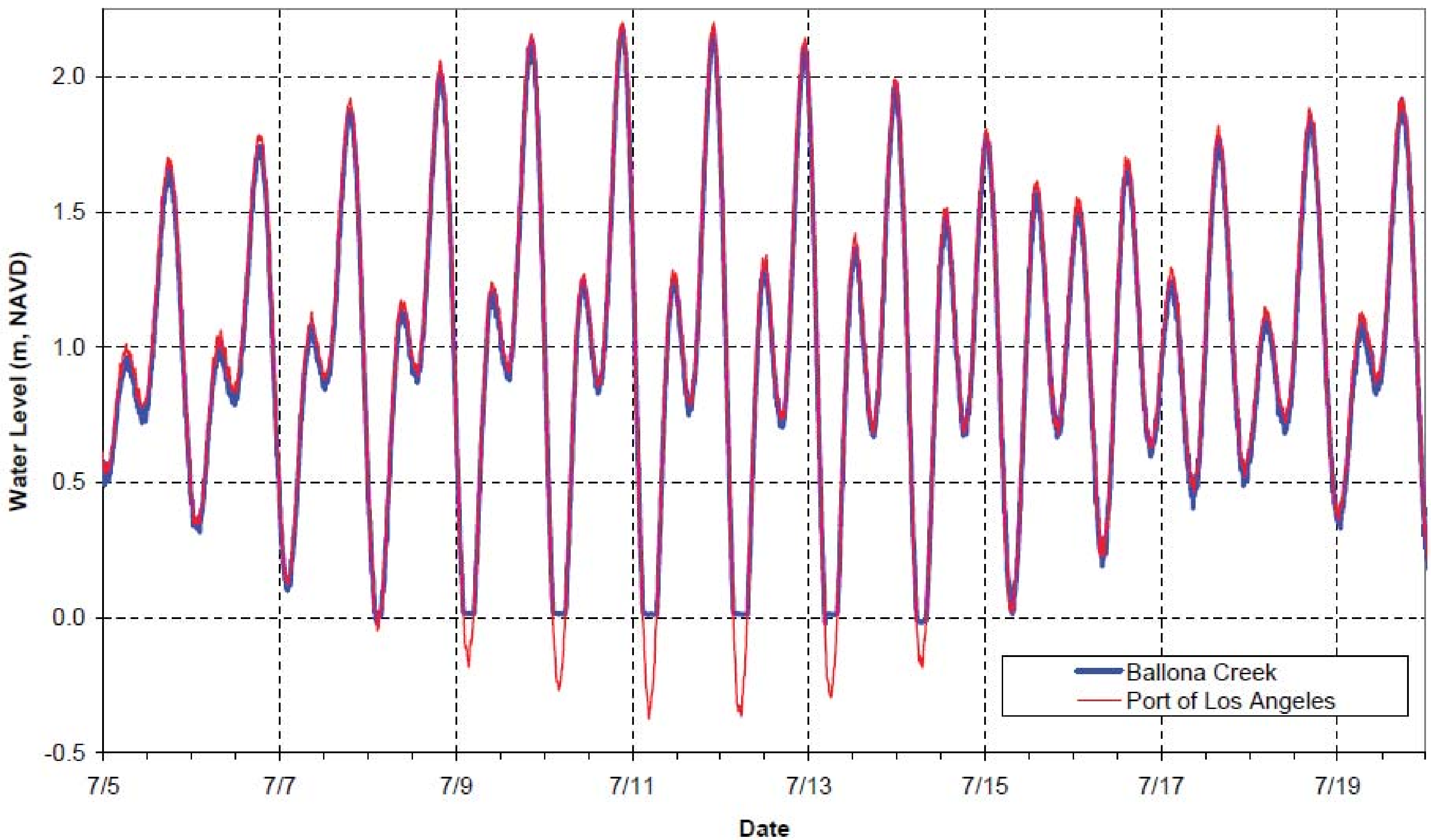
Source: R.J. Lung & Associates aerial survey (1998) and PWA (2006) channel cross sections

figure 2
Lower Ballona Modeling

Model Bathymetry, Area B Wetland

PWA Ref# 1793.01

PWA



Source: NOAA (Station ID 9410660) and Nearshore and Wetland Surveys (2006)

figure 3

Lower Ballona Modeling

Port of Los Angeles and Ballona Creek Observed Water Levels

PWA

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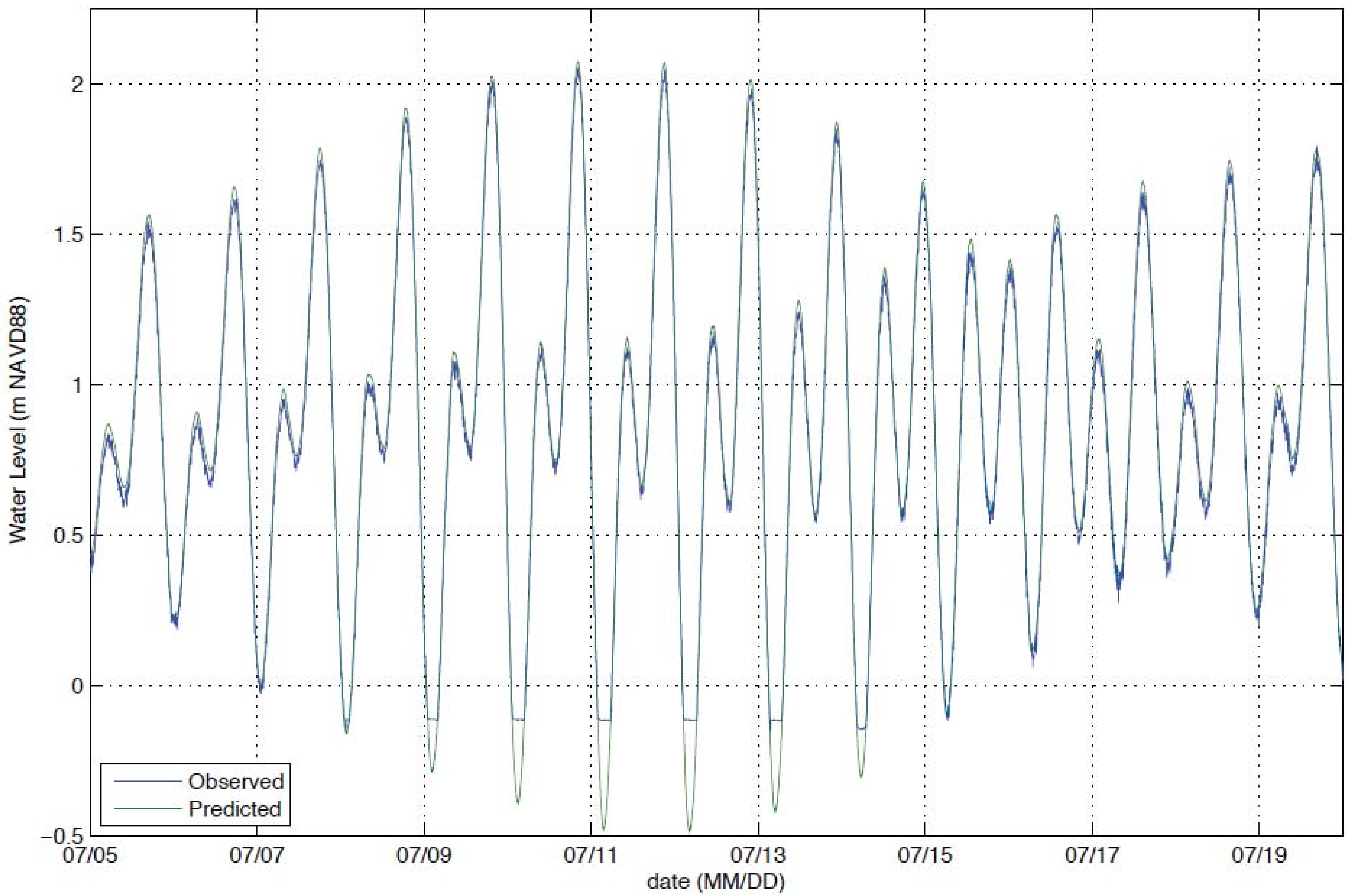

Source: USACE field observations and EFDC model predictions

Figure 4
Lower Ballona Modeling

Predicted vs. Observed Water levels, 2006 – Ballona Creek

PWA Ref# 1793.1

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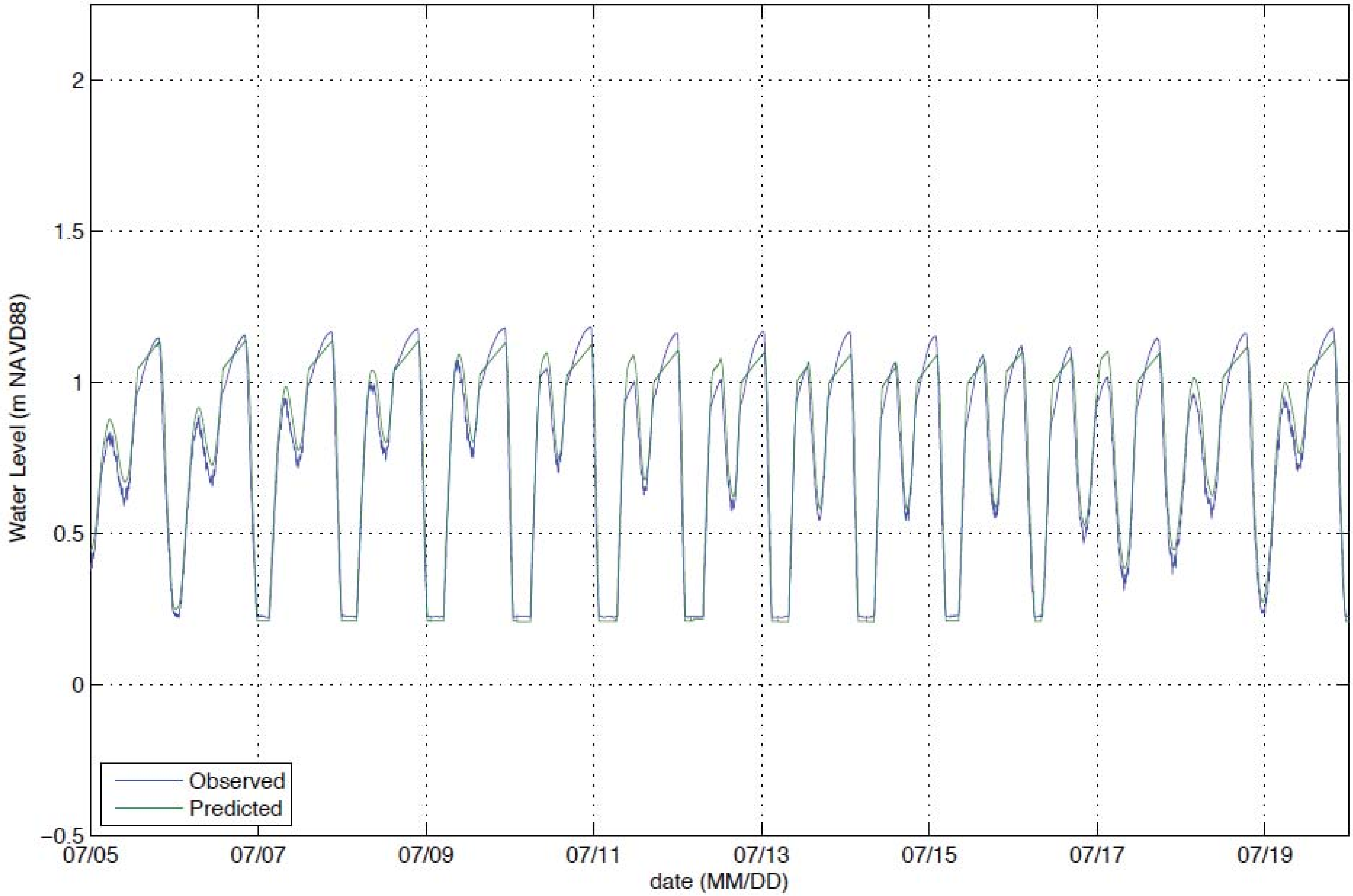

Source: USACE field observations and EFDC model predictions

Figure 5
Lower Ballona Modeling

Predicted vs. Observed Water levels, 2006 – Area B Wetland

PWA Ref# 1793.1

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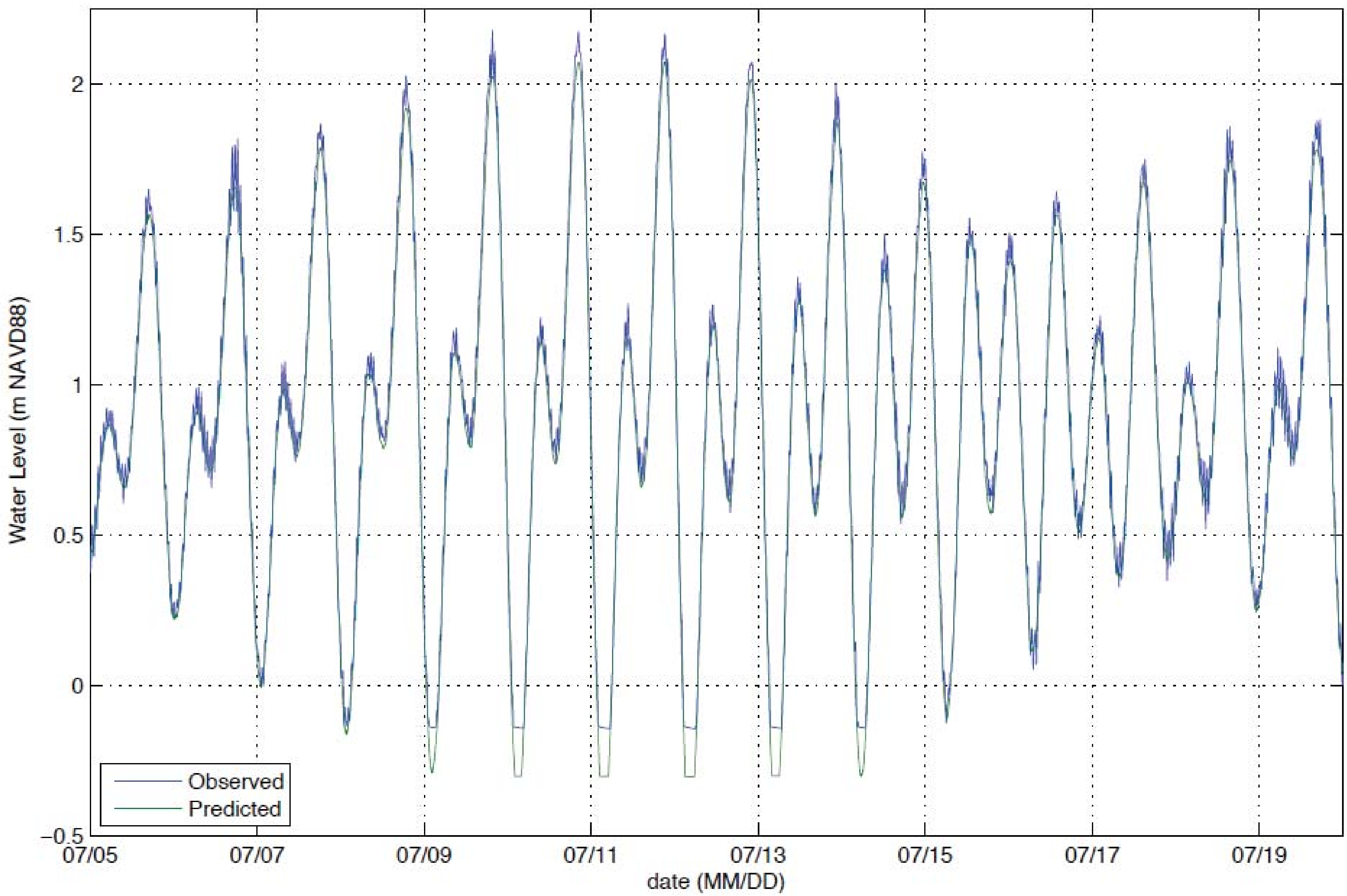

Source: PWA field observations and EFDC model predictions

Figure 6
Lower Ballona Modeling

Predicted vs. Observed Water levels, 2006 – Fiji Ditch

PWA Ref# 1793.1

PWA

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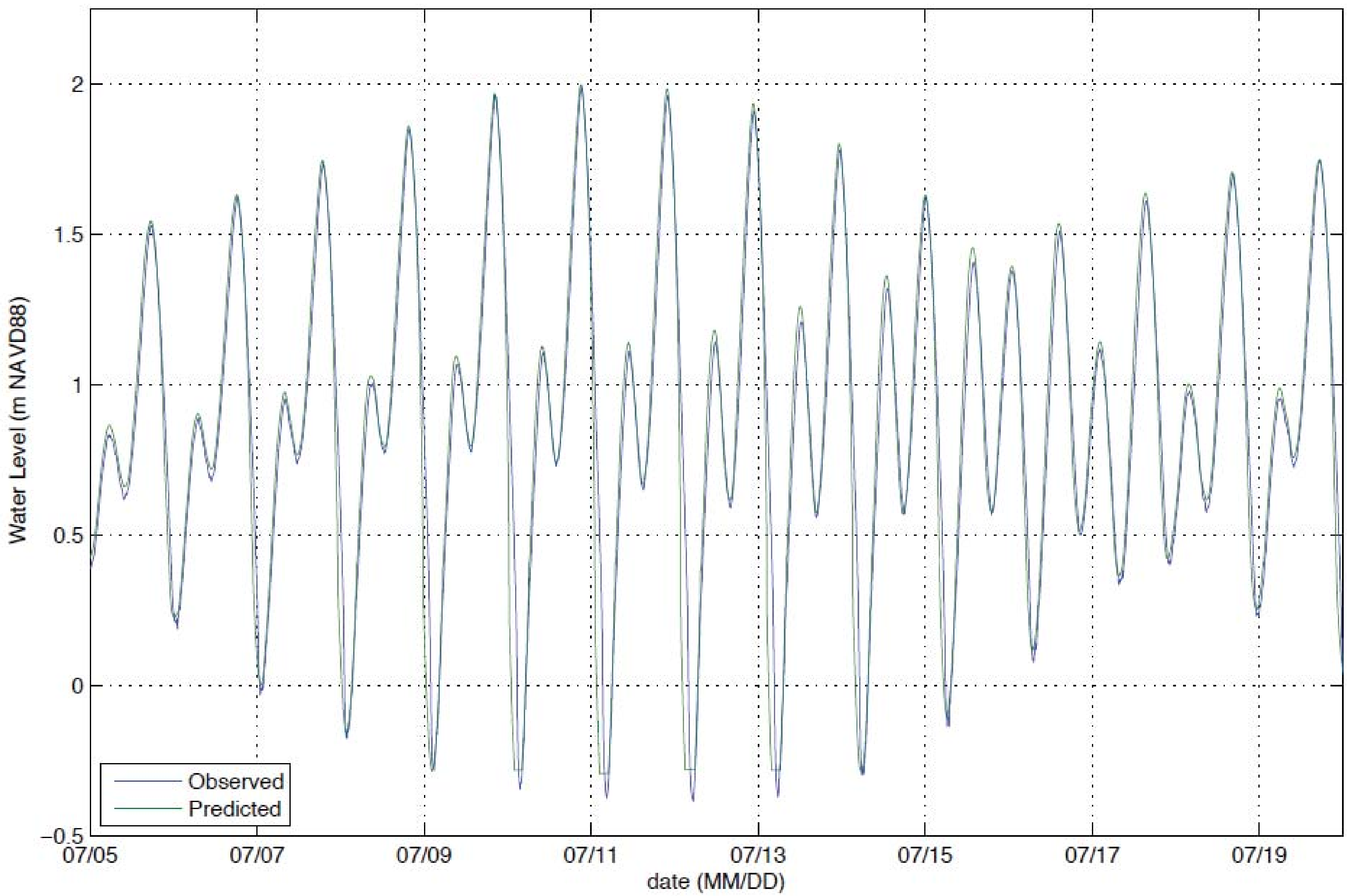

Source: PWA field observations and EFDC model predictions

Figure 7
Lower Ballona Modeling

Predicted vs. Observed Water levels, 2006 – Del Rey Lagoon

PWA Ref# 1793.1

PWA

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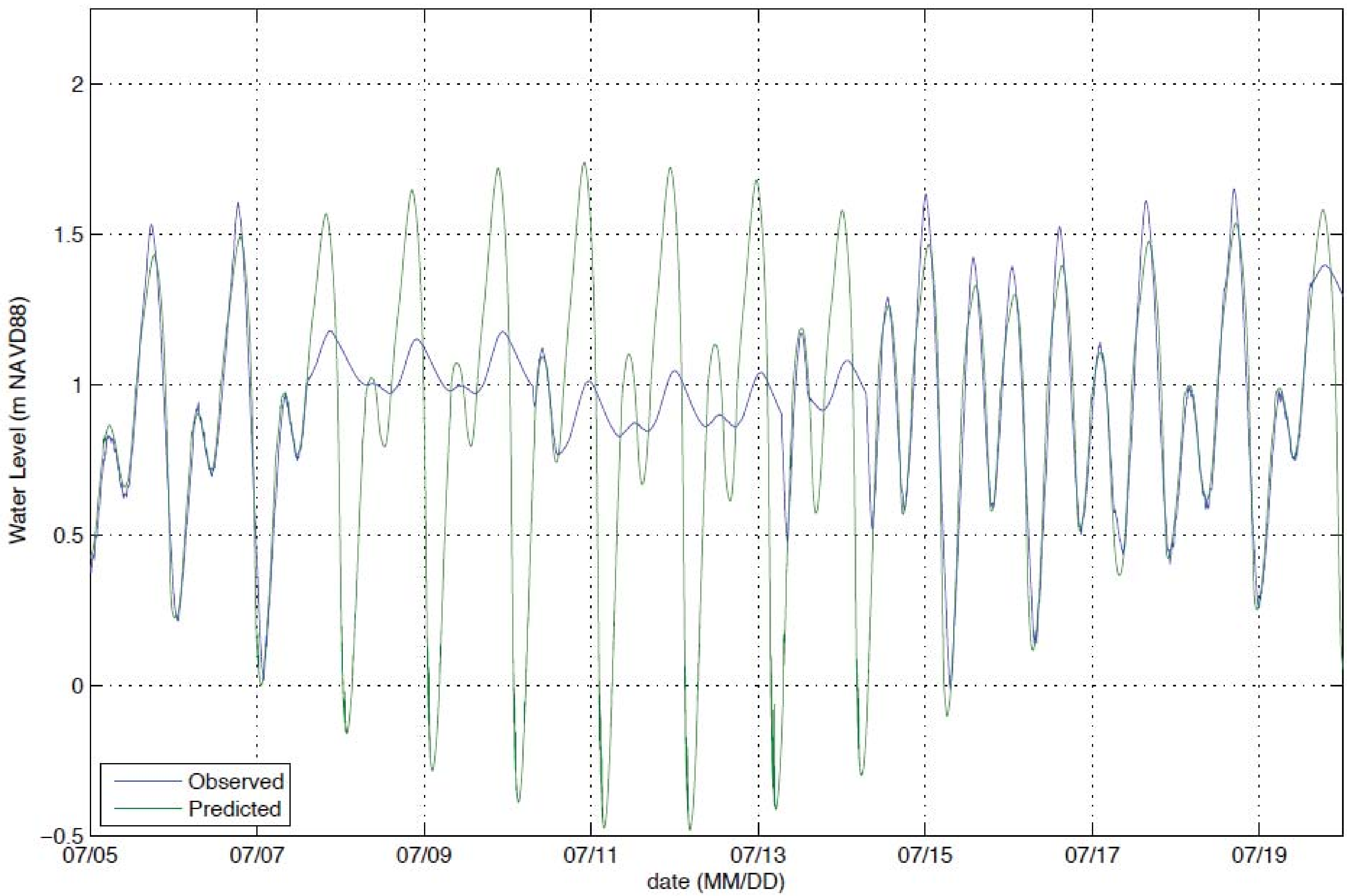

Source: PWA field observations and EFDC model predictions

Figure 8
Lower Ballona Modeling

Predicted vs. Observed Water levels, 2006 – Ballona Lagoon

PWA Ref# 1793.1

PWA

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C-2. MARSH CHANNEL REPRESENTATION IN LOWER BALLONA EFDC MODEL

1. INTRODUCTION

This section outlines the methodology implemented to represent tidal channel morphology and layout in the Lower Ballona Wetlands EFDC numerical model. The purpose of the numerical model is not to model fine scale hydrodynamics or velocities in the tidal channels (existing or future), but to describe the hydraulic characteristics and flushing of each restoration parcel. The procedure is based on the methods presented in the "Design Guidelines for Tidal Channels in Coastal Wetlands," prepared by PWA in January 1995 for the U.S. Army Corps of Engineers. The guidelines present empirical relationships between morphologic characteristics of marsh channels (channel top width, depth, and cross sectional area) and diurnal tidal prism. Characteristics of marsh morphometry (channel order, length, sinuosity, drainage density, etc.) are also tabulated. The tidal prism dataset includes sites from San Diego Bay (Chula Vista) and San Francisco Bay (Novato, Corte Madera, and Newark Slough). The marsh morphometry dataset includes a more extensive analysis of sites from southern California, north San Francisco Bay, and south San Francisco Bay.

The approach taken to implement the appropriate channel characteristics in the model was to first determine what the detailed tidal channel characteristics would be, and then to aggregate these for inclusion into the model, given the grid cell size limitations. A general outline of the procedure is presented below:

1. Approximate channel order, length, and number of channels based on channel morphometry relationships with marsh area (Section 2).
2. Approximate channel geometry (width and thalweg depth) based on tidal prism using hydraulic geometry relationships (Section 3).
3. Aggregate channel morphology and morphometry for inclusion into the model (Section 4).

2. CHANNEL MORPHOMETRY

Marsh morphometry refers to the plan view features of tidal marshes, such as channel length, sinuosity, channel order, and density of channels. The general outline presented in the Design Guidelines is reproduced below:

1. Determine the order of the drainage system that can be accommodated within the site based on the marsh area.
2. Calculate the total channel length based on an assumed drainage density (typically 0.01-0.02 ft/ft^2).
3. Estimate the number of channels of each order.
4. Partition the length among the different order channels.

The results for Area B East Wetland are presented below as an example of the methodology and assumptions used in the analysis.

1. For a given marsh area of approximately 35 acres, Figure 7.1-4 of the design guidelines was used to select a maximum channel order of 4 for the parcel.
2. Drainage densities at numerous California marshes tend to fall between 0.01-0.02 ft/ft^2. A drainage density of 0.01 ft/ft^2 was selected to minimize construction costs and allow for natural evolution of the site. From this drainage density, a total length of channels of 15,250 ft was determined.
3. The number of channels of each order was determined assuming a bifurcation ratio of 3.5. This ratio predicts 1 fourth-order channel, 4 third-order channels, 12 second-order channels, and 43 first-order channels, although not all orders can be represented in the model due to grid cell size limitations.
4. Table 7-6 and Figure 7.3-1 of the Design Guidelines give typical channel distributions for California marshes. The following distribution of channel length was assumed for the 4th through 1st order channels: 10%, 15%, 30%, and 45%. The total length of channels was used with the channel order distributions to determine the length of each order channel.

3. HYDRAULIC GEOMETRY

The term hydraulic geometry refers the empirical relationships between channel discharge and channel geometry. The hydraulic geometry relationships presented in the Design Guidelines relate diurnal tidal prism with channel width, depth, and cross sectional area. A predicted tidal prism of 25 acre-ft was determined to represent the diurnal tidal prism for the 35-acre Area B East Wetland parcel using Figure 5.2-1. The top width and depth of the 4th order channel were determined assuming this tidal prism. For the lower order channels, the total tidal prism was distributed incrementally based on the bifurcation ratio, after subtracting out the intertidal storage volume of the next higher order channel. The partitioned tidal prism was used in the hydraulic geometry relationships for each channel order.

4. IMPLEMENTATION OF CHANNEL MORPHOLOGY IN MODEL BATHYMETRY

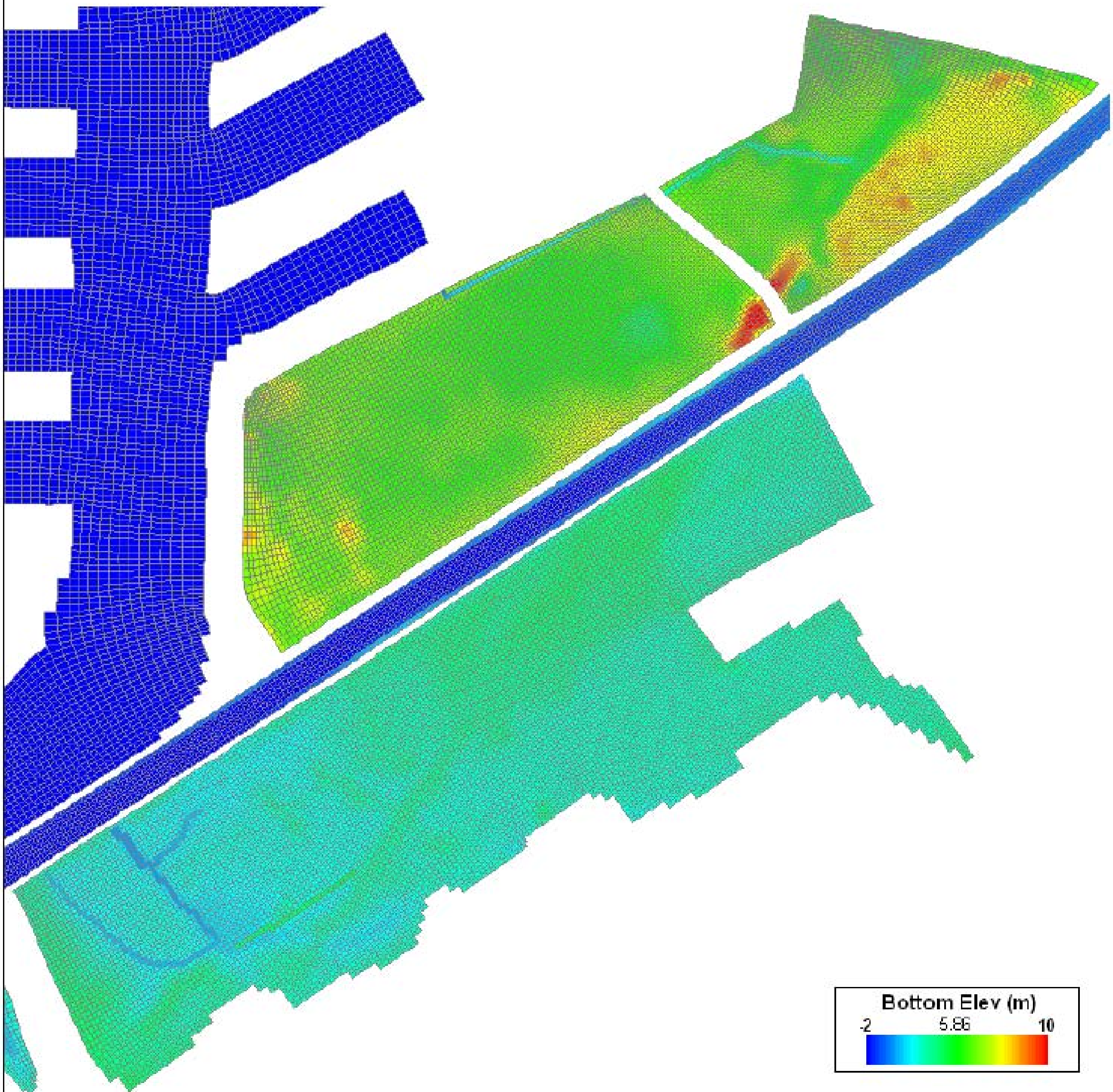
For each channel order, the predicted top width was compared to the grid cell size of the EFDC model grid, nominally equal to 9 m (29.5 ft). The predicted top widths of the 3rd and 4th order channels were 28 ft and 54 ft, roughly equivalent to one and two cell widths, respectively. The model tidal prism was calculated as the total intertidal channel storage volume for a diurnal tide range of 5.49 ft (LA tide gage, #9410660). The resulting tidal prism was 19 acre-ft, 24% less than the predicted tidal prism of 25 acre-ft. This is due to the lack of first and second order channels in the model. To account for the remaining 6 acre-ft, 4 of the 12 second-order channels were implemented at a width of one grid cell. The number of grid cells for each channel order was determined by dividing the length per channel by the nominal grid size. An idealized channel layout was then overlaid on the existing topography grid based on the widths, depths, and lengths determined from the Design Guidelines. The bed elevation of the highest-order channel is constant along its length. Along-channel bed elevations of lower-order channels were linearly interpolated from the channel junction to the channel end (i.e., from the predicted elevation of the higher-order channel to the predicted elevation of the lower-order channel). Elevations of the future marshplain (non-channel regions within the wetland footprint) were set at MHHW (1.61 m NAVD).

The channel layout was adjusted iteratively to correctly reproduce the expected future tidal prism for the marsh restoration parcel. The model tidal prism was confirmed by comparing the total intertidal channel storage volume to the predicted diurnal tidal prism for the given marsh area. Future model refinement could be to develop a more detailed bathymetry grid in the region of tidal channels.

C-3. LOWER BALLONA EFDC MODEL – ALTERNATIVES BATHYMETRY

Sections C-1 and C-2 above describe the model development and calibration procedures. Figure 9 through Figure 14 show the model bathymetries for each alternative.

Figures



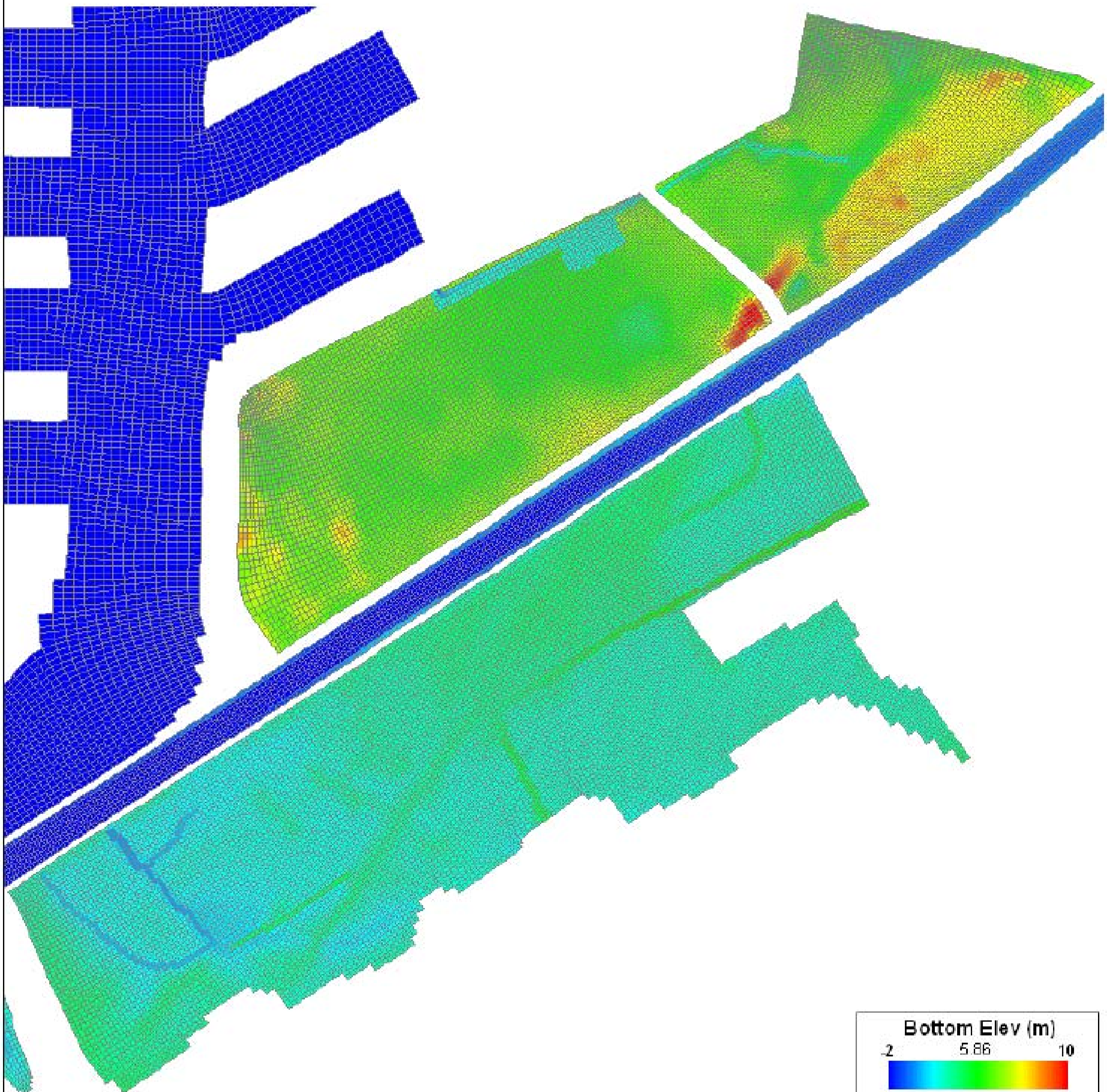
Source: EFDC model setup.
Notes: Bottom elevations shown in meters NAVD.

figure 9
Ballona Wetlands Restoration Project

Existing Conditions (No Action) Bathymetry

PWA Ref# 1793

PWA



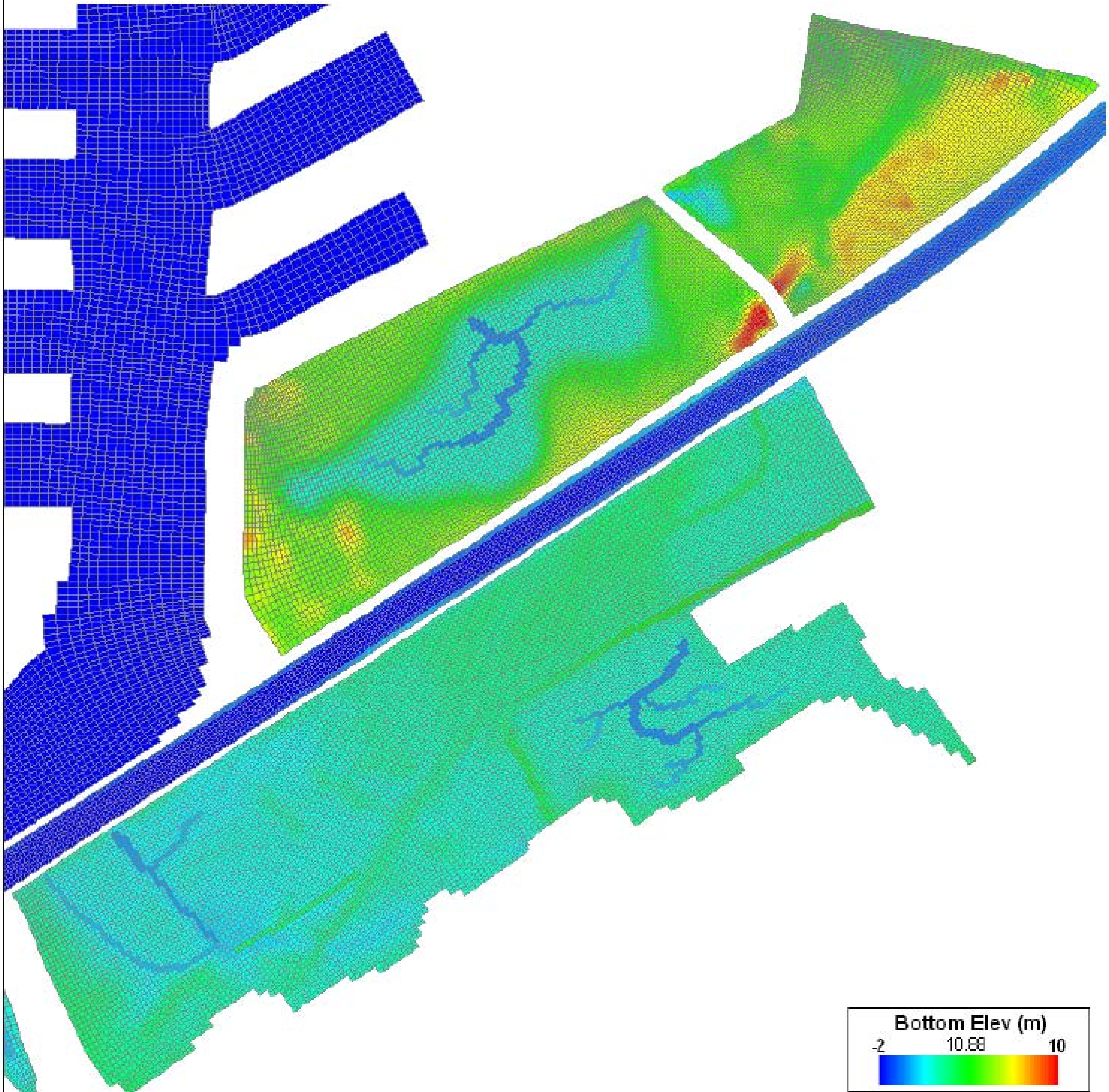
Source: EFDC model setup.
Notes: Bottom elevations shown in meters NAVD.

figure 10
Ballona Wetlands Restoration Project

Alt 1 – Muted Tidal Bathymetry

PWA Ref# 1793

PWA



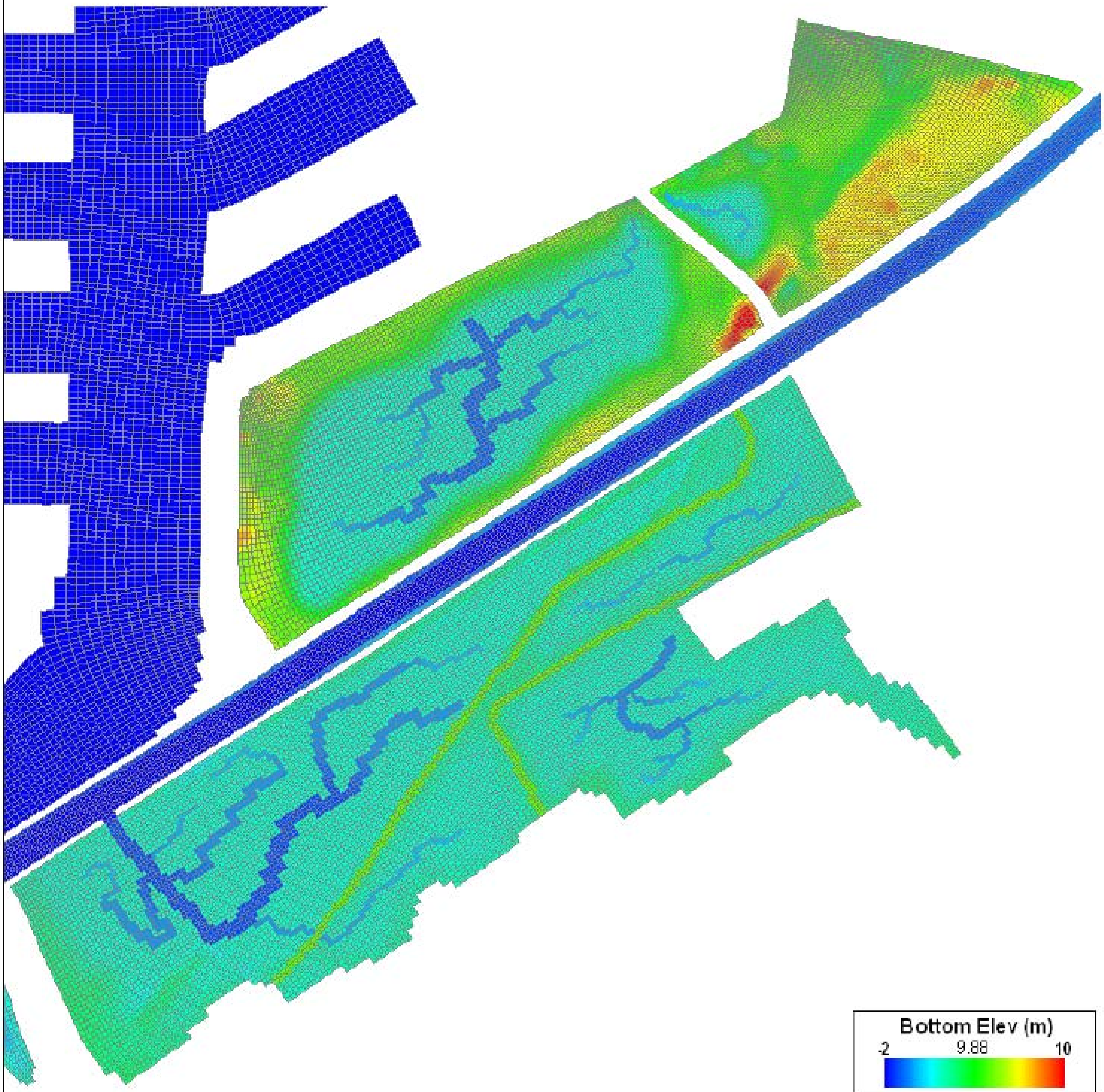
Source: EFDC model setup.
Notes: Bottom elevations shown in meters NAVD.

figure 11
Ballona Wetlands Restoration Project

Alt 2 – Partial Tidal Bathymetry

PWA Ref# 1793

PWA



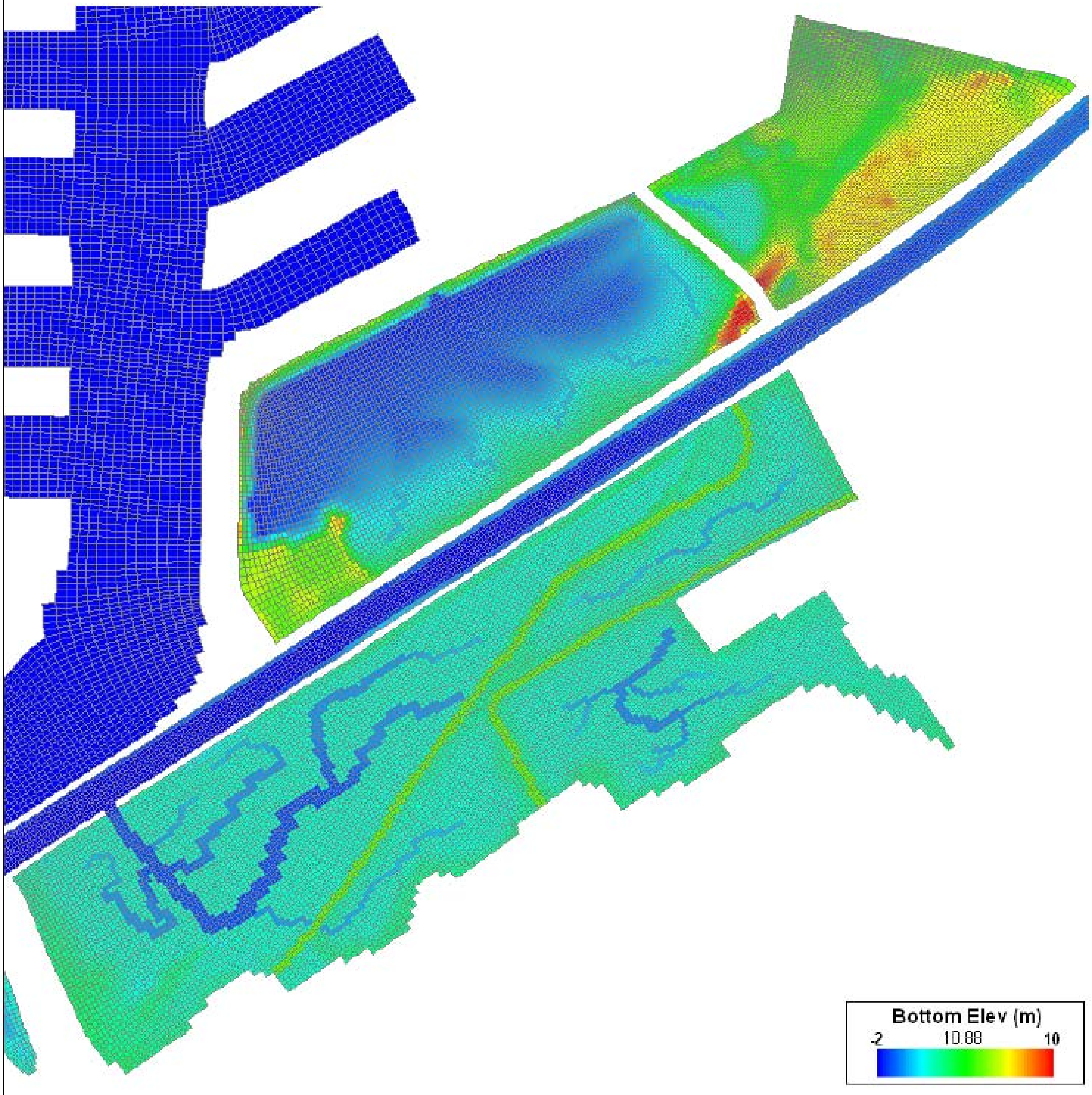
Source: EFDC model setup.
Notes: Bottom elevations shown in meters NAVD.

figure *12*
Ballona Wetlands Restoration Project

Alt 3 – Full Tidal Bathymetry

PWA Ref# 1793

PWA

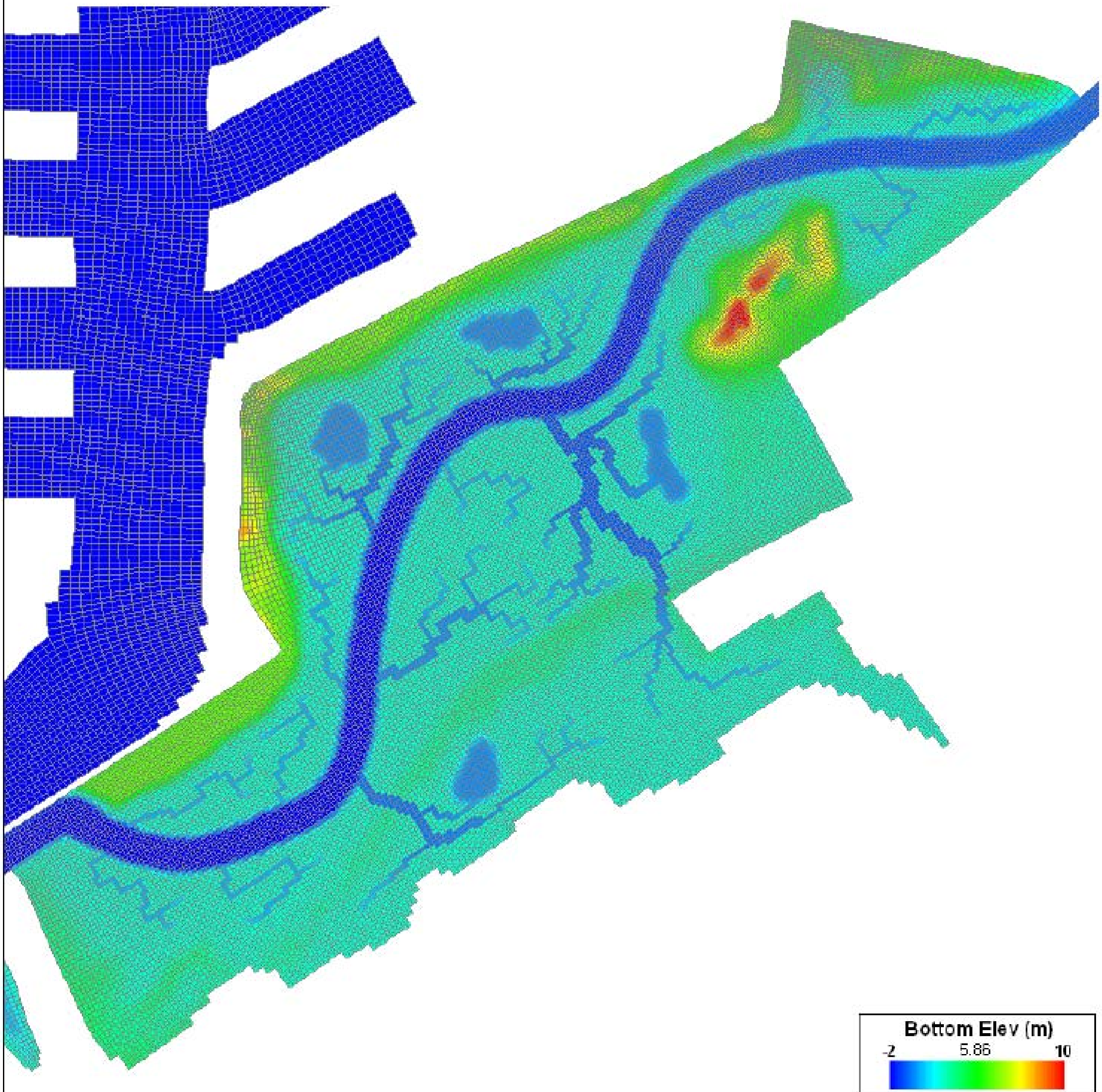


Source: EFDC model setup.
Notes: Bottom elevations shown in meters NAVD.

figure 13
Ballona Wetlands Restoration Project

Alt 4 – Area A Subtidal Bathymetry

PWA Ref# 1793



Source: EFDC model setup.
Notes: Bottom elevations shown in meters NAVD.

figure 14
Ballona Wetlands Restoration Project

Alt 5 – New Creek Bathymetry

PWA Ref# 1793

PWA

C-4. SUPPORTING DOCUMENTATION FOR SECTION 3.3 HYDROLOGY

Section 3.3 of the Lower Ballona Creek Restoration Feasibility Study discusses the expected hydrology for each proposed alternative. The text and figures below provide supporting documentation for the specific model results discussed in the report as well as related model results not explicitly discussed in the Feasibility Study. The section numbers below correspond to the relevant subsections of Section 3.3 (Hydrology).

Section 3.3.1 - Muted Tidal System versus Full Tidal System

Inundation regime is the percentage of time that a given water level is exceeded during a neap-spring tidal cycle. It is a useful parameter for characterizing the tidal inundation at a particular location with a specific elevation. The inundation frequency curves corresponding to Table 3-7 are shown in Figure 15.

Section 3.3.2 - Tidal prism

Tidal prism is the volume of water passing through a channel cross section on each tide (ebb or flood). Tidal prism was evaluated for each restoration area at four cross sections: (1) mouth of Ballona Creek, (2) mouth of Marina Del Rey, (3) Basin H entrance, and (4) Marina del Rey above Basin H. Tidal prism was estimated by integrating the discharge time series at each cross section for each tide (flood or ebb). The mean tidal prism of all floods and all ebbs was estimated for all runs that spanned the full spring-neap cycle. The results are shown in Table 1.

Section 3.3.3 – Connections

Area B southwest wetland SRT and culvert connection

Figure 16 shows a sample water level comparison for the culvert sizing and SRT optimization for the Area B southwest wetland. Two culvert geometries are tested: (1) 2 x 5 ft culverts and (2) 3 x 5 ft culverts. Three elevations are tested for the SRT: 3.6 ft, 4.9 ft, and 6.6 ft NAVD. Increasing the culvert area increases the tide range within the wetland and improves drainage from the wetland to Ballona Creek. The effect of the SRT in limiting high water within the site is seen once the Ballona Creek water levels reach the closure elevation.

Area B southeast wetland, Area A small marsh, Area A large marsh, Area A subtidal

Figure 17 illustrates the procedure adopted to size the culvert connections to each wetland. The number of culverts was increased until the tide range within the wetland approximately matched that of Ballona Creek. As can be seen in Figure 17, once the number of culverts increases beyond six 5-ft culverts, there are very small incremental gains in tide range for relatively large increases in culvert cross sectional area. The same procedure was followed to size the culverts for the small and large marshes and subtidal portion of Area A, shown in Figure 18, Figure 19, and Figure 20, respectively.

Area B southwest breach

The Area B breach was sized with a similar objective to the culvert sizing described above. The breach was sized to allow full conveyance of the tidal signal to the wetland (i.e. no tidal damping or muting). A sample water level comparison is shown in Figure 21.

Section 3.3.4 - Channel Network

Section 3.3.4 of the Feasibility Report discusses the expected channel network characteristics for each alternative. See Appendix C-2 (Marsh channel representation in Lower Ballona EFDC model) for a more detailed explanation of the methodology used to develop the channel networks.

Section 3.3.6 - Excursion Length

Section 3.3.6 of the Feasibility Report provides a qualitative discussion of tidal excursion lengths and implications for hydraulic connectivity and mixing in Ballona Creek. Excursion length was examined at the same cross sections locations as for the tidal prism analysis: (1) mouth of Ballona Creek, (2) mouth of Marina del Rey, and (3) Entrance to Basin H. For this application, excursion length was calculated by integrating the velocity time series over each tidal cycle to obtain the tidal excursion for each flood or ebb tide. The median tidal excursion lengths for flood and ebb were then tabulated for each model run. The results are shown in Table 2.

Section 3.3.7 – Flooding

50-yr hydrograph

The Ballona Creek Ecosystem Restoration Feasibility Study Hydrology Appendix (USACE 2008) presents results of a flood frequency analysis and rainfall-runoff model for the Ballona Creek watershed. A discharge-frequency relationship for Ballona Creek at Sawtelle Boulevard for the period 1928-2005 was developed to predict the hydrograph for the 50-yr discharge event (Figure 22). Ballona Creek hydrographs for the 50-year event were provided to PWA by the USACE. PWA then used these hydrographs to estimate the discharge from Sepulveda Channel and from Centinela Channel. These estimates were used as boundary conditions for the model.

50-yr flood water levels

The restoration alternatives were evaluated under flood conditions by using the EFDC model to predict water levels resulting from the 50-yr flood. The predicted peak water levels near the SRT for existing conditions (Figure 23) compare well with the USACE predictions at the same location. Overall changes to the system under Alternative 1 and Alternative 2 are minimal, resulting in nearly identical water level predictions in Ballona Creek as for Existing Conditions (Figure 24, Figure 25). Because of flow through the culverts is limited, water levels within the southeast wetlands peak at lower values than within Ballona Creek and also take longer to drain off with the falling flood water levels (Figure 25). Alternative 3's peak water levels in Ballona Creek were lower than the Existing Conditions peak because the large expanse of wetlands in this alternative provides storage for the flood waters (Figure 26). For floods under Alternatives 1-3, predicted water levels in Area A are not altered since these wetlands are not connected to Ballona Creek. Therefore, Alternative 4, which is identical to Alternative 3 except for the subtidal region of Area A, was not modeled with flood conditions. For Alternative 5, water levels were assessed both upstream near Area C and at the SRT. While the upstream water levels are higher as a consequence of the channel and water surface slope, Alternative 5's upstream water levels are below that of existing conditions (Figure 27). This suggests that flood hazard is unlikely to increase with restoration.

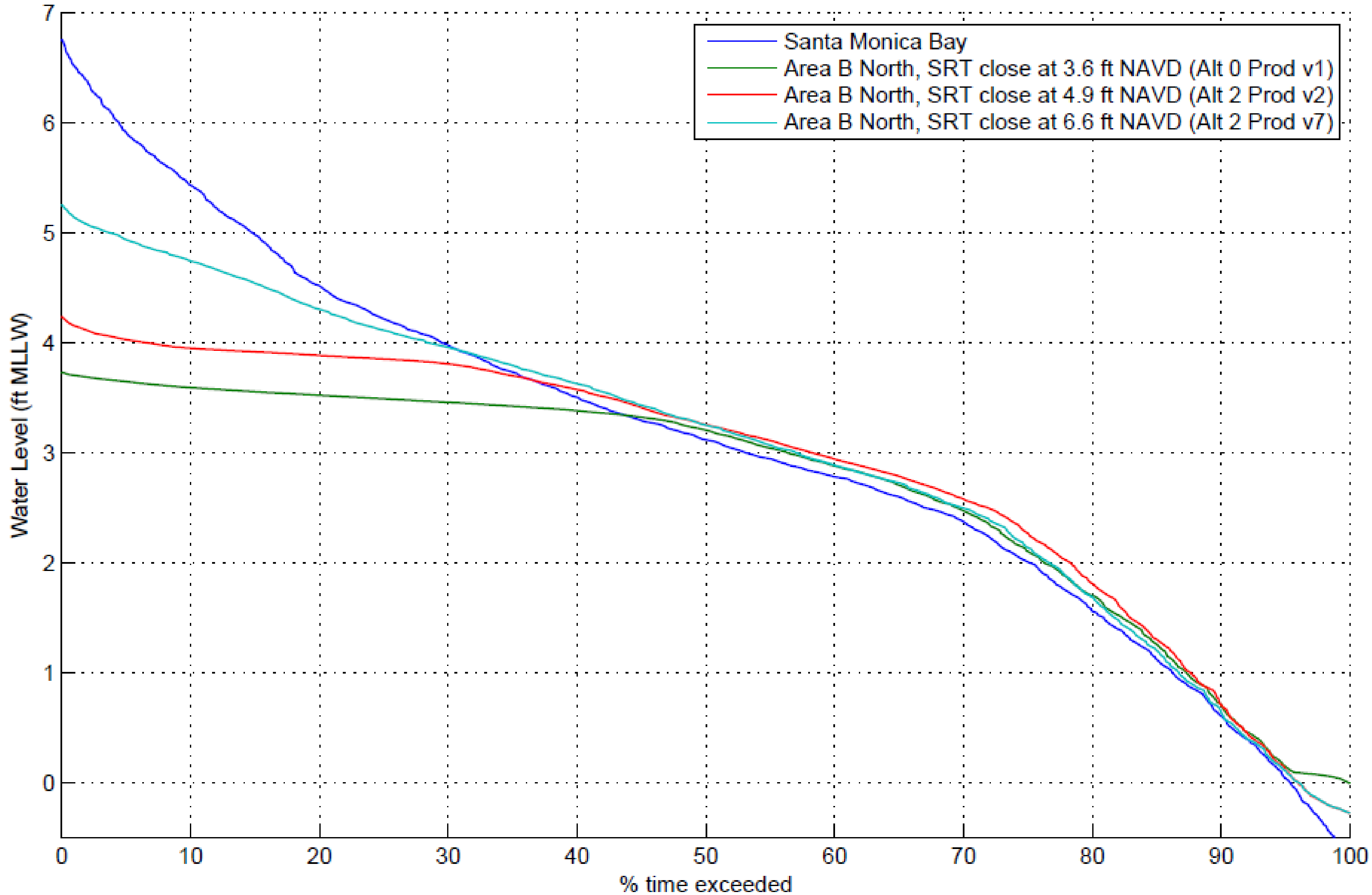
Storm Surge Analysis

Water levels at the Port of Los Angeles were examined using an event selection approach to identify typical storm surge events (super-elevation of water levels above astronomical tides). Events were selected based on events identified in the Ballona Creek Ecosystem Restoration Feasibility Study Hydrology Appendix (USACE 2008), since coastal storms often exhibit high precipitation and storm surge. Typical surges ranged from 0.5 to 1.5 ft above astronomical tides, with a maximum of 1.65 ft during the 1997-1998 El Niño winter. Storm surge events lasted approximately 3-7 days. Table 3 shows a summary of the event-based analysis.

Additional Model Runs

Additional model runs were conducted for each alternative to inform the culvert sizing, SRT closure elevations, and other aspects of the model setup. The full run catalog is shown in Table 4.

Figures



Source: EFDC model predictions

Figure 15
Lower Ballona Wetlands

Inundation frequency, Area B southwest SRT

PWA Ref# 1793.1

PWA

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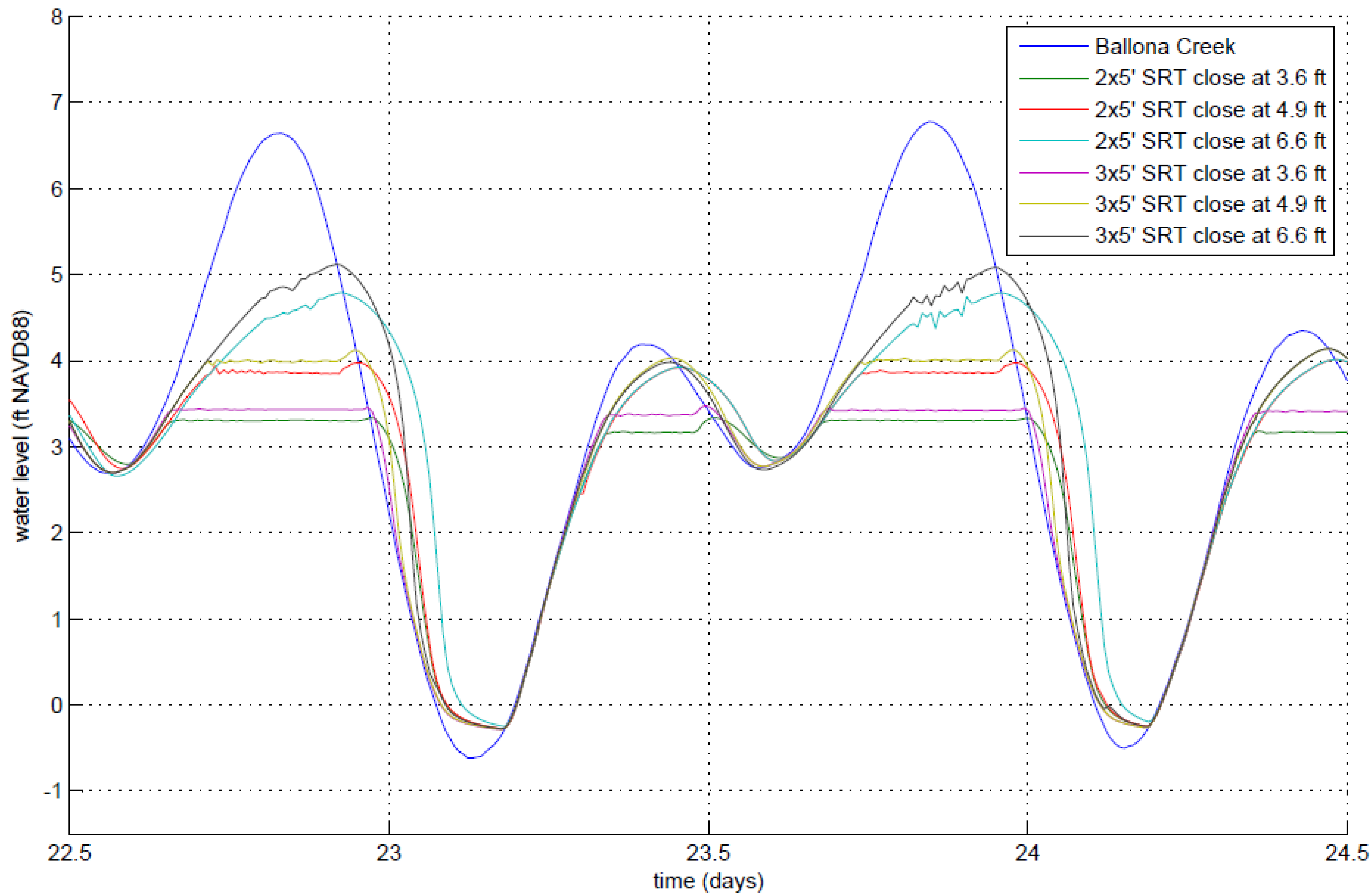

Source: EFDC model predictions

Figure 16
Lower Ballona Wetlands

Culvert sizing and SRT optimization, Area B southwest

PWA Ref# 1793.1

PWA

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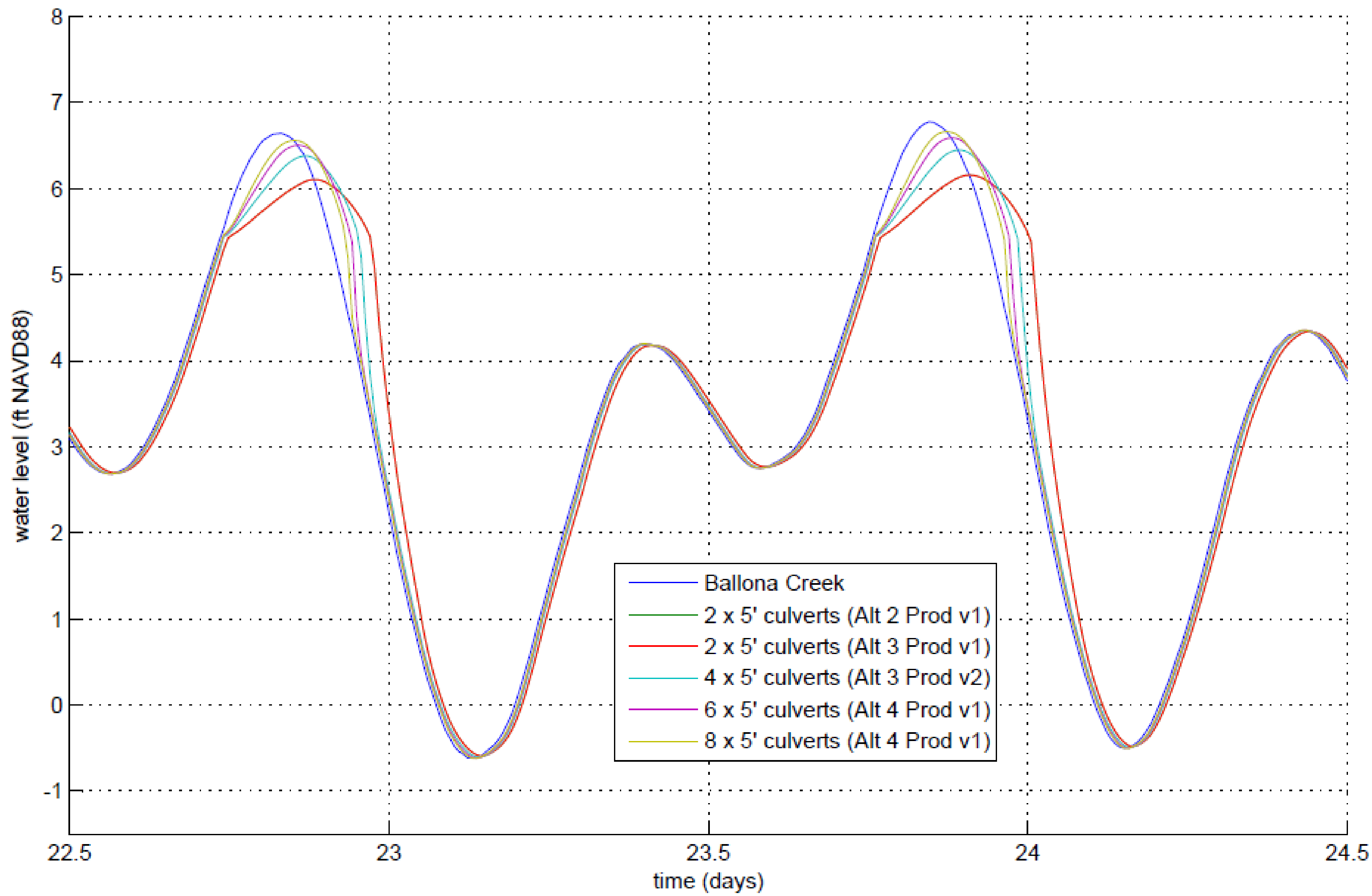

Source: EFDC model predictions

Figure 17
Lower Ballona Wetlands

Culvert Sizing, Area B SE Marsh

PWA Ref# 1793.1

PWA

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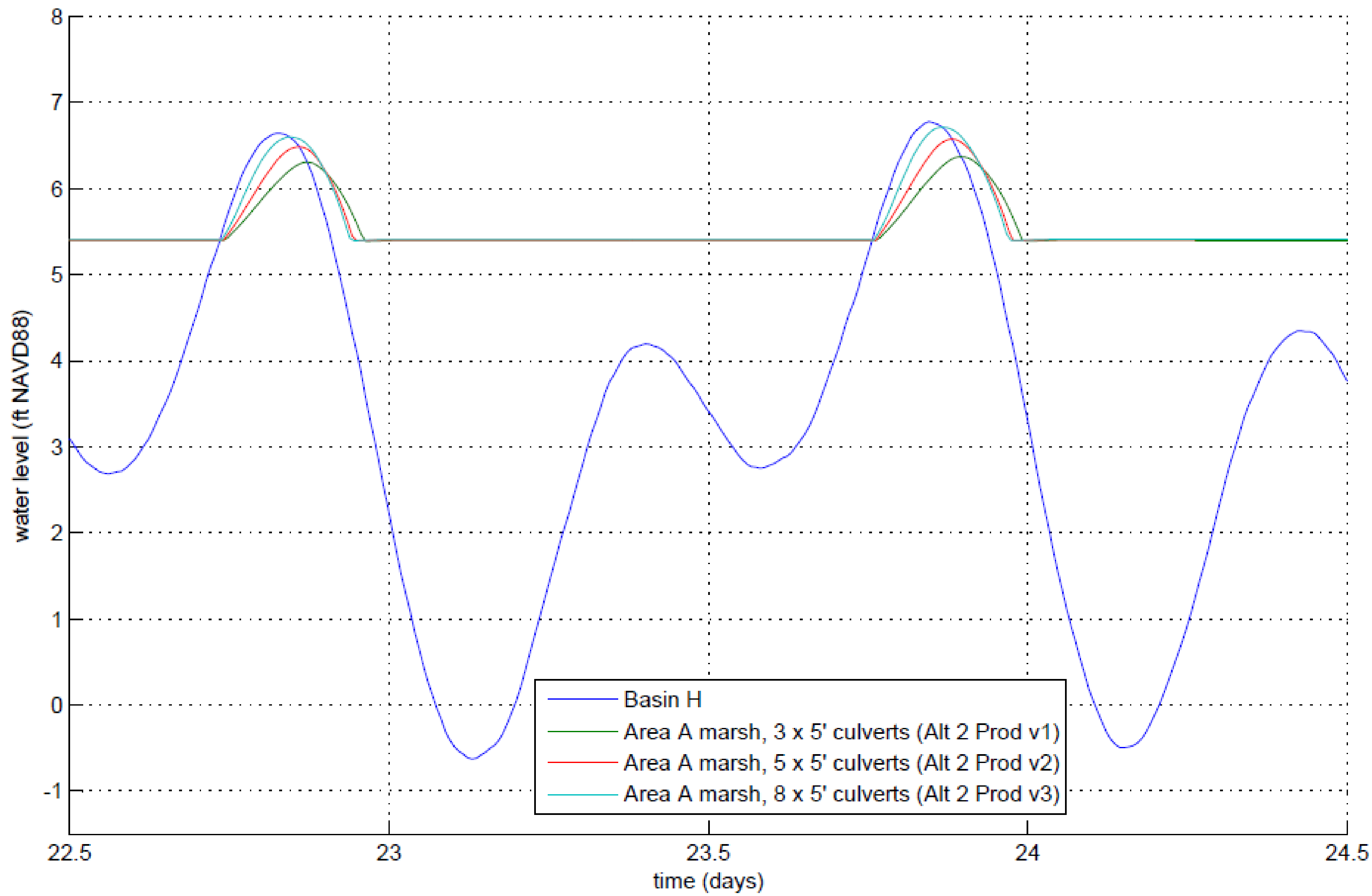


Source: EFDC model predictions

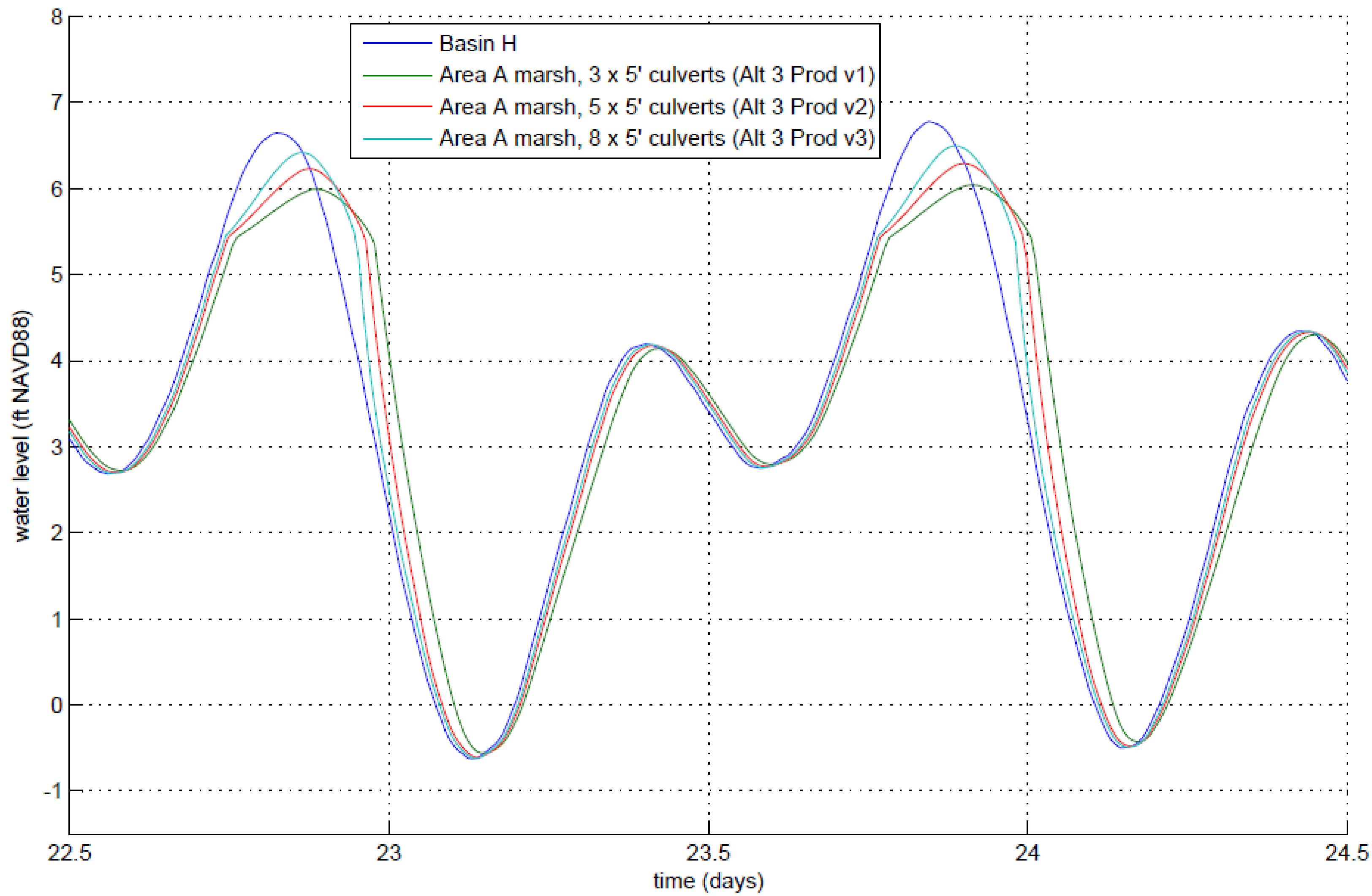
Figure 18
Lower Ballona Wetlands

Culvert Sizing, Area A Small Marsh

PWA Ref# 1793.1

PWA

C:\m.brennan\Projects\1793_Ballona\Modeling\Alternatives\Analysis\Culvert sizing\compare_culverts_AreaA_small_marsh.m



Source: EFDC model predictions

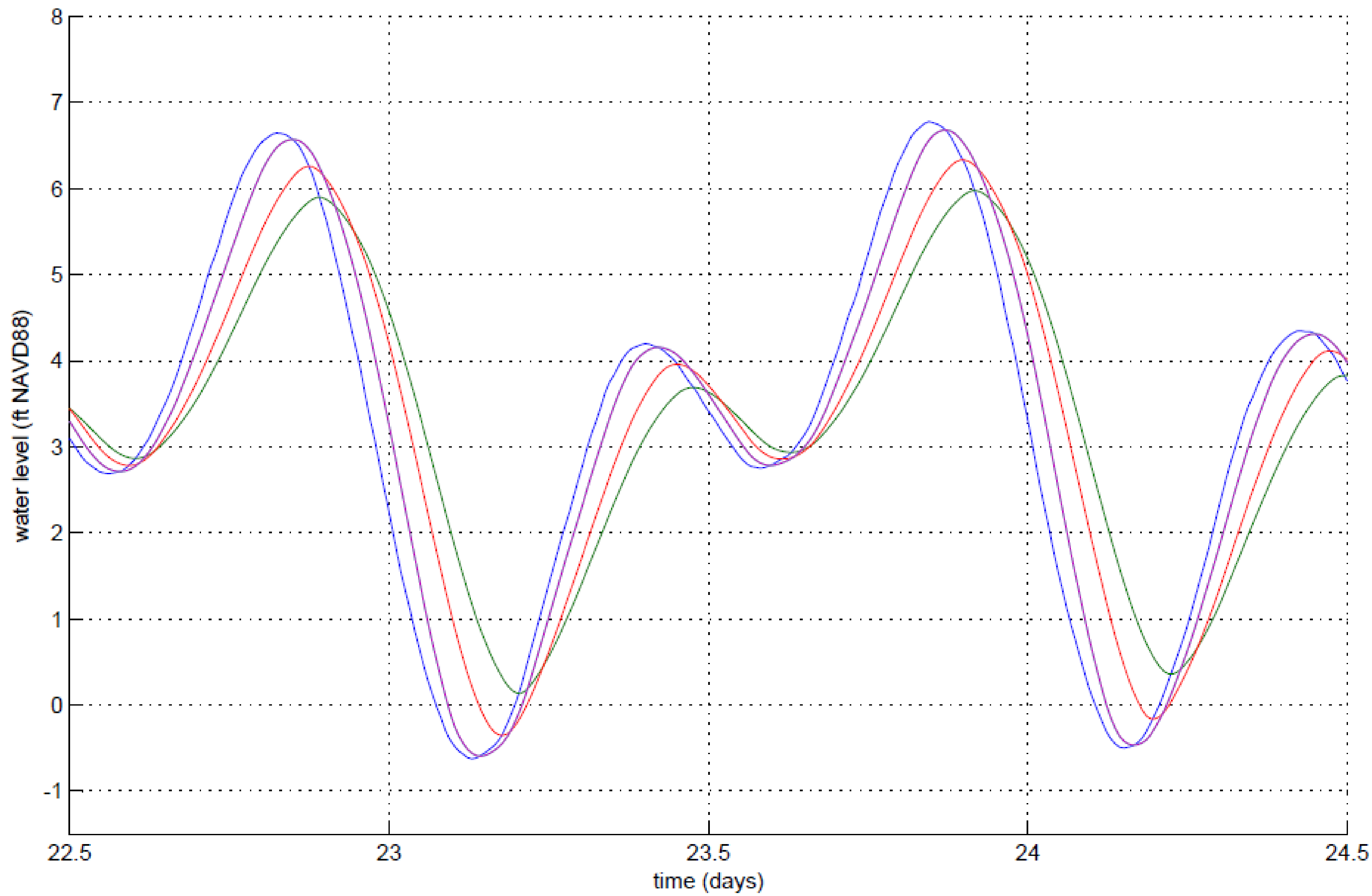
Figure 19
Lower Ballona Wetlands

Culvert Sizing, Area A Large Marsh

PWA Ref# 1793.1

PWA

C:\m.brennan\Projects\1793_Ballona\Modeling\Alternatives\Analysis\Culvert sizing\compare_culverts_AreaA_large_marsh.m



Source: EFDC model predictions

- Basin H
- Area A subtidal, 8 x 5' culverts (Alt 4 Prod v1)
- Area A subtidal, 12 x 5' culverts (Alt 4 Prod v2)
- Area A subtidal, 2x(12 x 5') culverts (Alt 4 Prod v5)
- Area A subtidal, 2x(12 x 5') culverts @ Via Venetia (Alt 4 Prod v6)

Figure 20
Lower Ballona Wetlands

Culvert Sizing, Area A Subtidal

PWA Ref# 1793.1

PWA

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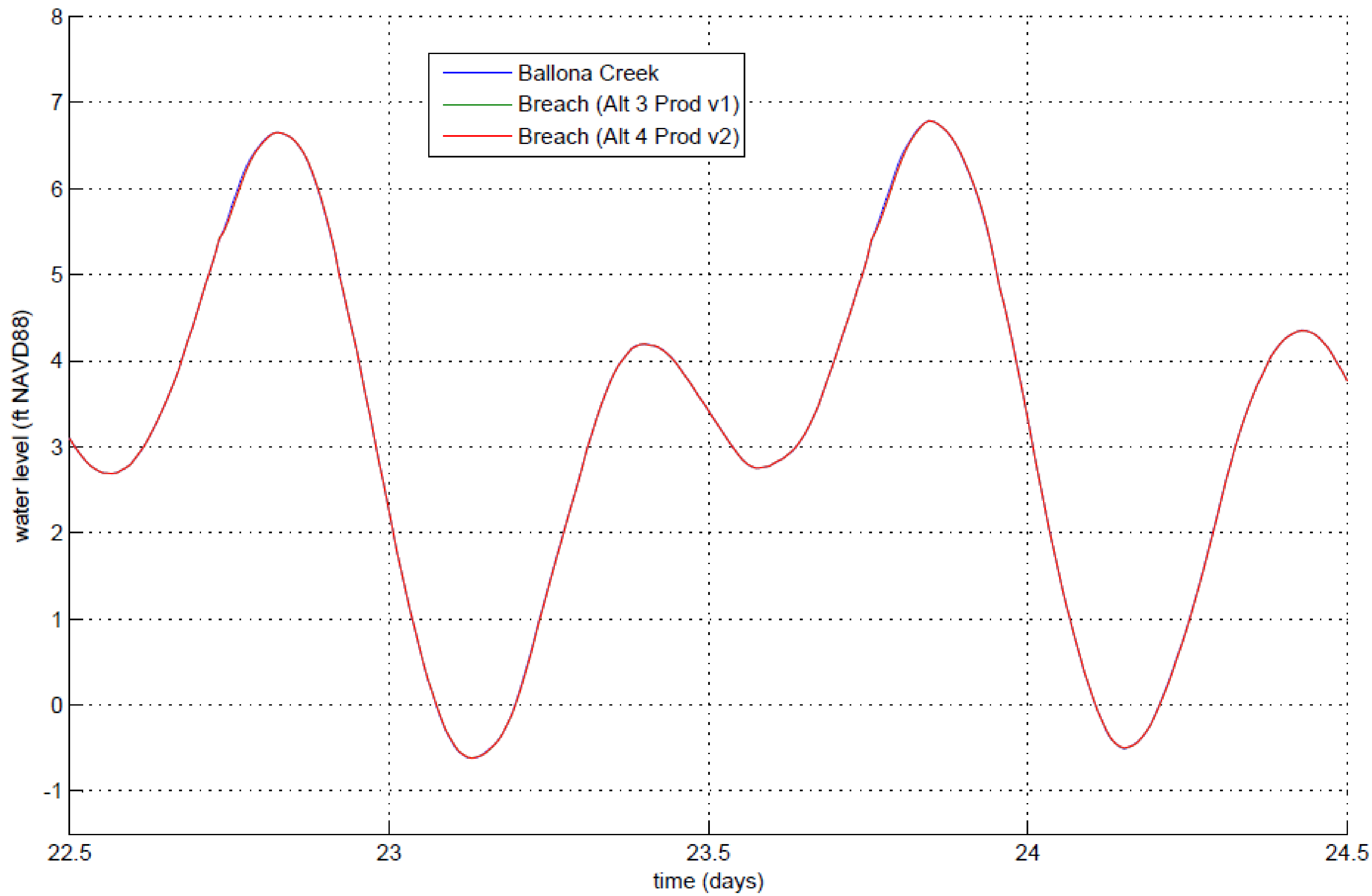

Source: EFDC model predictions

Figure 21
Lower Ballona Wetlands

Culvert Sizing, Area B Southwest Breach

PWA Ref# 1793.1

PWA

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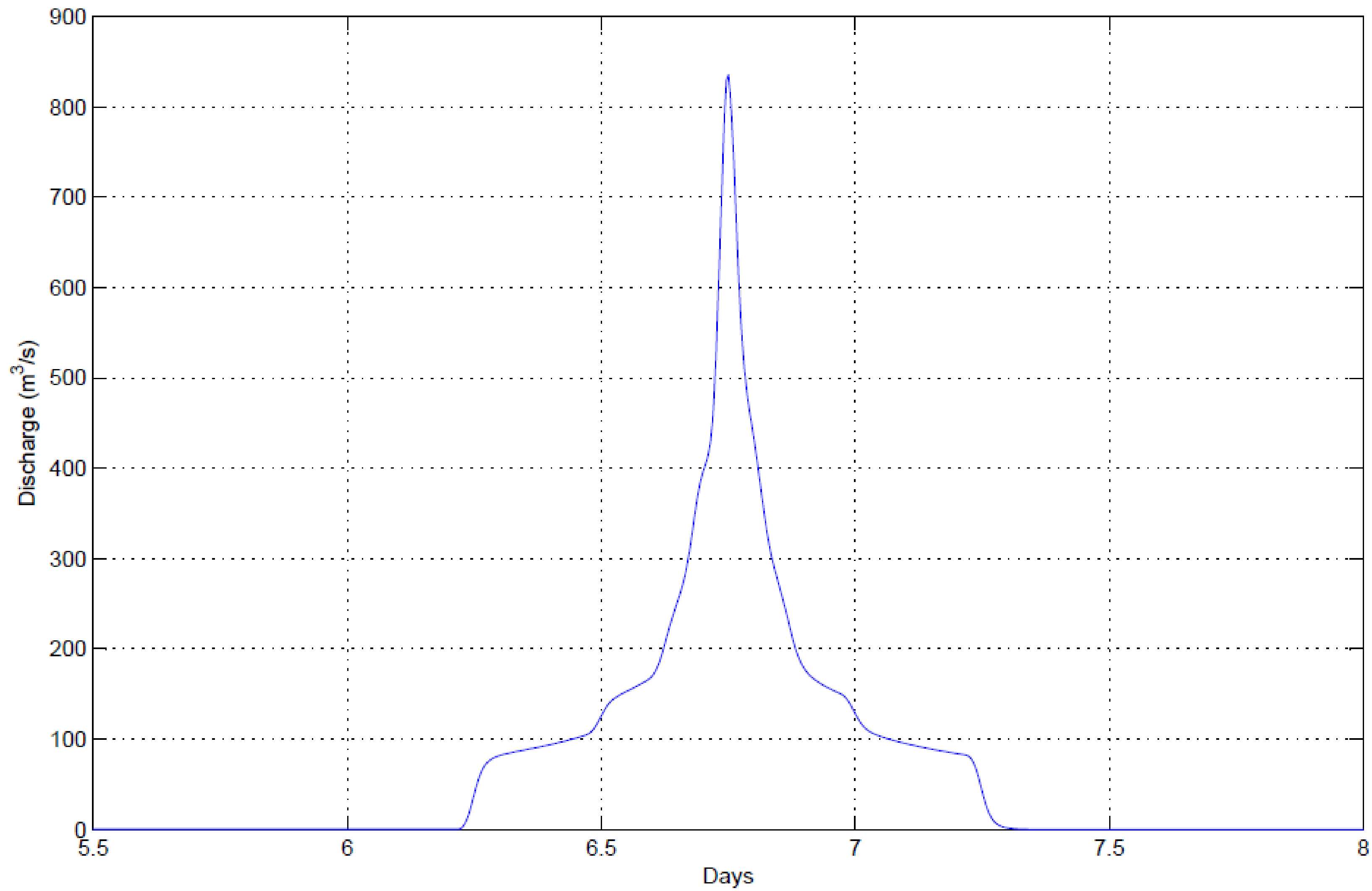


Source: Ballona Creek Ecosystem Restoration Feasibility Study Hydrology Appendix F3 - Without Project Hydrologic Analysis. January 2008. U.S. Army Corps of Engineers, South Pacific Division, Los Angeles District

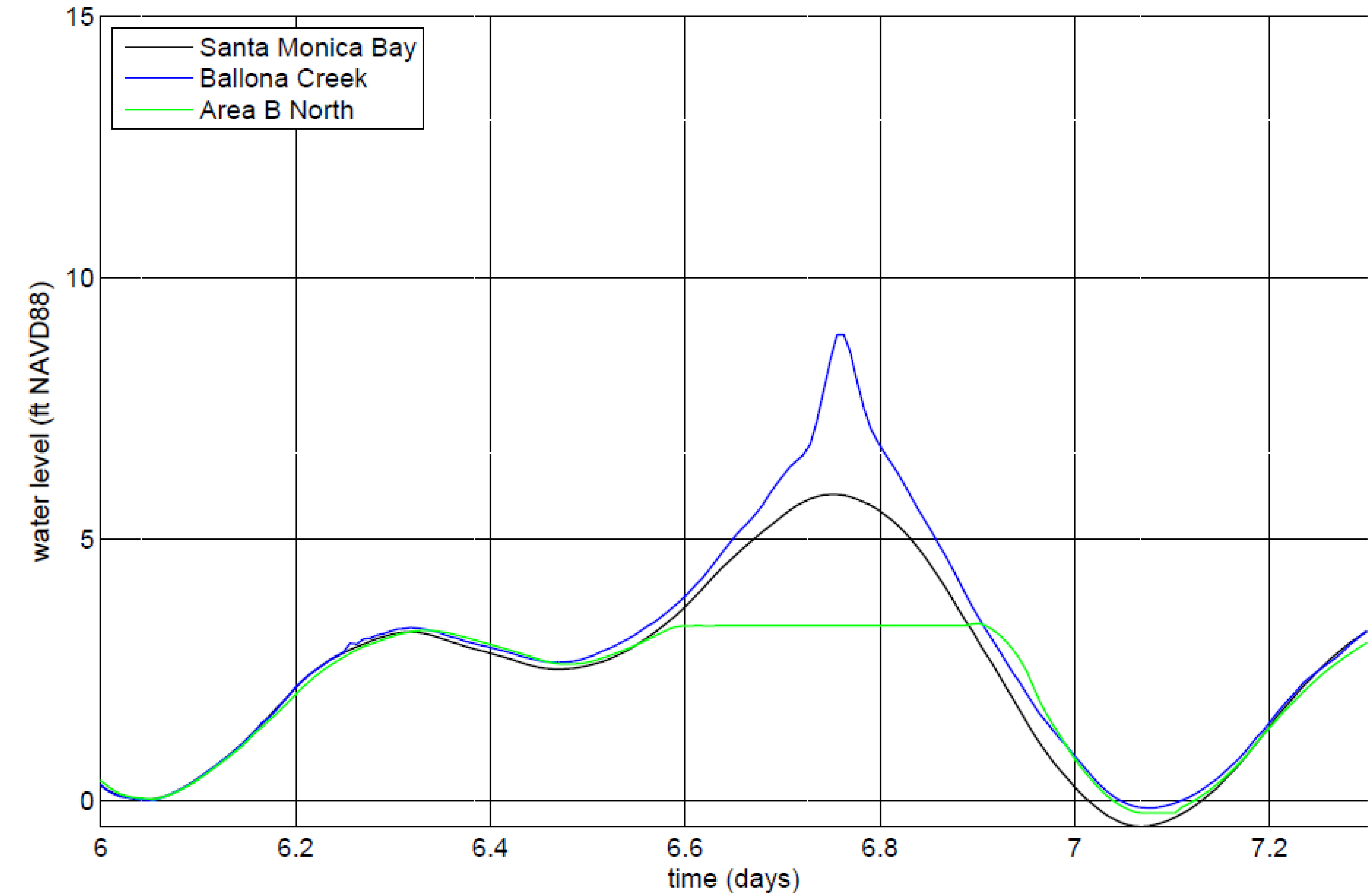
Figure 22
Ballona Wetlands Restoration Project

Ballona Creek 50-yr hydrograph at Sawtelle Blvd

PWA Ref# 1793

PWA

J:\1793_Ballona_Wetlands\1793.01_Modeling\Reporting\Modeling appendix\Flooding\plot_50yr_hydrograph.m



Source: EFDC model predictions

Figure 23
Lower Ballona Wetlands

Existing Conditions: Water Levels, 50-yr Flood

PWA Ref# 1793.1

PWA

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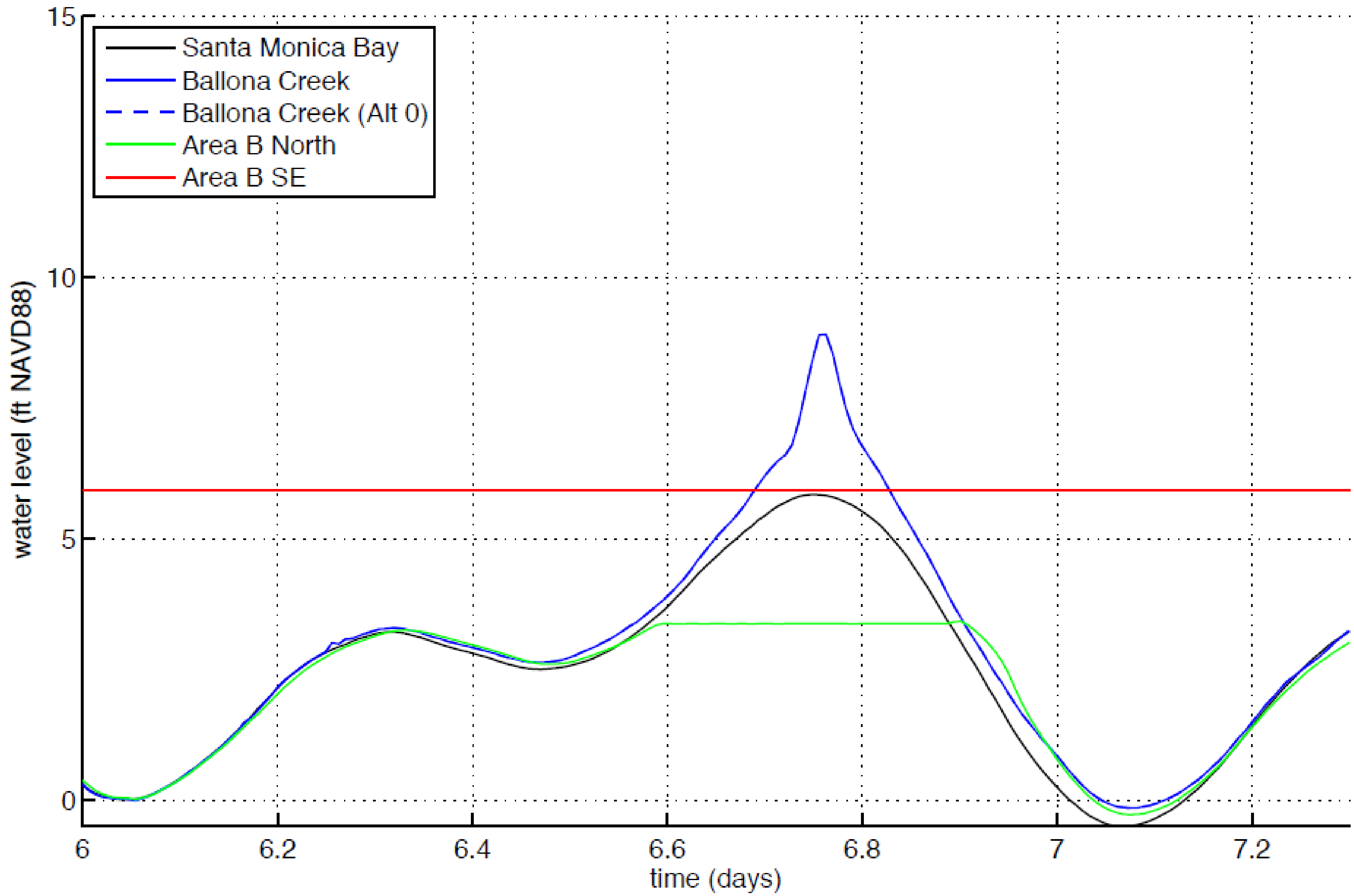


Source: EFDC model predictions

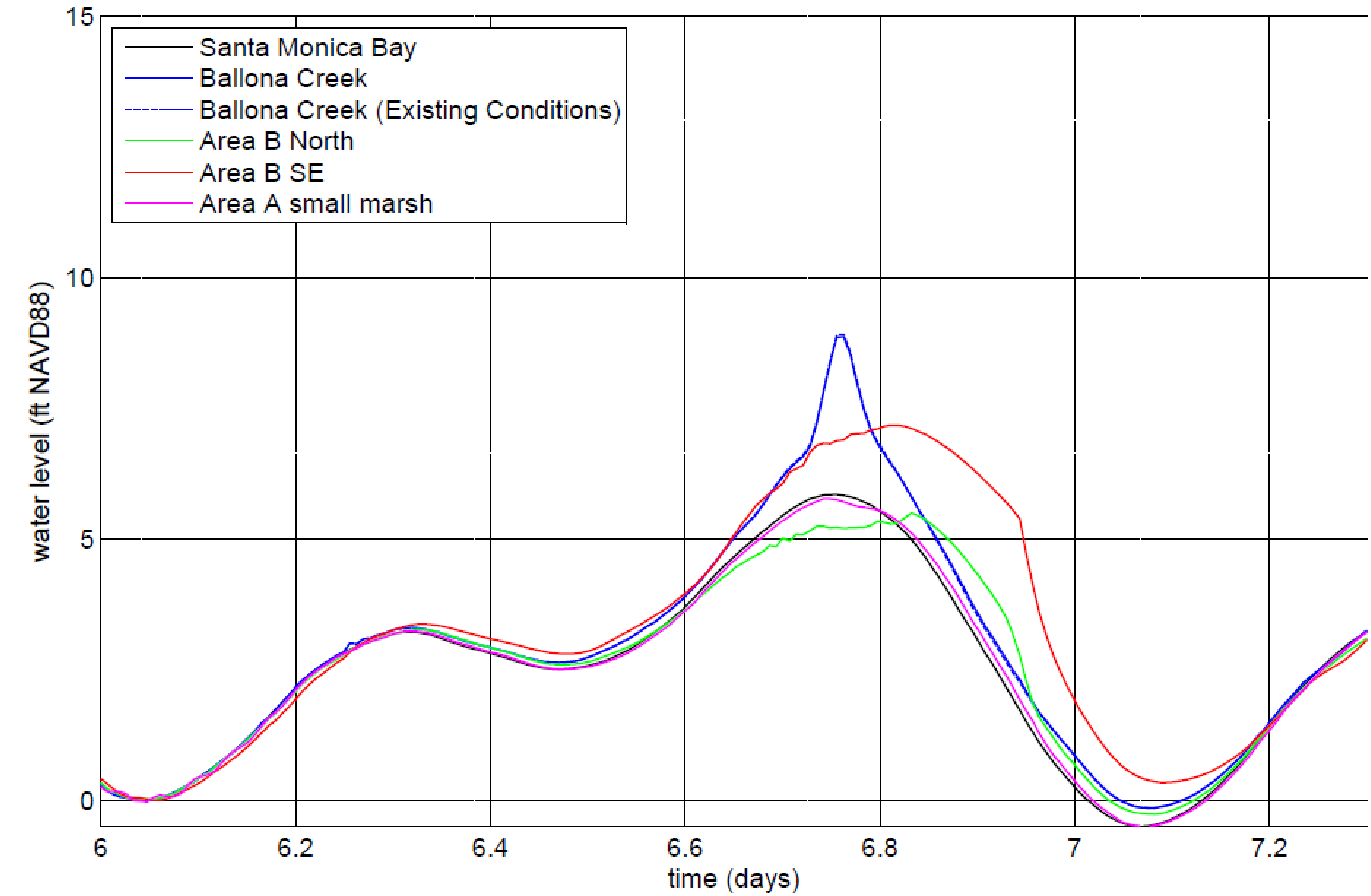
Figure 24
Lower Ballona Wetlands

Alt. 1: Water Levels, 50−yr Flood

PWA Ref# 1793.1

PWA

C:\m.brennan\Projects\1793_Ballona\Modeling\Alternatives\Analysis\Flooding\plot_alt1_flood.m



Source: EFDC model predictions

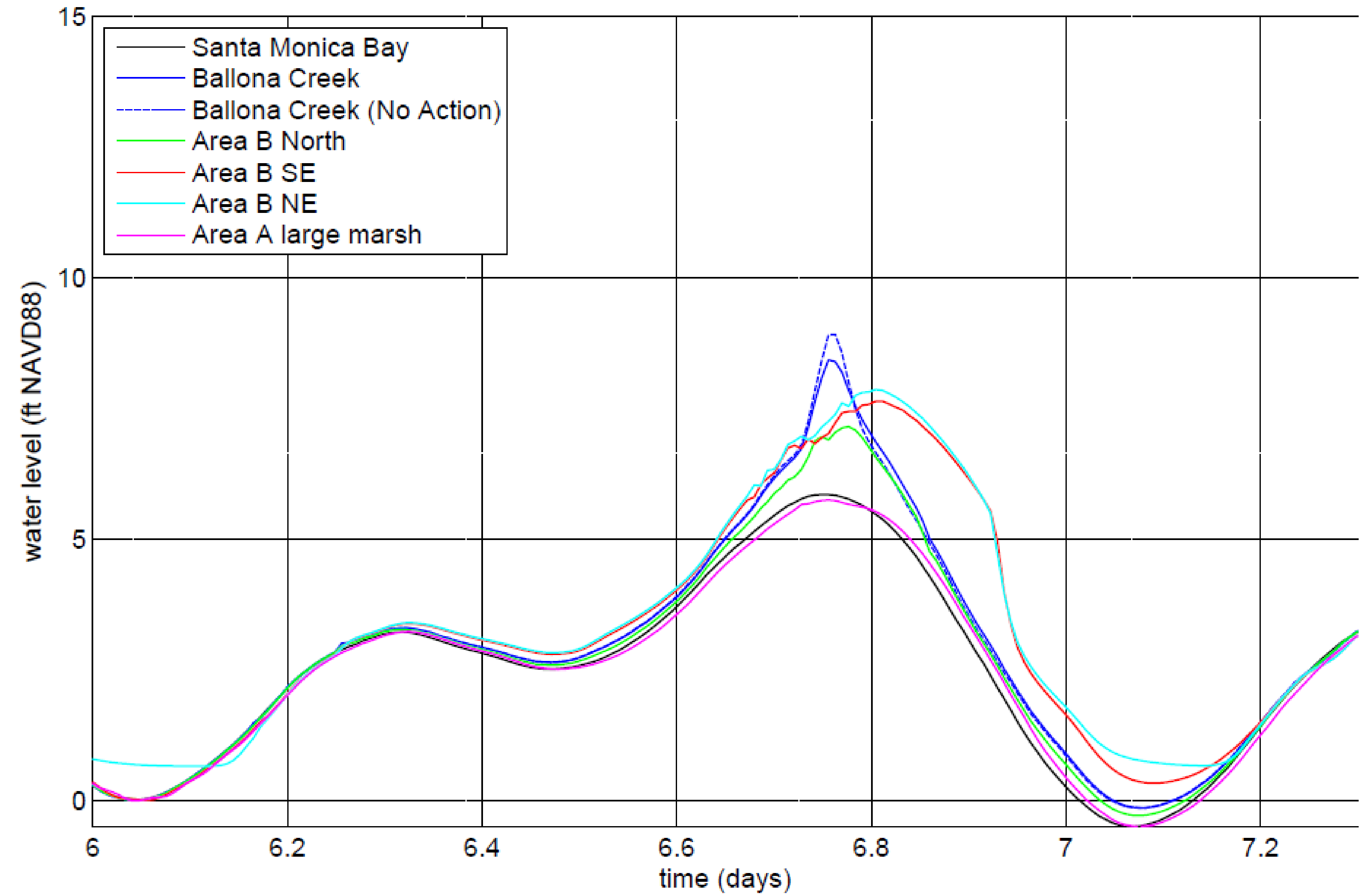
Figure 25
Lower Ballona Wetlands

Alt. 2: Water Levels, 50-yr Flood

PWA Ref# 1793.1

PWA

C:\m.brennan\Projects\1793_Ballona\Modeling\Alternatives\Analysis\Flooding\plot_alt2_flood.m



Source: EFDC model predictions

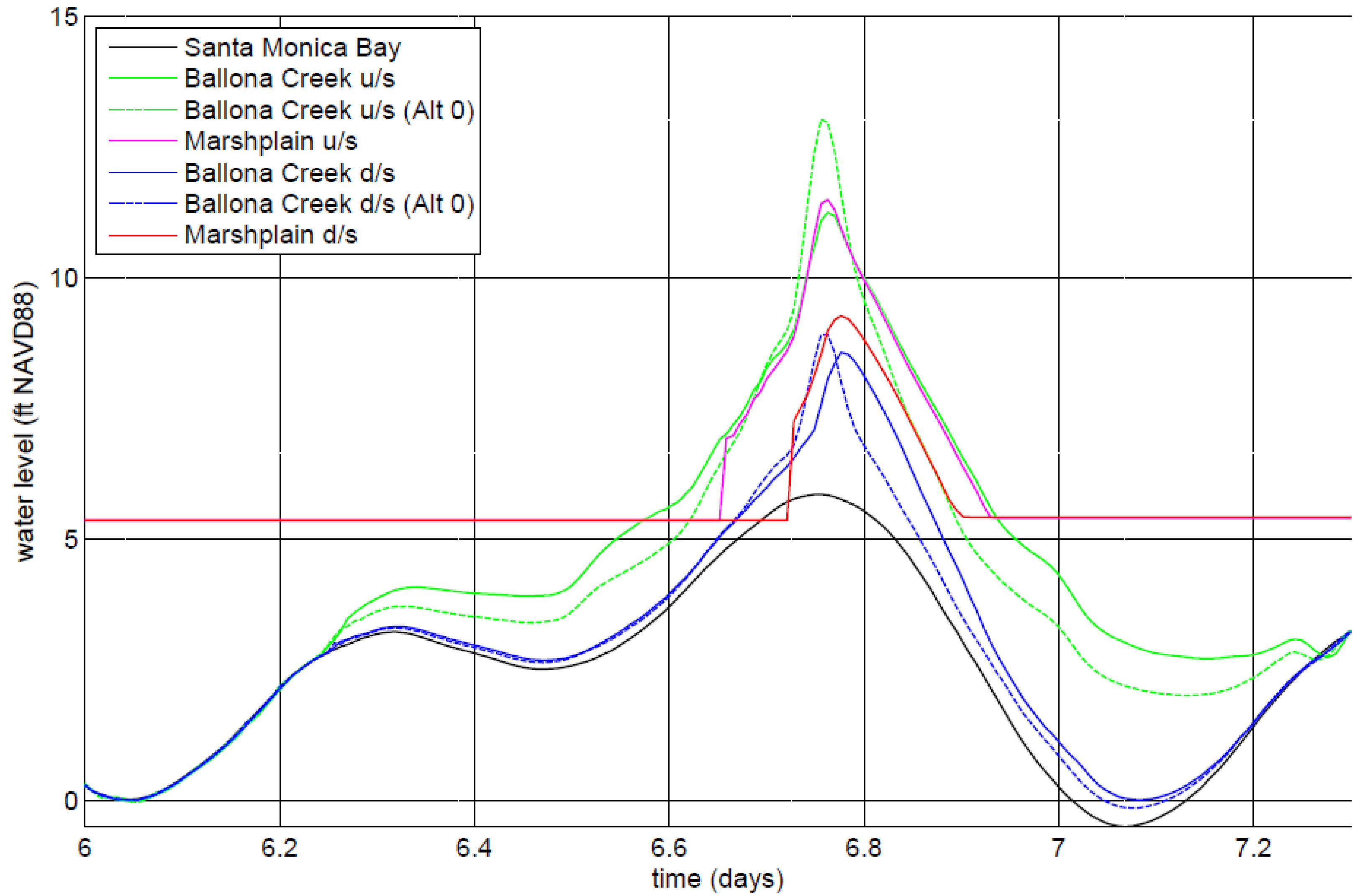
Figure 26
Lower Ballona Wetlands

Alt. 3: Water Levels, 50-yr Flood

PWA Ref# 1793.1

PWA

C:\m.brennan\Projects\1793_Ballona\Modeling\Alternatives\Analysis\Flooding\plot_alt3_flood_2.m



Source: EFDC model predictions

Figure 27
Lower Ballona Wetlands

Alt. 5: Water Levels, 50-yr Flood

PWA Ref# 1793.1

PWA

C:\m.brennan\Projects\1793_Ballona\Modeling\Alternatives\Analysis\Flooding\plot_alt5_flood.m

Table 1. Modeled Tidal Prism at Selected Cross Sections
1793.01 Ballona Wetlands Restoration Project
Tidal prism in ac-ft

	Mouth of Ballona Creek		**Mouth of Marina del Rey**		**Entrance to Basin H**		**Marina del Rey above Basin H**	
Model Run*	mean flood	mean ebb	mean flood	mean ebb	mean flood	mean ebb	mean flood	mean ebb
Alt 0 Prod v1	231	-243	1291	-1400	9	-10	382	-350
Alt 1 Prod v1	235	-279	1402	-1287	12	-14	364	-416
Alt 2 Prod v1	267	-314	1384	-1343	31	-35	376	-432
Alt 2 Prod v2	274	-306	1348	-1383	36	-44	382	-440
Alt 2 Prod v3	277	-405	1221	-1418	48	-53	464	-529
Alt 2 Prod v7	284	-331	1281	-1385	43	-47	394	-424
Alt 3 Prod v1	386	-416	1404	-1362	54	-55	388	-431
Alt 3 Prod v2	390	-419	1409	-1367	60	-68	382	-409
Alt 3 Prod v4	396	-427	1477	-1438	69	-70	380	-456
Alt 4 Prod v1	391	-421	1625	-1488	294	-298	376	-448
Alt 4 Prod v2	392	-421	1701	-1651	345	-348	414	-448
Alt 4 Prod v5	392	-421	1765	-1714	381	-371	461	-466
Alt 4 Prod v6	392	-421	1764	-1713	10	-10	509	-516
Alt 5 Prod v1	599	-627	1400	-1284	11	-12	381	-409

* See run catalog for more detailed description of model setup for each run.

Table 2. Median tidal excursions lengths
1793.01 Ballona Wetlands Restoration Project

	Ballona Creek		Marina del Rey		Basin H Entrance	
Model Run*	flood (mi)	ebb (mi)	flood (mi)	ebb (mi)	flood (mi)	ebb (mi)
Alt 0 - No action\Prod v1	0.63	-0.71	0.75	-0.52	0.01	-0.01
Alt 1 - Muted tidal\Prod v1	0.64	-0.72	0.67	-0.57	0.01	-0.02
Alt 2 - Partial tidal\Prod v1	0.69	-0.76	0.69	-0.58	0.04	-0.03
Alt 2 - Partial tidal\Prod v2	0.71	-0.82	0.69	-0.58	0.06	-0.02
Alt 2 - Partial tidal\Prod v7	0.79	-0.83	0.69	-0.58	0.04	-0.02
Alt 3 - Full tidal\Prod v1	1.03	-0.95	0.70	-0.59	0.07	-0.05
Alt 3 - Full tidal\Prod v2	1.03	-0.95	0.70	-0.59	0.12	-0.04
Alt 3 - Full tidal\Prod v4	1.03	-0.95	0.70	-0.59	0.11	-0.04
Alt 4 - Area A subtidal\Prod v1	1.03	-0.95	0.78	-0.65	0.37	-0.10
Alt 4 - Area A subtidal\Prod v2	1.03	-0.95	0.81	-0.69	0.41	-0.18
Alt 4 - Area A subtidal\Prod v5	1.03	-0.95	0.85	-0.72	0.47	-0.20
Alt 4 - Area A subtidal\Prod v6	1.03	-0.95	0.84	-0.72	0.01	-0.01
Alt 5 - New creek\Prod v1	1.52	-1.43	0.67	-0.57	0.01	-0.02

* See run catalog for more detailed description of model setup for each run.
Note: mi = miles

Table 3. Storm Surge Event-based Analysis for Ballona Creek Mouth
1793.01 Ballona Wetlands Modeling
J. Vandever (PWA)
Date: April 10, 2008

Event*	Description	Storm Dates	Peak Surge (ft)**	Date/Time***	Approx. Duration (days)****
1	Series of winter storms tracked eastward from North Pacific	27 February - 3 March 1938	0.76	3/2/38 15:40	3
2	Winter storm, combination of warm Pacific cyclone and cold coastal storm	21-23 January 1943	1.35	1/22/43 21:10	3.5
3a	Low-latitude north Pacific cyclone	3-4 March 1943	0.54	3/3/43 18:00	2.5
3b			0.75	2/22/43 20:00	4
4	Combination of cold low pressure system moving down coast and subtropical cyclone	19-21 November 1967	0.64	11/21/67 19:10	4
5a	Series of unusually intense low latitude Pacific storms	18-26 January 1969	0.86	1/21/69 5:00	4.5
5b	Series of unusually intense low latitude Pacific storms	18-26 January 1969	0.80	1/25/69 7:00	5.5
6	Pacific cyclone cold front	3-4 December 1974	-	-	-
7	Persistent series of warm, subtropical Pacific storms from SW	5-13 February 1978	1.58	2/10/78 1:30	6
8	Persistent series of warm, subtropical Pacific storms from SW	27 February - 5 March 1978	1.32	3/1/78 2:00	7
9a	1982-83 El Nino Winter	1982-83 Winter	1.64	3/2/83 1:20	7
9b	1982-83 El Nino Winter		1.23	2/2/83 15:30	7
10	High storm event in SF Bay	3 December 1983	-	-	-
11	1997-1998 El Nino Winter	1997-98 Winter	1.65	2/3/1998 9:30	3

Average Surge	**1.1**

* Events were selected based on the COE Ballona Creek Ecosystem Study Appendix F3 Hydrology.
* Peak surge determined from the max residual between observed and predicted water level at NOAA Station #9410660 Los Angeles
** Dates and times are given in local standard time (LST)
*** Approximate storm durations were determined by visually examining the residual time series for each event

Table 4. Ballona Wetlands Modeling Run Catalog					
Restoration alternatives	**Run name**	**Status P=planned S=setup R=running C=complete A=analyzed**	**Tide or Flood**	**Run period, days**	**Project area configuration**
No Action					
	Calibration v1	C	Tide	0.1-19.1	Area B N: Existing SRT (2x5' culverts)
	Alt 0 - Prod v1	C	Tide	10.88-28.88	Area B N: Existing SRT (2x5' culverts)
	Alt 0 - Prod fld v6	C	Flood	5.86-7.36	Area B N: Existing SRT (2x5' culverts)
Alt 1- Muted tidal					
	Alt 1 - Prod v1	A	Tide	10.88-28.88	Area B N: Existing SRT (2x5' culverts, cutoff at 1.1 m NAVD) Area B SE: 2x5' culverts, cutoff at 2 m NAVD
	Alt 1 - Prod v2	A	Tide	10.88-21.1	Area B N: Modified SRT (4x5' culverts, cutoff at 1.5 m NAVD) Area B SE: 4x5' culverts, cutoff at 2.25 m NAVD
	Alt 1 - Prod fld v2	R	Flood	5.28-6.78	Area B N: Existing SRT (2x5' culverts, cutoff at 1.1 m NAVD) Area B SE: 2x5' culverts, cutoff at 2 m NAVD
	Alt 1 - Prod fld v3	R	Flood	5.86-7.36	Area B N: Existing SRT (2x5' culverts, cutoff at 1.1 m NAVD) Area B SE: 2x5' culverts, cutoff at 2 m NAVD
Alt 2 - Partial tidal					
	Alt 2 - Prod v1	A	Tide	10.88-28.88	Area B N: Existing SRT (2x5' culverts, cutoff at 1.1 m NAVD) Area B SE: 2x5' culverts Area A: 3x5' culverts, Dock 52
	Alt 2 - Prod v2	A	Tide	10.88-28.88	Area B N: Modified SRT (2x5' culverts, cutoff at 1.5 m NAVD) Area B SE: 2x5' culverts Area A: 5x5' culverts, Dock 52
	Alt 2 - Prod v3	A	Tide	21.8-24.8	Area B N: Modified SRT (2x5' culverts, cutoff at 2.0 m NAVD) Area B SE: 2x5' culverts Area A: 8x5' culverts, Dock 52
	Alt 2 - Prod v4	A	Tide	21.8-24.8	Area B N: Modified SRT (3x5' culverts, cutoff at 2.0 m NAVD) Area B SE: 2x5' culverts Area A: 8x5' culverts, Dock 52
	Alt 2 - Prod v5	A	Tide	21.8-24.8	Area B N: Modified SRT (3x5' culverts, cutoff at 1.5 m NAVD) Area B SE: 2x5' culverts Area A: 8x5' culverts, Dock 52
	Alt 2 - Prod v6	A	Tide	21.8-24.7	Area B N: Modified SRT (3x5' culverts, cutoff at 1.1 m NAVD) Area B SE: 2x5' culverts Area A: 8x5' culverts, Dock 52
	Alt 2 - Prod v7	A	Tide	10.88-28.88	Area B N: Modified SRT (3x5' culverts, cutoff at 2.0 m NAVD) Area B SE: 2x5' culverts Area A: 8x5' culverts, Dock 52
	Alt 2 - Prod fld v2	C	Flood	5.28-6.78	Area B N: Modified SRT (2x5' culverts, cutoff at 2.0 m NAVD) Area B SE: 2x5' culverts Area A: 8x5' culverts, Dock 52
	Alt 2 - Prod fld v3	C	Flood	5.86-7.36	Area B N: Modified SRT (2x5' culverts, cutoff at 2.0 m NAVD) Area B SE: 2x5' culverts Area A: 8x5' culverts, Dock 52
Alt 3 - Fully tidal					
	Alt 3 - Prod v1	A	Tide	10.88-28.88	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 2x5' culverts Area A: 3x5' culverts, Dock 52
	Alt 3 - Prod v2	A	Tide	10.88-28.88	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 4x5' culverts Area A: 5x5' culverts, Dock 52
	Alt 3 - Prod v3	A	Tide	21.8-24.7	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 4x5' culverts Area A: 8x5' culverts, Dock 52
	Alt 3 - Prod v4	A	Tide	9.88-28.88	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 4x5' culverts Area A: 8x5' culverts, Dock 52
	Alt 3 - Prod fld v4	C	Flood	5.86-7.36	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 2x5' culverts Area A: 3x5' culverts, Dock 52

Alt 4 - Subtidal					
	Alt 4 - Prod v1	A	Tide	10.88-28.88	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 6x5' culverts Area A: 8x5' culverts, Dock 52
	Alt 4 - Prod v2	A	Tide	10.88-28.88	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 8x5' culverts Area A: 12x5' culverts, Dock 52
	Alt 4 - Prod v3	A	Tide	10.88-11.2	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 8x5' culverts Area A: 8*(12x5' culverts), Dock 52
	Alt 4 - Prod v4	A	Tide	10.88-11.2	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 8x5' culverts Area A: 4*(12x5' culverts), Dock 52
	Alt 4 - Prod v5	A	Tide	10.88-28.88	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 8x5' culverts Area A: 2*(12x5' culverts), Dock 52
	Alt 4 - Prod v6	C	Tide	10.88-28.88	Area B N: Breach to Creek Area B NE: 2x5' culverts Area B SE: 8x5' culverts Area A: 2*(12x5' culverts), Via Venetia
Alt 5 - New creek					
	Alt 5 - Prod v1	C	Tide	10.88-28.88	Phase 3
	Alt 5 - Prod fld v4	P	Flood	5.86-7.36	Phase 3
SLR / Storm surge					

APPENDIX D.
DETAILED COST ESTIMATES AND SUPPORTING INFORMATION

Table D-1. Summary of Engineer's Estimates[1] for Alternatives 1 to 5. Costs in Millions of Dollars

Alternative	Area A	Area B	Area C	Total
1	$4.0	$2.6	--	**$6.6**
2	$42.6	$16.0	$3.3	**$61.8**
3	$69.3	$55.5	$5.2	**$130.0**
4	$108.4	$55.5	$5.2	**$169.0**
5	$99.8	$59.0	$50.4	**$209.3**
	Phase 1	**Phase 2**	**Phase 3**	
5 [2]	$110.4	$48.8	$50.5	**$209.7**

Notes

1 - Estimated construction costs include a 35% contingency

2 - The cost estimate for phasing Alternative 5 is higher due to the construction of a temporary levee

Table D-2. Estimated Volumes of Excess Material to Be Stockpiled and Rough Calcuation of Possible Stockpile Areas and Number of Truck Loads.

	Stockpile Volume (CY)				Stockpile Volume (ac-ft)				5-ft High Stockpile Areas (ac) [1]				10-ft High Stockpile Areas (ac) [1]				No. Truck Loads [2]
	Area A	**Area B**	**Area C**	**Total**	**Area A**	**Area B**	**Area C**	**Total**	**Area A**	**Area B**	**Area C**	**Total**	**Area A**	**Area B**	**Area C**	**Total**	**Total**
Alternative 1	86,400	-	-	86,400	50	-	-	**50**	11	-	-	**11**	6	-	-	**6**	**8,640**
Alternative 2	955,900	196,040	89,500	1,241,440	590	120	60	**770**	120	25	13	**158**	62	14	7	**83**	**124,144**
Alternative 3	1,684,880	963,700	141,000	2,789,580	1,040	600	90	**1,730**	211	122	19	**352**	108	63	10	**182**	**278,958**
Alternative 4	2,748,440	963,700	141,000	3,853,140	1,700	600	90	**2,390**	344	122	19	**485**	176	63	10	**249**	**385,314**
Alternative 5	2,665,700	1,218,100	1,347,800	5,231,600	1,650	760	840	**3,250**	334	155	171	**659**	170	80	88	**338**	**523,160**
	Phase 1	**Phase 2**	**Phase 3**		**Phase 1**	**Phase 2**	**Phase 3**		**Phase 1**	**Phase 2**	**Phase 3**		**Phase 1**	**Phase 2**	**Phase 3**		
Alternative 5	2,889,960	923,500	1,344,600	5,158,060	1,790	570	830	**3,190**	362	116	169	**647**	185	60	87	**332**	**515,806**

Notes

1- Assumes circular stockpile with 5:1 (h:v) side slopes. Area calculation uses insitu volume and does not account for losses, bulking, or compaction.

2- Assumes 10 CY per truck load as an order of magnitude index

Table D-3. Summary of Estimated Costs[1] for Disposal Options. Costs in Millions of Dollars

		Alt 1				Alt 2				Alt 3				Alt 4				Alt 5				Alt 5 with Phasing [2]			
		Area A	Area B	Area C	Total	Area A	Area B	Area C	Total	Area A	Area B	Area C	Total	Area A	Area B	Area C	Total	Area A	Area B	Area C	Total	Phase 1	Phase 2	Phase 3	Total [2]
On-Site Work		$4.0	$2.6	--	**$6.6**	$42.6	$16.0	$3.3	**$61.8**	$69.3	$55.5	$5.2	**$130.0**	$108.4	$55.5	$5.2	**$169.0**	$99.8	$59.0	$50.4	**$209.3**	$110.4	$48.8	$50.5	**$209.7**
Disposal Volume (CY)		86,400	0	0	**86,400**	955,900	196,040	89,500	**1,241,440**	1,684,880	963,700	141,000	**2,789,580**	2,748,440	963,700	141,000	**3,853,140**	2,665,700	1,218,100	1,347,800	**5,231,600**	2,889,960	923,500	1,344,600	**5,158,060**
Off-Site Disposal Options																									
Option 1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**	$1.3	--	--	**$1.3**	$14.7	$3.0	$1.4	**$19.1**	$26.0	$14.8	$2.2	**$43.0**	$42.3	$14.8	$2.2	**$59.4**	$41.1	$18.8	$20.8	**$81.0**	$44.5	$14.2	$20.7	**$81.0**
Option 3	**Beneficial Use - Landfill Cover**	$4.2	--	--	**$4.2**	$45.9	$9.4	$4.3	**$59.7**	$81.0	$46.3	$6.8	**$134.1**	$132.1	$46.3	$6.8	**$185.2**	$128.1	$58.5	$64.8	**$252.6**	$138.9	$44.4	$64.6	**$252.6**
Option 4	**Disposal at Hazardous Waste Landfill [3]**																								
Option 5	**Offshore Disposal (low end of range)**	$1.3	--	--	**$1.3**	$14.7	$3.0	$1.4	**$19.1**	$26.0	$14.8	$2.2	**$43.0**	$42.3	$14.8	$2.2	**$59.4**	$41.1	$18.8	$20.8	**$81.0**	$44.5	$14.2	$20.7	**$81.0**
	Offshore Disposal (high end of range)	$3.6	--	--	**$3.6**	$39.3	$8.1	$3.7	**$51.0**	$69.2	$39.6	$5.8	**$114.6**	$112.9	$39.6	$5.8	**$158.3**	$109.5	$50.0	$55.4	**$216.0**	$118.7	$37.9	$55.2	**$216.0**
Option 6	**Beach Disposal (low end of range)**	$1.3	--	--	**$1.3**	$14.7	$3.0	$1.4	**$19.1**	$26.0	$14.8	$2.2	**$43.0**	$42.3	$14.8	$2.2	**$59.4**	$41.1	$18.8	$20.8	**$81.0**	$44.5	$14.2	$20.7	**$81.0**
	Beach Disposal (high end of range)	$2.7	--	--	**$2.7**	$29.5	$6.0	$2.8	**$38.3**	$51.9	$29.7	$4.3	**$86.0**	$84.7	$29.7	$4.3	**$118.7**	$82.1	$37.5	$41.5	**$162.0**	$89.1	$28.5	$41.4	**$162.0**
Grand Totals for Disposal Options																									
Option 1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**	$5.4	--	--	**$5.4**	$57.3	$19.0	$4.7	**$81.0**	$95.3	$70.4	$7.4	**$173.0**	$150.7	$70.4	$7.4	**$228.4**	$140.9	$77.8	$71.2	**$290.3**	$155.0	$63.1	$71.2	**$290.7**
Option 3	**Beneficial Use - Landfill Cover**	$8.2	--	--	**$8.2**	$88.5	$25.4	$7.6	**$121.5**	$150.3	$101.8	$12.0	**$264.1**	$240.4	$101.8	$12.0	**$354.2**	$227.9	$117.6	$115.2	**$461.9**	$249.3	$93.2	$115.1	**$462.3**
Option 4	**Disposal at Hazardous Waste Landfill [3]**																								
Option 5	**Offshore Disposal (low end of range)**	$5.4	--	--	**$5.4**	$57.3	$19.0	$4.7	**$81.0**	$95.3	$70.4	$7.4	**$173.0**	$150.7	$70.4	$7.4	**$228.4**	$140.9	$77.8	$71.2	**$290.3**	$155.0	$63.1	$71.2	**$290.7**
	Offshore Disposal (high end of range)	$7.6	--	--	**$7.6**	$81.9	$24.0	$7.0	**$112.9**	$138.6	$95.1	$11.0	**$244.6**	$221.3	$95.1	$11.0	**$327.4**	$209.3	$109.1	$105.8	**$425.2**	$229.2	$86.8	$105.7	**$425.7**
Option 6	**Beach Disposal (low end of range)**	$5.4	--	--	**$5.4**	$57.3	$19.0	$4.7	**$81.0**	$95.3	$70.4	$7.4	**$173.0**	$150.7	$70.4	$7.4	**$228.4**	$140.9	$77.8	$71.2	**$290.3**	$155.0	$63.1	$71.2	**$290.7**
	Beach Disposal (high end of range)	$6.7	--	--	**$6.7**	$72.1	$22.0	$6.0	**$100.1**	$121.3	$85.2	$9.5	**$216.0**	$193.1	$85.2	$9.5	**$287.8**	$181.9	$96.6	$92.0	**$371.2**	$199.5	$77.3	$91.9	**$371.7**

Notes

1 - Estimated construction costs include a 35% contingency

2 - The cost estimate for phasing Alternative 5 is higher due to the construction of a temporary levee

3 - Estimate not included for Beneficial Use - Landfill Cover, contamintant report pending

Table D-4. Summary of Unit Costs and Cost Estimate Assuptions

Item	Description	Unit	Unit Cost	Notes
Unit Costs				**Notes**
Item	**Description**	**Unit**	**Unit Cost**	
	Mobilization			
1	Mobilization	LS		8% of subtotal used as a typical value. This value may be high.
	Demolition			
2	Demo culvert, daylight channel	LF	$1,000	
	Excavation	CY		Excavation of material only. Transportation included in Item 9.
3	Excavate to Marshplain	CY	$15	Excavate material from existing grade to marshplain elevation.
4	New Ballona Creek	CY	$15	Excavate material to create new Ballona Creek channel.
5	Channels Order 5	CY	$15	Excavate material to create large channels
6	Channels Order 4	CY	$15	Excavate material to create medium channels
7	Channels Order 3	CY	$15	Excavate material to create small channels
8	Breach	CY	$15	Excavate material to create breach
	Transportation	CY		Transportation of excavated material only. Placement of material in stockpile included in Item 12.
9	Onsite trucking	CY	$5	Truck transportation of excavated material to locations of fill and stockpile in each sub-area. Does not include transportation between sub-areas.
	New Levees	CY		
10	Levee Fill - no road	CY	$10	Levee construction using earth fill from material excavated onsite in each sub-area
11	Levee Fill - with road	CY	$17	Levee construction per above and paved roadway.
	Stockpile	CY		
12	Place material at stockpile	CY	$5	Placement of excavated material in excess of fill material in a stockpile in each sub-area. Excavation (Items 3-8) and transporation (Item 9) included separately.
	Levee Lowering and Ballona Creek Fill			
13	Levee Lowering	CY	$5	Excavation of earth material from existing levees along Ballona Creek. Removal and salvage of rip rap included in Item 15.
14	Ballona Creek Fill	CY	$5	Fill placement in existing Ballona Creek channel by sidecasting excavated material from levee lowering to fill Ballona Creek and using some excavated material (Items 2-8)
15	Salvage Rip Rap	CY	$10	Removal of rip-rap from existing levees
16	Buried rock protection	CY	$20	Assumes half the salvaged volume is used for protection and remainder is taken off-site for use by contractor
	Water Control Structures			
17	Culvert	SF	$2,010	New culvert
18	Tide Gate	LS	$100,000	New tide gate for culvert
	Subtotal			
	Contingency			35% contingency included for concept-level cost estimate.
	Total			
Disposal Options - Cost Estimates from POLA / Weston and SCC				
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**			
	Mobilization	LS		8% of subtotal used as a typical value. This value may be high.
	Sediment Removal	CY	$3	From POLA / Weston
	Barge Sediment (approx. 30 NM)	CY	$4.50	From POLA / Weston
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	CY	$3	From POLA / Weston
	Subtotal			
	Contingency			35% contingency included for concept-level cost estimate.
	Total for Option 1			
3	**Beneficial Use - Landfill Cover**			
	Mobilization	LS		8% of subtotal used as a typical value. This value may be high.
	Sediment Removal	CY	$3	From POLA / Weston
	Barge Sediment (approx. 30 NM)	CY	$5	From POLA / Weston
	Stockpiling & Staging Material at POLA	CY	$1	From POLA / Weston
	Truck Material to Site (100 mi at $0.20/cy)	CY	$20	From POLA / Weston
	Placement, grading, compaction at Site	CY	$4.25	From POLA / Weston
	Subtotal			
	Contingency			35% contingency included for concept-level cost estimate.
	Total for Option 2			
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**			
5	**Offshore Disposal [1]**			
	Mobilization	LS		8% of subtotal used as a typical value. This value may be high.
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	CY	$28	Based on $28 per cubic meter cost from Upper Newport Bay project for dredging and disposal about three miles offshore provide by SCC
	Subtotal			
	Contingency			35% contingency included for concept-level cost estimate.
	Total for Option 3			
6	**Beach Disposal [1]**			
	Mobilization	LS		
	Sediment Removal and Beach Disposal	CY	$21	Based on cost for Option 1 / 2 with additional $10/CY premium for beach disposal
	Subtotal			
	Contingency			
	Total for Option 4			

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 1 Area A

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$240,000**
1	Mobilization	1	LS	$240,000	$240,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**109,500**	CY		**$1,642,500**
3	Excavate to Marshplain	109,500	CY	$15	$1,642,500
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	0	CY	$15	$0
6	Channels Order 4	0	CY	$15	$0
7	Channels Order 3	0	CY	$15	$0
8	Breach	0	CY	$15	$0
	Transportation	**109,500**	CY		**$547,500**
9	Onsite trucking	109,500	CY	$5	$547,500
	New Levees	**0**	CY		**$0**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**86,400**	CY		**$547,500**
12	Place material at stockpile	109,500	CY	$5	$547,500
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$2,977,500**
	Contingency	35%			**$1,042,200**
	Total				**$4,019,700**

Disposal Options - Cost Estimates from POLA / Weston and SCC

1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$79,000	$79,000
	Sediment Removal	86,400	CY	$3	$259,200
	Barge Sediment (approx. 30 NM)	86,400	CY	$4.50	$388,800
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	86,400	CY	$3	$259,200
	Subtotal				**$986,200**
	Contingency	35%			**$345,200**
	Total for Option 1				**$1,331,400**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$247,000	$247,000
	Sediment Removal	86,400	CY	$3	$259,200
	Barge Sediment (approx. 30 NM)	86,400	CY	$4.50	$388,800
	Stockpiling & Staging Material at POLA	86,400	CY	$1	$86,400
	Truck Material to Site (100 mi at $0.20/cy)	86,400	CY	$20	$1,728,000
	Placement, grading, compaction at Site	86,400	CY	$4.25	$367,200
	Subtotal				**$3,076,600**
	Contingency	35%			**$1,076,900**
	Total for Option 2				**$4,153,500**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$211,000	$211,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	86,400	CY	$28	$2,419,200
	Subtotal				**$2,630,200**
	Contingency	35%			**$920,600**
	Total for Option 3				**$3,550,800**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$158,000	$158,000
	Sediment Removal and Beach Disposal	86,400	CY	$21	$1,814,400
	Subtotal				**$1,972,400**
	Contingency	35%			**$690,300**
	Total for Option 4				**$2,662,700**

Grand Totals with Disposal Options

1 / 2	**Disposal at POLA**	**$5,351,100**
3	**Upland Disposal**	**$8,173,200**
5	**Offshore Disposal [1]**	**$7,570,500**
6	**Beach Disposal [1]**	**$6,682,400**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 1 Area B

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$160,000**
1	Mobilization	1	LS	$160,000	$160,000
	Demolition				**$1,400,000**
2	Demo culvert, daylight chan	1,400	LF	$1,000	$1,400,000
	Excavation	**0**	CY		**$0**
3	Excavate to Marshplain	0	CY	$15	$0
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	0	CY	$15	$0
6	Channels Order 4	0	CY	$15	$0
7	Channels Order 3	0	CY	$15	$0
8	Breach	0	CY	$15	$0
	Transportation	**23,100**	CY		**$115,500**
9	Onsite trucking	23,100	CY	$5	$115,500
	New Levees	**23,100**	CY		**$231,000**
10	Levee Fill - no road	23,100	CY	$10	$231,000
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**0**	CY		**$0**
12	Place material at stockpile	0	CY	$5	$0
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$1,906,500**
	Contingency	35%			**$667,300**
	Total				**$2,573,800**

Disposal Options - Cost Estimates from POLA / Weston and SCC

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$0	$0
	Sediment Removal	0	CY	$3	$0
	Barge Sediment (approx. 30 NM)	0	CY	$4.50	$0
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	0	CY	$3	$0
	Subtotal				**$0**
	Contingency	35%			**$0**
	Total for Option 1				**$0**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$0	$0
	Sediment Removal	0	CY	$3	$0
	Barge Sediment (approx. 30 NM)	0	CY	$4.50	$0
	Stockpiling & Staging Material at POLA	0	CY	$1	$0
	Truck Material to Site (100 mi at $0.20/cy)	0	CY	$20	$0
	Placement, grading, compaction at Site	0	CY	$4.25	$0
	Subtotal				**$0**
	Contingency	35%			**$0**
	Total for Option 2				**$0**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$0	$0
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	0	CY	$28	$0
	Subtotal				**$0**
	Contingency	35%			**$0**
	Total for Option 3				**$0**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$0	$0
	Sediment Removal and Beach Disposal	0	CY	$21	$0
	Subtotal				**$0**
	Contingency	35%			**$0**
	Total for Option 4				**$0**

Grand Totals with Disposal Options

1 / 2	**Disposal at POLA**	**$2,573,800**
3	**Upland Disposal**	**$2,573,800**
5	**Offshore Disposal [1]**	**$2,573,800**
6	**Beach Disposal [1]**	**$2,573,800**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 2 Area A

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$2,530,000**
1	Mobilization	1	LS	$2,530,000	$2,530,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**955,900**	CY		**$14,338,500**
3	Excavate to Marshplain	951,700	CY	$15	$14,275,500
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	0	CY	$15	$0
6	Channels Order 4	2,430	CY	$15	$36,450
7	Channels Order 3	1,770	CY	$15	$26,550
8	Breach	0	CY	$15	$0
	Transportation	**955,900**	CY		**$4,779,500**
9	Onsite trucking	955,900	CY	$5	$4,779,500
	New Levees	**0**	CY		**$0**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**955,900**	CY		**$4,779,500**
12	Place material at stockpile	955,900	CY	$5	$4,779,500
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$5,125,000**
17	Culvert	2,500	SF	$2,010	$5,025,000
18	Tide Gate	1	LS	$100,000	$100,000
	Subtotal				**$31,552,500**
	Contingency	35%			**$11,043,400**
	Total				**$42,595,900**

Disposal Options - Cost Estimates from POLA / Weston and SCC

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$873,000	$873,000
	Sediment Removal	955,900	CY	$3	$2,867,700
	Barge Sediment (approx. 30 NM)	955,900	CY	$4.50	$4,301,550
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	955,900	CY	$3	$2,867,700
	Subtotal				**$10,909,950**
	Contingency	35%			**$3,818,500**
	Total for Option 1				**$14,728,450**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$2,723,000	$2,723,000
	Sediment Removal	955,900	CY	$3	$2,867,700
	Barge Sediment (approx. 30 NM)	955,900	CY	$4.50	$4,301,550
	Stockpiling & Staging Material at POLA	955,900	CY	$1	$955,900
	Truck Material to Site (100 mi at $0.20/cy)	955,900	CY	$20	$19,118,000
	Placement, grading, compaction at Site	955,900	CY	$4.25	$4,062,575
	Subtotal				**$34,028,725**
	Contingency	35%			**$11,910,100**
	Total for Option 2				**$45,938,825**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$2,328,000	$2,328,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	955,900	CY	$28	$26,765,200
	Subtotal				**$29,093,200**
	Contingency	35%			**$10,182,700**
	Total for Option 3				**$39,275,900**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$1,746,000	$1,746,000
	Sediment Removal and Beach Disposal	955,900	CY	$21	$20,073,900
	Subtotal				**$21,819,900**
	Contingency	35%			**$7,637,000**
	Total for Option 4				**$29,456,900**

Grand Totals with Disposal Options

1 / 2	**Disposal at POLA**	**$57,324,350**
3	**Upland Disposal**	**$88,534,725**
5	**Offshore Disposal [1]**	**$81,871,800**
6	**Beach Disposal [1]**	**$72,052,800**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 2 Area B

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$950,000**
1	Mobilization	1	LS	$950,000	$950,000
	Demolition				**$1,400,000**
2	Demo culvert, daylight chan	1,400	LF	$1,000	$1,400,000
	Excavation	**277,970**	CY		**$4,169,550**
3	Excavate to Marshplain	274,400	CY	$15	$4,116,000
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	0	CY	$15	$0
6	Channels Order 4	2,040	CY	$15	$30,600
7	Channels Order 3	1,530	CY	$15	$22,950
8	Breach	0	CY	$15	$0
	Transportation	**277,970**	CY		**$1,389,850**
9	Onsite trucking	277,970	CY	$5	$1,389,850
	New Levees	**81,930**	CY		**$819,300**
10	Levee Fill - no road	81,930	CY	$10	$819,300
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**196,040**	CY		**$980,200**
12	Place material at stockpile	196,040	CY	$5	$980,200
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$2,110,000**
17	Culvert	1,000	SF	$2,010	$2,010,000
18	Tide Gate	1	LS	$100,000	$100,000
	Subtotal				**$11,818,900**
	Contingency	35%			**$4,136,700**
	Total				**$15,955,600**

Disposal Options - Cost Estimates from POLA / Weston and SCC

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$179,000	$179,000
	Sediment Removal	196,040	CY	$3	$588,120
	Barge Sediment (approx. 30 NM)	196,040	CY	$4.50	$882,180
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	196,040	CY	$3	$588,120
	Subtotal				**$2,237,420**
	Contingency	35%			**$783,100**
	Total for Option 1				**$3,020,520**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$559,000	$559,000
	Sediment Removal	196,040	CY	$3	$588,120
	Barge Sediment (approx. 30 NM)	196,040	CY	$4.50	$882,180
	Stockpiling & Staging Material at POLA	196,040	CY	$1	$196,040
	Truck Material to Site (100 mi at $0.20/cy)	196,040	CY	$20	$3,920,800
	Placement, grading, compaction at Site	196,040	CY	$4.25	$833,170
	Subtotal				**$6,979,310**
	Contingency	35%			**$2,442,800**
	Total for Option 2				**$9,422,110**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$478,000	$478,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	196,040	CY	$28	$5,489,120
	Subtotal				**$5,967,120**
	Contingency	35%			**$2,088,500**
	Total for Option 3				**$8,055,620**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$358,000	$358,000
	Sediment Removal and Beach Disposal	196,040	CY	$21	$4,116,840
	Subtotal				**$4,474,840**
	Contingency	35%			**$1,566,200**
	Total for Option 4				**$6,041,040**

Grand Totals with Disposal Options

Item	Description	Total Cost
1 / 2	**Disposal at POLA**	**$18,976,120**
3	**Upland Disposal**	**$25,377,710**
5	**Offshore Disposal [1]**	**$24,011,220**
6	**Beach Disposal [1]**	**$21,996,640**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 2 Area C

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$200,000**
1	Mobilization	1	LS	$200,000	$200,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**89,500**	CY		**$1,342,500**
3	Excavate to Marshplain	89,500	CY	$15	$1,342,500
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	0	CY	$15	$0
6	Channels Order 4	0	CY	$15	$0
7	Channels Order 3	0	CY	$15	$0
8	Breach	0	CY	$15	$0
	Transportation	**89,500**	CY		**$447,500**
9	Onsite trucking	89,500	CY	$5	$447,500
	New Levees	**0**	CY		**$0**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**89,500**	CY		**$447,500**
12	Place material at stockpile	89,500	CY	$5	$447,500
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$2,437,500**
	Contingency	35%			**$853,200**
	Total				**$3,290,700**

Disposal Options - Cost Estimates from POLA / Weston and SCC

1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$82,000	$82,000
	Sediment Removal	89,500	CY	$3	$268,500
	Barge Sediment (approx. 30 NM)	89,500	CY	$4.50	$402,750
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	89,500	CY	$3	$268,500
	Subtotal				**$1,021,750**
	Contingency	35%			**$357,700**
	Total for Option 1				**$1,379,450**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$255,000	$255,000
	Sediment Removal	89,500	CY	$3	$268,500
	Barge Sediment (approx. 30 NM)	89,500	CY	$4.50	$402,750
	Stockpiling & Staging Material at POLA	89,500	CY	$1	$89,500
	Truck Material to Site (100 mi at $0.20/cy)	89,500	CY	$20	$1,790,000
	Placement, grading, compaction at Site	89,500	CY	$4.25	$380,375
	Subtotal				**$3,186,125**
	Contingency	35%			**$1,115,200**
	Total for Option 2				**$4,301,325**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$218,000	$218,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	89,500	CY	$28	$2,506,000
	Subtotal				**$2,724,000**
	Contingency	35%			**$953,400**
	Total for Option 3				**$3,677,400**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$164,000	$164,000
	Sediment Removal and Beach Disposal	89,500	CY	$21	$1,879,500
	Subtotal				**$2,043,500**
	Contingency	35%			**$715,200**
	Total for Option 4				**$2,758,700**

Grand Totals with Disposal Options

1 / 2	**Disposal at POLA**	**$4,670,150**
3	**Upland Disposal**	**$7,592,025**
5	**Offshore Disposal [1]**	**$6,968,100**
6	**Beach Disposal [1]**	**$6,049,400**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 3 Area A

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$4,110,000**
1	Mobilization	1	LS	$4,110,000	$4,110,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**1,684,880**	CY		**$25,273,200**
3	Excavate to Marshplain	1,673,700	CY	$15	$25,105,500
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	3,540	CY	$15	$53,100
6	Channels Order 4	4,240	CY	$15	$63,600
7	Channels Order 3	3,400	CY	$15	$51,000
8	Breach	0	CY	$15	$0
	Transportation	**1,684,880**	CY		**$8,424,400**
9	Onsite trucking	1,684,880	CY	$5	$8,424,400
	New Levees	**0**	CY		**$0**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**1,684,880**	CY		**$8,424,400**
12	Stockpile	1,684,880	CY	$5	$8,424,400
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$5,125,000**
17	Culvert	2,500	SF	$2,010	$5,025,000
18	Tide Gate	1	LS	$100,000	$100,000
	Subtotal				**$51,357,000**
	Contingency	35%			**$17,975,000**
	Total				**$69,332,000**

Disposal Options - Cost Estimates from POLA / Weston and SCC

1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$1,539,000	$1,539,000
	Sediment Removal	1,684,880	CY	$3	$5,054,640
	Barge Sediment (approx. 30 NM)	1,684,880	CY	$4.50	$7,581,960
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	1,684,880	CY	$3	$5,054,640
	Subtotal				**$19,230,240**
	Contingency	35%			**$6,730,600**
	Total for Option 1				**$25,960,840**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$4,799,000	$4,799,000
	Sediment Removal	1,684,880	CY	$3	$5,054,640
	Barge Sediment (approx. 30 NM)	1,684,880	CY	$4.50	$7,581,960
	Stockpiling & Staging Material at POLA	1,684,880	CY	$1	$1,684,880
	Truck Material to Site (100 mi at $0.20/cy)	1,684,880	CY	$20	$33,697,600
	Placement, grading, compaction at Site	1,684,880	CY	$4.25	$7,160,740
	Subtotal				**$59,978,820**
	Contingency	35%			**$20,992,600**
	Total for Option 2				**$80,971,420**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$4,103,000	$4,103,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	1,684,880	CY	$28	$47,176,640
	Subtotal				**$51,279,640**
	Contingency	35%			**$17,947,900**
	Total for Option 3				**$69,227,540**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$3,077,000	$3,077,000
	Sediment Removal and Beach Disposal	1,684,880	CY	$21	$35,382,480
	Subtotal				**$38,459,480**
	Contingency	35%			**$13,460,800**
	Total for Option 4				**$51,920,280**

Grand Totals with Disposal Options

1 / 2	**Disposal at POLA**	**$95,292,840**
3	**Upland Disposal**	**$150,303,420**
5	**Offshore Disposal [1]**	**$138,559,540**
6	**Beach Disposal [1]**	**$121,252,280**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 3 Area B

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$3,290,000**
1	Mobilization	1	LS	$3,290,000	$3,290,000
	Demolition				**$1,400,000**
2	Demo culvert, daylight chan	1,400	LF	$1,000	$1,400,000
	Excavation	**1,259,910**	CY		**$18,898,650**
3	Excavate to Marshplain	1,229,400	CY	$15	$18,441,000
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	5,560	CY	$15	$83,400
6	Channels Order 4	9,390	CY	$15	$140,850
7	Channels Order 3	8,180	CY	$15	$122,700
8	Breach	7,380	CY	$15	$110,700
	Transportation	**1,252,530**	CY		**$6,262,650**
9	Onsite trucking	1,252,530	CY	$5	$6,262,650
	New Levees	**288,830**	CY		**$4,336,600**
10	Levee Fill - no road	81,930	CY	$10	$819,300
11	Levee Fill - with road	206,900	CY	$17	$3,517,300
	Stockpile	**963,700**	CY		**$4,818,500**
12	Stockpile	963,700	CY	$5	$4,818,500
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$2,110,000**
17	Culvert	1,000	SF	$2,010	$2,010,000
18	Tide Gate	1	LS	$100,000	$100,000
	Subtotal				**$41,116,400**
	Contingency	35%			**$14,390,800**
	Total				**$55,507,200**

Disposal Options - Cost Estimates from POLA / Weston and SCC

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$880,000	$880,000
	Sediment Removal	963,700	CY	$3	$2,891,100
	Barge Sediment (approx. 30 NM)	963,700	CY	$4.50	$4,336,650
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	963,700	CY	$3	$2,891,100
	Subtotal				**$10,998,850**
	Contingency	35%			**$3,849,600**
	Total for Option 1				**$14,848,450**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$2,745,000	$2,745,000
	Sediment Removal	963,700	CY	$3	$2,891,100
	Barge Sediment (approx. 30 NM)	963,700	CY	$4.50	$4,336,650
	Stockpiling & Staging Material at POLA	963,700	CY	$1	$963,700
	Truck Material to Site (100 mi at $0.20/cy)	963,700	CY	$20	$19,274,000
	Placement, grading, compaction at Site	963,700	CY	$4.25	$4,095,725
	Subtotal				**$34,306,175**
	Contingency	35%			**$12,007,200**
	Total for Option 2				**$46,313,375**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$2,347,000	$2,347,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	963,700	CY	$28	$26,983,600
	Subtotal				**$29,330,600**
	Contingency	35%			**$10,265,800**
	Total for Option 3				**$39,596,400**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$1,760,000	$1,760,000
	Sediment Removal and Beach Disposal	963,700	CY	$21	$20,237,700
	Subtotal				**$21,997,700**
	Contingency	35%			**$7,699,200**
	Total for Option 4				**$29,696,900**

Grand Totals with Disposal Options

Item	Description	Total Cost
1 / 2	**Disposal at POLA**	**$70,355,650**
3	**Upland Disposal**	**$101,820,575**
5	**Offshore Disposal [1]**	**$95,103,600**
6	**Beach Disposal [1]**	**$85,204,100**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 3 Area C

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$310,000**
1	Mobilization	1	LS	$310,000	$310,000
	Demolition				**$0**
2	Demo culvert, daylight ch	0	LF	$1,000	$0
	Excavation	**141,000**	CY		**$2,115,000**
3	Excavate to Marshplain	141,000	CY	$15	$2,115,000
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	0	CY	$15	$0
6	Channels Order 4	0	CY	$15	$0
7	Channels Order 3	0	CY	$15	$0
8	Breach	0	CY	$15	$0
	Transportation	**141,000**	CY		**$705,000**
9	Onsite trucking	141,000	CY	$5	$705,000
	New Levees	**0**	CY		**$0**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**141,000**	CY		**$705,000**
12	Stockpile	141,000	CY	$5	$705,000
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$3,835,000**
	Contingency	35%			**$1,342,300**
	Total				**$5,177,300**
	Disposal Options - Cost Estimates from POLA / Weston and SCC				
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$129,000	$129,000
	Sediment Removal	141,000	CY	$3	$423,000
	Barge Sediment (approx. 30 NM)	141,000	CY	$4.50	$634,500
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	141,000	CY	$3	$423,000
	Subtotal				**$1,609,500**
	Contingency	35%			**$563,400**
	Total for Option 1				**$2,172,900**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$402,000	$402,000
	Sediment Removal	141,000	CY	$3	$423,000
	Barge Sediment (approx. 30 NM)	141,000	CY	$4.50	$634,500
	Stockpiling & Staging Material at POLA	141,000	CY	$1	$141,000
	Truck Material to Site (100 mi at $0.20/cy)	141,000	CY	$20	$2,820,000
	Placement, grading, compaction at Site	141,000	CY	$4.25	$599,250
	Subtotal				**$5,019,750**
	Contingency	35%			**$1,757,000**
	Total for Option 2				**$6,776,750**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$344,000	$344,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	141,000	CY	$28	$3,948,000
	Subtotal				**$4,292,000**
	Contingency	35%			**$1,502,200**
	Total for Option 3				**$5,794,200**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$258,000	$258,000
	Sediment Removal and Beach Disposal	141,000	CY	$21	$2,961,000
	Subtotal				**$3,219,000**
	Contingency	35%			**$1,126,700**
	Total for Option 4				**$4,345,700**

Grand Totals with Disposal Options

1 / 2	**Disposal at POLA**	**$7,350,200**
3	**Upland Disposal**	**$11,954,050**
5	**Offshore Disposal [1]**	**$10,971,500**
6	**Beach Disposal [1]**	**$9,523,000**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 4 Area A

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$6,430,000**
1	Mobilization	1	LS	$6,430,000	$6,430,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**2,748,440**	CY		**$41,226,600**
3	Excavate to Marshplain	2,748,000	CY	$15	$41,220,000
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	0	CY	$15	$0
6	Channels Order 4	0	CY	$15	$0
7	Channels Order 3	440	CY	$15	$6,600
8	Breach	0	CY	$15	$0
	Transportation	**2,748,440**	CY		**$13,742,200**
9	Onsite trucking	2,748,440	CY	$5	$13,742,200
	New Levees	**0**	CY		**$0**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**2,748,440**	CY		**$13,742,200**
12	Stockpile	2,748,440	CY	$5	$13,742,200
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$5,125,000**
17	Culvert	2,500	SF	$2,010	$5,025,000
18	Tide Gate	1	LS	$100,000	$100,000
	Subtotal				**$80,266,000**
	Contingency	35%			**$28,093,100**
	Total				**$108,359,100**

Disposal Options - Cost Estimates from POLA / Weston and SCC

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$2,510,000	$2,510,000
	Sediment Removal	2,748,440	CY	$3	$8,245,320
	Barge Sediment (approx. 30 NM)	2,748,440	CY	$4.50	$12,367,980
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	2,748,440	CY	$3	$8,245,320
	Subtotal				**$31,368,620**
	Contingency	35%			**$10,979,100**
	Total for Option 1				**$42,347,720**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$7,828,000	$7,828,000
	Sediment Removal	2,748,440	CY	$3	$8,245,320
	Barge Sediment (approx. 30 NM)	2,748,440	CY	$4.50	$12,367,980
	Stockpiling & Staging Material at POLA	2,748,440	CY	$1	$2,748,440
	Truck Material to Site (100 mi at $0.20/cy)	2,748,440	CY	$20	$54,968,800
	Placement, grading, compaction at Site	2,748,440	CY	$4.25	$11,680,870
	Subtotal				**$97,839,410**
	Contingency	35%			**$34,243,800**
	Total for Option 2				**$132,083,210**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$6,692,000	$6,692,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	2,748,440	CY	$28	$76,956,320
	Subtotal				**$83,648,320**
	Contingency	35%			**$29,277,000**
	Total for Option 3				**$112,925,320**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$5,019,000	$5,019,000
	Sediment Removal and Beach Disposal	2,748,440	CY	$21	$57,717,240
	Subtotal				**$62,736,240**
	Contingency	35%			**$21,957,700**
	Total for Option 4				**$84,693,940**

Grand Totals with Disposal Options

Item	Description	Total Cost
1 / 2	**Disposal at POLA**	**$150,706,820**
3	**Upland Disposal**	**$240,442,310**
5	**Offshore Disposal [1]**	**$221,284,420**
6	**Beach Disposal [1]**	**$193,053,040**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 4 Area B

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$3,290,000**
1	Mobilization	1	LS	$3,290,000	$3,290,000
	Demolition				**$1,400,000**
2	Demo culvert, daylight chan	1,400	LF	$1,000	$1,400,000
	Excavation	**1,259,910**	CY		**$18,898,650**
3	Excavate to Marshplain	1,229,400	CY	$15	$18,441,000
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	5,560	CY	$15	$83,400
6	Channels Order 4	9,390	CY	$15	$140,850
7	Channels Order 3	8,180	CY	$15	$122,700
8	Breach	7,380	CY	$15	$110,700
	Transportation	**1,252,530**	CY		**$6,262,650**
9	Onsite trucking	1,252,530	CY	$5	$6,262,650
	New Levees	**288,830**	CY		**$4,336,600**
10	Levee Fill - no road	81,930	CY	$10	$819,300
11	Levee Fill - with road	206,900	CY	$17	$3,517,300
	Stockpile	**963,700**	CY		**$4,818,500**
12	Stockpile	963,700	CY	$5	$4,818,500
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$2,110,000**
17	Culvert	1,000	SF	$2,010	$2,010,000
18	Tide Gate	1	LS	$100,000	$100,000
	Subtotal				**$41,116,400**
	Contingency	35%			**$14,390,800**
	Total				**$55,507,200**

Disposal Options - Cost Estimates from POLA / Weston and SCC

1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$880,000	$880,000
	Sediment Removal	963,700	CY	$3	$2,891,100
	Barge Sediment (approx. 30 NM)	963,700	CY	$4.50	$4,336,650
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	963,700	CY	$3	$2,891,100
	Subtotal				**$10,998,850**
	Contingency	35%			**$3,849,600**
	Total for Option 1				**$14,848,450**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$2,745,000	$2,745,000
	Sediment Removal	963,700	CY	$3	$2,891,100
	Barge Sediment (approx. 30 NM)	963,700	CY	$4.50	$4,336,650
	Stockpiling & Staging Material at POLA	963,700	CY	$1	$963,700
	Truck Material to Site (100 mi at $0.20/cy)	963,700	CY	$20	$19,274,000
	Placement, grading, compaction at Site	963,700	CY	$4.25	$4,095,725
	Subtotal				**$34,306,175**
	Contingency	35%			**$12,007,200**
	Total for Option 2				**$46,313,375**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$2,347,000	$2,347,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	963,700	CY	$28	$26,983,600
	Subtotal				**$29,330,600**
	Contingency	35%			**$10,265,800**
	Total for Option 3				**$39,596,400**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$1,760,000	$1,760,000
	Sediment Removal and Beach Disposal	963,700	CY	$21	$20,237,700
	Subtotal				**$21,997,700**
	Contingency	35%			**$7,699,200**
	Total for Option 4				**$29,696,900**

Grand Totals with Disposal Options

1 / 2	**Disposal at POLA**	**$70,355,650**
3	**Upland Disposal**	**$101,820,575**
5	**Offshore Disposal [1]**	**$95,103,600**
6	**Beach Disposal [1]**	**$85,204,100**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 4 Area C

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$310,000**
1	Mobilization	1	LS	$310,000	$310,000
	Demolition				**$0**
2	Demo culvert, daylight cl	0	LF	$1,000	$0
	Excavation	**141,000**	CY		**$2,115,000**
3	Excavate to Marshplain	141,000	CY	$15	$2,115,000
4	New Ballona Creek	0	CY	$15	$0
5	Channels Order 5	0	CY	$15	$0
6	Channels Order 4	0	CY	$15	$0
7	Channels Order 3	0	CY	$15	$0
8	Breach	0	CY	$15	$0
	Transportation	**141,000**	CY		**$705,000**
9	Onsite trucking	141,000	CY	$5	$705,000
	New Levees	**0**	CY		**$0**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**141,000**	CY		**$705,000**
12	Stockpile	141,000	CY	$5	$705,000
	Levee Lowering and Ballona Creek Fill				**$0**
13	Levee Lowering	0	CY	$5	$0
14	Ballona Creek Fill	0	CY	$5	$0
15	Salvage Rip Rap	0	CY	$10	$0
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$3,835,000**
	Contingency	35%			**$1,342,300**
	Total				**$5,177,300**

Disposal Options - Cost Estimates from POLA / Weston and SCC

1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$129,000	$129,000
	Sediment Removal	141,000	CY	$3	$423,000
	Barge Sediment (approx. 30 NM)	141,000	CY	$4.50	$634,500
	Material (hydraulic unloader) or Disposal at CDF	141,000	CY	$3	$423,000
	Subtotal				**$1,609,500**
	Contingency	35%			**$563,400**
	Total for Option 1				**$2,172,900**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$402,000	$402,000
	Sediment Removal	141,000	CY	$3	$423,000
	Barge Sediment (approx. 30 NM)	141,000	CY	$4.50	$634,500
	Stockpiling & Staging Material at POLA	141,000	CY	$1	$141,000
	Truck Material to Site (100 mi at $0.20/cy)	141,000	CY	$20	$2,820,000
	Placement, grading, compaction at Site	141,000	CY	$4.25	$599,250
	Subtotal				**$5,019,750**
	Contingency	35%			**$1,757,000**
	Total for Option 2				**$6,776,750**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$344,000	$344,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	141,000	CY	$28	$3,948,000
	Subtotal				**$4,292,000**
	Contingency	35%			**$1,502,200**
	Total for Option 3				**$5,794,200**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$258,000	$258,000
	Sediment Removal and Beach Disposal	141,000	CY	$21	$2,961,000
	Subtotal				**$3,219,000**
	Contingency	35%			**$1,126,700**
	Total for Option 4				**$4,345,700**

Grand Totals with Disposal Options

1 / 2	**Disposal at POLA**	**$7,350,200**
3	**Upland Disposal**	**$11,954,050**
5	**Offshore Disposal [1]**	**$10,971,500**
6	**Beach Disposal [1]**	**$9,523,000**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 5 Area A

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$5,920,000**
1	Mobilization	1	LS	$5,920,000	$5,920,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**2,674,100**	CY		**$40,111,500**
3	Excavate to Marshplain	2,649,400	CY	$15	$39,741,000
4	New Ballona Creek	16,500	CY	$15	$247,500
5	Channels Order 5	1,200	CY	$15	$18,000
6	Channels Order 4	3,300	CY	$15	$49,500
7	Channels Order 3	3,700	CY	$15	$55,500
8	Breach	0	CY	$15	$0
	Transportation	**2,674,100**	CY		**$13,370,500**
9	Onsite trucking	2,674,100	CY	$5	$13,370,500
	New Levees	**0**	CY		**$0**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**2,665,700**	CY		**$13,328,500**
12	Stockpile	2,665,700	CY	$5	$13,328,500
	Levee Lowering and Ballona Creek Fill				**$1,189,400**
13	Levee Lowering	85,700	CY	$5	$428,500
14	Ballona Creek Fill	94,100	CY	$5	$470,500
15	Salvage Rip Rap	14,520	CY	$10	$145,200
16	Buried rock protection	7,260	CY	$20	$145,200
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$73,919,900**
	Contingency	35%			**$25,872,000**
	Total				**$99,791,900**

Disposal Options - Cost Estimates from POLA / Weston and SCC

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$2,434,000	$2,434,000
	Sediment Removal	2,665,700	CY	$3	$7,997,100
	Barge Sediment (approx. 30 NM)	2,665,700	CY	$4.50	$11,995,650
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	2,665,700	CY	$3	$7,997,100
	Subtotal				**$30,423,850**
	Contingency	35%			**$10,648,400**
	Total for Option 1				**$41,072,250**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$7,592,000	$7,592,000
	Sediment Removal	2,665,700	CY	$3	$7,997,100
	Barge Sediment (approx. 30 NM)	2,665,700	CY	$4.50	$11,995,650
	Stockpiling & Staging Material at POLA	2,665,700	CY	$1	$2,665,700
	Truck Material to Site (100 mi at $0.20/cy)	2,665,700	CY	$20	$53,314,000
	Placement, grading, compaction at Site	2,665,700	CY	$4.25	$11,329,225
	Subtotal				**$94,893,675**
	Contingency	35%			**$33,212,800**
	Total for Option 2				**$128,106,475**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$6,491,000	$6,491,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	2,665,700	CY	$28	$74,639,600
	Subtotal				**$81,130,600**
	Contingency	35%			**$28,395,800**
	Total for Option 3				**$109,526,400**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$4,868,000	$4,868,000
	Sediment Removal and Beach Disposal	2,665,700	CY	$21	$55,979,700
	Subtotal				**$60,847,700**
	Contingency	35%			**$21,296,700**
	Total for Option 4				**$82,144,400**

Grand Totals with Disposal Options

Item	Description	Total Cost
1 / 2	**Disposal at POLA**	**$140,864,150**
3	**Upland Disposal**	**$227,898,375**
5	**Offshore Disposal [1]**	**$209,318,300**
6	**Beach Disposal [1]**	**$181,936,300**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 5 Area B

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$3,500,000**
1	Mobilization	1	LS	$3,500,000	$3,500,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**1,440,000**	CY		**$21,600,000**
3	Excavate to Marshplain	1,398,600	CY	$15	$20,979,000
4	New Ballona Creek	27,700	CY	$15	$415,500
5	Channels Order 5	2,000	CY	$15	$30,000
6	Channels Order 4	5,500	CY	$15	$82,500
7	Channels Order 3	6,200	CY	$15	$93,000
8	Breach	0	CY	$15	$0
	Transportation	**1,440,000**	CY		**$7,200,000**
9	Onsite trucking	1,440,000	CY	$5	$7,200,000
	New Levees	**209,300**	CY		**$3,558,100**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	209,300	CY	$17	$3,558,100
	Stockpile	**1,218,100**	CY		**$6,090,500**
12	Stockpile	1,218,100	CY	$5	$6,090,500
	Levee Lowering and Ballona Creek Fill				**$1,783,600**
13	Levee Lowering	128,500	CY	$5	$642,500
14	Ballona Creek Fill	141,100	CY	$5	$705,500
15	Salvage Rip Rap	21,780	CY	$10	$217,800
16	Buried rock protection	10,890	CY	$20	$217,800
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$43,732,200**
	Contingency	35%			**$15,306,300**
	Total				**$59,038,500**

Disposal Options - Cost Estimates from POLA / Weston and SCC

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$1,113,000	$1,113,000
	Sediment Removal	1,218,100	CY	$3	$3,654,300
	Barge Sediment (approx. 30 NM)	1,218,100	CY	$4.50	$5,481,450
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	1,218,100	CY	$3	$3,654,300
	Subtotal				**$13,903,050**
	Contingency	35%			**$4,866,100**
	Total for Option 1				**$18,769,150**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$3,469,000	$3,469,000
	Sediment Removal	1,218,100	CY	$3	$3,654,300
	Barge Sediment (approx. 30 NM)	1,218,100	CY	$4.50	$5,481,450
	Stockpiling & Staging Material at POLA	1,218,100	CY	$1	$1,218,100
	Truck Material to Site (100 mi at $0.20/cy)	1,218,100	CY	$20	$24,362,000
	Placement, grading, compaction at Site	1,218,100	CY	$4.25	$5,176,925
	Subtotal				**$43,361,775**
	Contingency	35%			**$15,176,700**
	Total for Option 2				**$58,538,475**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$2,966,000	$2,966,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	1,218,100	CY	$28	$34,106,800
	Subtotal				**$37,072,800**
	Contingency	35%			**$12,975,500**
	Total for Option 3				**$50,048,300**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$2,225,000	$2,225,000
	Sediment Removal and Beach Disposal	1,218,100	CY	$21	$25,580,100
	Subtotal				**$27,805,100**
	Contingency	35%			**$9,731,800**
	Total for Option 4				**$37,536,900**

Grand Totals with Disposal Options

Item	Description	Total Cost
1 / 2	**Disposal at POLA**	**$77,807,650**
3	**Upland Disposal**	**$117,576,975**
5	**Offshore Disposal [1]**	**$109,086,800**
6	**Beach Disposal [1]**	**$96,575,400**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 5 Area C

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$2,990,000**
1	Mobilization	1	LS	$2,990,000	$2,990,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**1,352,000**	CY		**$20,280,000**
3	Excavate to Marshplain	1,324,700	CY	$15	$19,870,500
4	New Ballona Creek	21,800	CY	$15	$327,000
5	Channels Order 5	800	CY	$15	$12,000
6	Channels Order 4	2,200	CY	$15	$33,000
7	Channels Order 3	2,500	CY	$15	$37,500
8	Breach	0	CY	$15	$0
	Transportation	**1,352,000**	CY		**$6,760,000**
9	Onsite trucking	1,352,000	CY	$5	$6,760,000
	New Levees	**0**	CY		**$0**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**1,347,800**	CY		**$6,739,000**
12	Stockpile	1,347,800	CY	$5	$6,739,000
	Levee Lowering and Ballona Creek Fill				**$595,200**
13	Levee Lowering	42,900	CY	$5	$214,500
14	Ballona Creek Fill	47,100	CY	$5	$235,500
15	Salvage Rip Rap	7,260	CY	$10	$72,600
16	Buried rock protection	3,630	CY	$20	$72,600
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$37,364,200**
	Contingency	35%			**$13,077,500**
	Total				**$50,441,700**

Disposal Options - Cost Estimates from POLA / Weston and SCC

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$1,231,000	$1,231,000
	Sediment Removal	1,347,800	CY	$3	$4,043,400
	Barge Sediment (approx. 30 NM)	1,347,800	CY	$4.50	$6,065,100
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	1,347,800	CY	$3	$4,043,400
	Subtotal				**$15,382,900**
	Contingency	35%			**$5,384,100**
	Total for Option 1				**$20,767,000**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$3,839,000	$3,839,000
	Sediment Removal	1,347,800	CY	$3	$4,043,400
	Barge Sediment (approx. 30 NM)	1,347,800	CY	$4.50	$6,065,100
	Stockpiling & Staging Material at POLA	1,347,800	CY	$1	$1,347,800
	Truck Material to Site (100 mi at $0.20/cy)	1,347,800	CY	$20	$26,956,000
	Placement, grading, compaction at Site	1,347,800	CY	$4.25	$5,728,150
	Subtotal				**$47,979,450**
	Contingency	35%			**$16,792,900**
	Total for Option 2				**$64,772,350**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$3,282,000	$3,282,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	1,347,800	CY	$28	$37,738,400
	Subtotal				**$41,020,400**
	Contingency	35%			**$14,357,200**
	Total for Option 3				**$55,377,600**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$2,462,000	$2,462,000
	Sediment Removal and Beach Disposal	1,347,800	CY	$21	$28,303,800
	Subtotal				**$30,765,800**
	Contingency	35%			**$10,768,000**
	Total for Option 4				**$41,533,800**

Grand Totals with Disposal Options

Item	Description	Total Cost
1 / 2	**Disposal at POLA**	**$71,208,700**
3	**Upland Disposal**	**$115,214,050**
5	**Offshore Disposal [1]**	**$105,819,300**
6	**Beach Disposal [1]**	**$91,975,500**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 5 Phase 1

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$6,550,000**
1	Mobilization	1	LS	$6,550,000	$6,550,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**2,924,300**	CY		**$43,864,500**
3	Excavate to Marshplain	2,882,500	CY	$15	$43,237,500
4	New Ballona Creek	31,400	CY	$15	$471,000
5	Channels Order 5	1,500	CY	$15	$22,500
6	Channels Order 4	4,200	CY	$15	$63,000
7	Channels Order 3	4,700	CY	$15	$70,500
8	Breach	0	CY	$15	$0
	Transportation	**2,924,300**	CY		**$14,621,500**
9	Onsite trucking	2,924,300	CY	$5	$14,621,500
	New Levees	**49,240**	CY		**$492,400**
10	Levee Fill - no road	49,240	CY	$10	$492,400
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**2,889,960**	CY		**$14,449,800**
12	Stockpile	2,889,960	CY	$5	$14,449,800
	Levee Lowering and Ballona Creek Fill				**$1,828,500**
13	Levee Lowering	163,100	CY	$5	$815,500
14	Ballona Creek Fill	148,200	CY	$5	$741,000
15	Salvage Rip Rap	27,200	CY	$10	$272,000
16	Buried rock protection	0	CY	$20	$0
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$81,806,700**
	Contingency	35%			**$28,632,400**
	Total				**$110,439,100**

Disposal Options - Cost Estimates from POLA / Weston and SCC

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$2,639,000	$2,639,000
	Sediment Removal	2,889,960	CY	$3	$8,669,880
	Barge Sediment (approx. 30 NM)	2,889,960	CY	$4.50	$13,004,820
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	2,889,960	CY	$3	$8,669,880
	Subtotal				**$32,983,580**
	Contingency	35%			**$11,544,300**
	Total for Option 1				**$44,527,880**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$8,231,000	$8,231,000
	Sediment Removal	2,889,960	CY	$3	$8,669,880
	Barge Sediment (approx. 30 NM)	2,889,960	CY	$4.50	$13,004,820
	Stockpiling & Staging Material at POLA	2,889,960	CY	$1	$2,889,960
	Truck Material to Site (100 mi at $0.20/cy)	2,889,960	CY	$20	$57,799,200
	Placement, grading, compaction at Site	2,889,960	CY	$4.25	$12,282,330
	Subtotal				**$102,877,190**
	Contingency	35%			**$36,007,100**
	Total for Option 2				**$138,884,290**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$7,037,000	$7,037,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	2,889,960	CY	$28	$80,918,880
	Subtotal				**$87,955,880**
	Contingency	35%			**$30,784,600**
	Total for Option 3				**$118,740,480**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$5,278,000	$5,278,000
	Sediment Removal and Beach Disposal	2,889,960	CY	$21	$60,689,160
	Subtotal				**$65,967,160**
	Contingency	35%			**$23,088,500**
	Total for Option 4				**$89,055,660**

Grand Totals with Disposal Options

Item	Description	Total Cost
1 / 2	**Disposal at POLA**	**$154,966,980**
3	**Upland Disposal**	**$249,323,390**
5	**Offshore Disposal [1]**	**$229,179,580**
6	**Beach Disposal [1]**	**$199,494,760**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 5 Phase 2

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$2,900,000**
1	Mobilization	1	LS	$2,900,000	$2,900,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**1,192,500**	CY		**$17,887,500**
3	Excavate to Marshplain	1,165,500	CY	$15	$17,482,500
4	New Ballona Creek	15,500	CY	$15	$232,500
5	Channels Order 5	1,700	CY	$15	$25,500
6	Channels Order 4	4,600	CY	$15	$69,000
7	Channels Order 3	5,200	CY	$15	$78,000
8	Breach	0	CY	$15	$0
	Transportation	**1,192,500**	CY		**$5,962,500**
9	Onsite trucking	1,192,500	CY	$5	$5,962,500
	New Levees	**209,300**	CY		**$3,558,100**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	209,300	CY	$17	$3,558,100
	Stockpile	**923,500**	CY		**$4,617,500**
12	Stockpile	923,500	CY	$5	$4,617,500
	Levee Lowering and Ballona Creek Fill				**$1,253,500**
13	Levee Lowering	51,000	CY	$5	$255,000
14	Ballona Creek Fill	110,700	CY	$5	$553,500
15	Salvage Rip Rap	8,200	CY	$10	$82,000
16	Buried rock protection	18,150	CY	$20	$363,000
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$36,179,100**
	Contingency	35%			**$12,662,700**
	Total				**$48,841,800**

Disposal Options - Cost Estimates from POLA / Weston and SCC

Item	Description	Quantity	Unit	Unit Cost	Total Cost
1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$844,000	$844,000
	Sediment Removal	923,500	CY	$3	$2,770,500
	Barge Sediment (approx. 30 NM)	923,500	CY	$4.50	$4,155,750
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	923,500	CY	$3	$2,770,500
	Subtotal				**$10,540,750**
	Contingency	35%			**$3,689,300**
	Total for Option 1				**$14,230,050**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$2,630,000	$2,630,000
	Sediment Removal	923,500	CY	$3	$2,770,500
	Barge Sediment (approx. 30 NM)	923,500	CY	$4.50	$4,155,750
	Stockpiling & Staging Material at POLA	923,500	CY	$1	$923,500
	Truck Material to Site (100 mi at $0.20/cy)	923,500	CY	$20	$18,470,000
	Placement, grading, compaction at Site	923,500	CY	$4.25	$3,924,880
	Subtotal				**$32,874,630**
	Contingency	35%			**$11,506,200**
	Total for Option 2				**$44,380,830**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$2,249,000	$2,249,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	923,500	CY	$28	$25,858,000
	Subtotal				**$28,107,000**
	Contingency	35%			**$9,837,500**
	Total for Option 3				**$37,944,500**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$1,687,000	$1,687,000
	Sediment Removal and Beach Disposal	923,500	CY	$21	$19,393,500
	Subtotal				**$21,080,500**
	Contingency	35%			**$7,378,200**
	Total for Option 4				**$28,458,700**

Grand Totals with Disposal Options

1 / 2	**Disposal at POLA**	**$63,071,850**
3	**Upland Disposal**	**$93,222,630**
5	**Offshore Disposal [1]**	**$86,786,300**
6	**Beach Disposal [1]**	**$77,300,500**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

Alternative 5 Phase 3

Item	Description	Quantity	Unit	Unit Cost	Total Cost
	Mobilization				**$2,990,000**
1	Mobilization	1	LS	$2,990,000	$2,990,000
	Demolition				**$0**
2	Demo culvert, daylight chan	0	LF	$1,000	$0
	Excavation	**1,352,000**	CY		**$20,280,000**
3	Excavate to Marshplain	1,324,700	CY	$15	$19,870,500
4	New Ballona Creek	21,800	CY	$15	$327,000
5	Channels Order 5	800	CY	$15	$12,000
6	Channels Order 4	2,200	CY	$15	$33,000
7	Channels Order 3	2,500	CY	$15	$37,500
8	Breach	0	CY	$15	$0
	Transportation	**1,352,000**	CY		**$6,760,000**
9	Onsite trucking	1,352,000	CY	$5	$6,760,000
	New Levees	**0**	CY		**$0**
10	Levee Fill - no road	0	CY	$10	$0
11	Levee Fill - with road	0	CY	$17	$0
	Stockpile	**1,344,600**	CY		**$6,723,000**
12	Stockpile	1,344,600	CY	$5	$6,723,000
	Levee Lowering and Ballona Creek Fill				**$620,200**
13	Levee Lowering	42,900	CY	$5	$214,500
14	Ballona Creek Fill	50,300	CY	$5	$251,500
15	Salvage Rip Rap	8,160	CY	$10	$81,600
16	Buried rock protection	3,630	CY	$20	$72,600
	Water Control Structures				**$0**
17	Culvert	0	SF	$2,010	$0
18	Tide Gate	0	LS	$100,000	$0
	Subtotal				**$37,373,200**
	Contingency	35%			**$13,080,700**
	Total				**$50,453,900**

Disposal Options - Cost Estimates from POLA / Weston and SCC

1 / 2	**Unload Dredged Material at POLA / Disposal at CDF at POLA**				
	Mobilization	1	LS	$1,228,000	$1,228,000
	Sediment Removal	1,344,600	CY	$3	$4,033,800
	Barge Sediment (approx. 30 NM)	1,344,600	CY	$4.50	$6,050,700
	Unload Dredged Material (hydraulic unloader) or Disposal at CDF	1,344,600	CY	$3	$4,033,800
	Subtotal				**$15,346,300**
	Contingency	35%			**$5,371,300**
	Total for Option 1				**$20,717,600**
3	**Beneficial Use - Landfill Cover**				
	Mobilization	1	LS	$3,830,000	$3,830,000
	Sediment Removal	1,344,600	CY	$3	$4,033,800
	Barge Sediment (approx. 30 NM)	1,344,600	CY	$4.50	$6,050,700
	Stockpiling & Staging Material at POLA	1,344,600	CY	$1	$1,344,600
	Truck Material to Site (100 mi at $0.20/cy)	1,344,600	CY	$20	$26,892,000
	Placement, grading, compaction at Site	1,344,600	CY	$4.25	$5,714,550
	Subtotal				**$47,865,650**
	Contingency	35%			**$16,753,000**
	Total for Option 2				**$64,618,650**
4	**Disposal at Hazardous Waste Landfill - estimate not included, contamintant report pending**				
5	**Offshore Disposal [1]**				
	Mobilization	1	LS	$3,274,000	$3,274,000
	Sediment Removal and Offshore Disposal (approx. 3 mi offshore)	1,344,600	CY	$28	$37,648,800
	Subtotal				**$40,922,800**
	Contingency	35%			**$14,323,000**
	Total for Option 3				**$55,245,800**
6	**Beach Disposal [1]**				
	Mobilization	1	LS	$2,456,000	$2,456,000
	Sediment Removal and Beach Disposal	1,344,600	CY	$21	$28,236,600
	Subtotal				**$30,692,600**
	Contingency	35%			**$10,742,400**
	Total for Option 4				**$41,435,000**

Grand Totals with Disposal Options

1 / 2	**Disposal at POLA**	**$71,171,500**
3	**Upland Disposal**	**$115,072,550**
5	**Offshore Disposal [1]**	**$105,699,700**
6	**Beach Disposal [1]**	**$91,888,900**

Notes

1 - For Options 5 and 6, costs may range from the cost for Option 1 / 2 (lower end) up to the costs listed for Options 5 and 6 (upper end)

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APPENDIX B9
Restoration Projects Cost Comparison

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Appendix B9, Comparative Costs of Alternatives Considered

Table 1. Summary Comparing Restoration Costs Per Acre

Project	*Total Cost*	*Cost Per Restored Acre*
Ballona Wetlands Restoration Project - Alternative 1	$ 182,822,316	$ 908,208
Ballona Wetlands Restoration Project - Alternative 2	$ 144,765,227	$ 974,194
Ballona Wetlands Restoration Project - Alternative 3	$ 135,443,230	$ 2,574,966
Breuner Marsh Restoration Project	$ 14,425,248.00	$ 87,959
San Elijo Lagoon Restoration Project	$ 58,976,218.00	$ 393,175
Malibu Lagoon Restoration and Enhancement	$ 4,094,487	$ 240,852
San Dieguito Wetlands Restoration Project	$ 84,804,784	$ 526,738

Table 1a. Calculation of Per-Acre Costs - Ballona Wetlands Restoration Project Alternatives

	Ballona Wetlands Restoration Project				
Task	***Alternative 1- Phase 1***	***Alternative 1- Phase 2***	***Alternative 1 Total***	***Alternative 2***	***Alternative 3***
Mobilization & Demobilization	$ 7,100,000	$ 4,300,000	$ 11,400,000	$ 7,100,000	$ 4,300,000
Demolition and Removal	$ 467,500	$ 555,000	$ 1,022,500	$ 718,500	$ 105,000
Earthwork (Cut and Fill)	$ 62,969,500	$ 16,502,400	$ 79,471,900	$ 67,203,500	$ 29,575,000
Offsite hauling	$ 1,211,770	$ -	$ 1,211,770	$ 110,350	$ 55,466,700
Levee Transitions to existing levees	$ 549,750	$ 137,438	$ 687,188	$ 549,750	$ 274,875
Erosion Control Structures	$ 11,213,717	$ 7,433,333	$ 18,647,050	$ 10,934,967	$ -
Water Control Structures	$ 6,740,222	$ 2,760,000	$ 9,500,222	$ 6,740,222	$ 11,185,383
Public Access	$ 22,991,400	$ 1,704,000	$ 24,695,400	$ 22,933,000	$ 9,069,000
Planting	$ 2,756,060	$ 959,840	$ 3,715,900	$ 3,147,400	$ 2,093,400
Monitoring	$ 1,200,000	$ 800,000	$ 2,000,000	$ 1,200,000	$ 800,000
Total	$ 117,199,919	$ 35,152,011	$ 152,351,930	$ 120,637,689	$ 112,869,358
Contingency	$ 23,439,984	$ 7,030,402	$ 30,470,386	$ 24,127,538	$ 22,573,872
Total Cost	$ 140,639,903	$ 42,182,413	$ 182,822,316	$ 144,765,227	$ 135,443,230
Acres to be restored	138.2	63.1	201.3	148.6	52.6
Total Cost per Restored Acre	***$ 1,017,655***	***$ 668,501***	***$ 908,208***	***$ 974,194***	***$ 2,574,966***

Table 1b. Calculation of Per-Acre Costs - Breuner Marsh

Project Summary: Breuner Marsh Restoration Project

On behalf of a long list of project partners, the US EPA describes the Breuner Marsh Restoration Project as folows: "This project will create, restore and enhance 164 acres of wetlands and uplands habitat at Breuner Marsh along th Point Pinole Regional Shoreline in Richmond. The restored area will be a self-sustaining tidal wetlands area with adjacent seasonal wetlands and coastal prairie habitats, and will provide a key link in the Bay Trail system. The project is designed to accommodate a sea level rise of 55 inches by the year 2100 and includes uplands in order for the wetlands to be able to transgress inland. Site preparation has already begun and the project is estimated to be completed in 2016." (US EPA 2016)

Task	*Year*	*Cost*	*Cost in 2017 Dollars*
Preconstruction	2015	$ 1,400,000	$ 1,425,612
Construction Management, Engineering/Design	2015	$ 2,600,000	$ 2,647,565
Phase I	2014	$ 2,500,000	$ 2,548,757
Phase II	2015	$ 1,700,000	$ 1,731,100
Phase III	2016	$ 5,000,000	$ 5,053,920
Monitoring	2015	$ 1,000,000	$ 1,018,294
Total Cost			***$ 14,425,248***
Acres to be Restored			***164***
Total Cost Per Restored Acre			***$ 87,959***

Notes

1. Land acquisition costs are not included.
2. Preconstruction costs include planning, environmental compliance and permitting.
3. Phase I tasks include hazardous soil removal, site preparation, grading, portion of tidal wetland/seasonal wetland construction.
4. Phase II tasks include a portion of tidal wetland/seasonal wetland construction, and portion of public access improvements, bathrooms, etc.
5. Phase III tasks include remaining work, including public access improvements, boardwalk and trail construction, etc.

References

California Coastal Conservancy, 2016a. Wetlands Costs Worksheet Breuner Marsh. November 14, 2016.

U.S. EPA, 2016. Breuner Marsh Restoration Project [https://www.epa.gov/sfbay-delta/breuner-marsh-restoration-project]. Updated May 31, 2016.

Table 1c. Calculation of Per-Acre Costs - San Elijo Lagoon Restoration Project

Project Summary

The San Elijo Lagoon Restoration Project has two components: the restoration of San Elijo Lagoon and the disposal or reuse of materials excavated as part of that restoration. The project would restore ecological functions in San Elijo Lagoon within the San Elijo Lagoon Ecological Reserve, which is located in the City of Encinitas, San Diego County, California. The restoration area comprises approximately 960 acres primarily within the Reserve, including the lagoon. (U.S. Army Corps of Engineers and County of San Diego Department of Parks and Recreation 2016). Project activities include dredging an over-dredge pit, channels, placing beach fill, placing offshore fill, constructing habitat areas, constructing pedestrian bridges, placing rock revetment, planting and irrigation.

Task	*Year*	*Cost*	*Cost in 2017 Dollars*	
Mobilization	2016	$ 7,114,500	$ 7,191,223	
Site preparation (grubbing, invasives removal, etc.)	2016	$ 8,328,000	$ 8,417,810	
Relocation of utilities	Not applicable			
Grading and earthwork and dredging	2016	$ 30,632,500	$ 30,962,843	Includes Dredging, Filling, Traffic Control, QC/QA, SWPPP
Construction of structures	2016	$ 8,455,000	$ 8,546,179	Includes Drainage RSP, Ped Bridges
Irrigation installation	2016	$ 1,010,000	$ 1,020,892	
Planting Maintenance (during monitoring period)	2016	$ 2,807,000	$ 2,837,271	
Monitoring (including reporting)	Not available			
Total Cost			***$ 58,976,218***	
Acres to be Restored			***150***	
Total Cost Per Restored Acre			***$ 393,175***	

Notes

References

California Coastal Conservancy, 2016b. Wetlands Costs Worksheet San Elijo. November 14, 2016.

U.S. Army Corps of Engineers and County of San Diego Department of Parks and Recreation, 2016. San Elijo Lagoon Restoration Project Environmental Impact Report / Environmental Impact Statement. SCH# 2011111013 [https://www.sanelijo.org/sites/sanelijo.org/files/Publications/San%20Elijo%20Lagoon%20Restoration%20Project%20EIR.pdf] February 2016.

Table 1d. Calculation of Per-Acre Costs - Malibu Lagoon Restoration and Enhancement

Project Summary

The restoration and enhancement of the Malibu Lagoon (approximately 17 acres of estuarine wetlands) will include activities relating to the following: water management, habitat management, access, and monitoring to facilitate implementation of the monitoring program and subsequent environmental review and permitting. (Moffatt & Nichol 2005) More specifically, restoration will include recontouring the western lagoon, demolishing three bridges, removing inappropriate vegetation, replanting with native species appropriate for the site, and the construction of interpretive landscape.

Task	*Year*	*Cost*	*Cost in 2017 Dollars*
Mobilization	2012	$ 205,000	$ 215,499
Site preparation (grubbing, invasives removal, etc.)	2012	$ 680,000	$ 714,827
Relocation of utilities	Not applicable		
Grading and earthwork	2012	$ 900,000	$ 946,095
Construction of structures	2012	$ 887,000	$ 932,429
Irrigation installation	2012	$ 228,000	$ 239,677
Planting Maintenance (included in monitoring estimate)	Spring 2013-Spring 2018		
Monitoring (including reporting)	Spring 2013-Spring 2018	$ 450,000	$ 473,047
Project Management and Inspection		$ 545,000	$ 572,913
Total Cost			***$ 4,094,487***
Acres to be Restored			***17***
Total Cost Per Restored Acre			***$ 240,852***

Notes

References

California Coastal Conservancy, 2016c. Wetlands Costs Worksheet Malibu Lagoon. November 4, 2016.

Moffatt & Nichol, 2005. Final Malibu Lagoon Restoration and Enhancement Plan. [http://www.parks.ca.gov/pages/980/files/000%20appendix%20a%20-%20malibu%20lagoon%20restoration%20and%20enhancement%20plan.pdf] June 17, 2005.

Table 1e. Calculation of Per-Acre Costs - San Dieguito Wetlands Restoration Project

Project Summary

The San Dieguito Wetlands Restoration has been described as "intended to offset impacts to fish eggs and larvae attributed to the San Onofre Nuclear Generating Station (SONGS) once-through ocean cooling water system operation. The project restored 161 acres of degraded historical wetlands adjacent to the San Dieguito River between El Camino Real and the Del Mar beach.... A key requirement of the restoration is keeping the tidal inlet at the river mouth in an essentially open condition indefinitely." (Southern California Edison 2016).

Task	*Year*	*Cost*	*Cost in 2017 Dollars*
Phase 1: Early conceptual planning, siting studies, land acquisition	1997-1998	$ 7,400,000	$ 7,479,802
Phase 2: Preliminary design and engineering, CEQA documentation, litigation	1999-2003	$ 8,200,000	$ 8,288,429
Phase 3: Final engineering, permitting	2004-2006	$ 8,000,000	$ 8,086,273
Phase 4: Construction and Mitigation	2007-2012	$ 50,000,000	$ 50,539,204
Phase 5: Post-Construction Maintenance, Monitoring and Reporting	2012-2015	$ 10,300,000	$ 10,411,076
Total Cost			***$ 84,804,784***
Acres to be Restored			***161***
Total Cost per Acre			***$ 526,738***

Notes

1. Each year since 1997 includes approximately $1 M in Coastal Commission independent oversight and monitoring, per the 1997 Coastal Development Permit for SONGS Marine Mitigation.
2. Each year since 2009 includes approximately $300 K in JPA public access element maintenance.
3. Dollars have been adjusted from 2016 (the year reported) to 2017 to account for inflation and for purposes of comparison.

References

Southern California Edison, 2016. San Dieguito Wetlands Restoration Project, Summary of Costs/Phases. April 20, 2016.

Southern California Edison, 2005. San Dieguito Wetlands Restoration Project Final Restoration Plan. [http://marinemitigation.msi.ucsb.edu/documents/wetland/sce_reports/san_dieguito-lagoon-final-restoration-plan_112005.pdf] November 2005.

Table 1a. Calculation of Per-Acre Costs - Ballona Wetlands Restoration Project Alternatives

Table 1f. Calculation of Per-Acre Costs - Ballona Wetlands Restoration Project Alternatives With Raised Roads
Ballona Wetlands Restoration Project

Task	Alternative 1	Alternative 2	Alternative 3	Alt. 1 with Raised Roads	Alt. 2 with Raised Roads	Alt. 3 with Raised Roads
Mobilization & Demobilization	$ 11,400,000	$ 7,100,000	$ 4,300,000	(See Alt 1)	(See Alt 2)	(See Alt 3)
Demolition and Removal	$ 1,022,500	$ 718,500	$ 105,000			
Earthwork (Cut and Fill)	$ 79,471,900	$ 67,203,500	$ 29,575,000			
Offsite hauling	$ 1,211,770	$ 110,350	$ 55,466,700			
Levee Transitions to existing levees	$ 687,188	$ 549,750	$ 274,875			
Erosion Control Structures	$ 18,647,050	$ 10,934,967	$ -			
Water Control Structures	$ 9,500,222	$ 6,740,222	$ 11,185,383			
Public Access	$ 24,695,400	$ 22,933,000	$ 9,069,000			
Planting	$ 3,715,900	$ 3,147,400	$ 2,093,400			
Monitoring	$ 2,000,000	$ 1,200,000	$ 800,000			
Total	$ 152,351,930	$ 120,637,689	$ 112,869,358			
Contingency	$ 30,470,386	$ 24,127,538	$ 22,573,872			
Subtotal Cost (without Road Raising)	$ 182,822,316	$ 144,765,227	$ 135,443,230	$ 182,822,316	$ 144,765,227	$ 135,443,230
Additional Cost - Road Raising Option 1	$ -	$ -	$ -	$ 200,000,000	$ 200,000,000	$ 200,000,000
Additional Cost - Road Raising Option 2	$ -	$ -	$ -	$ 143,000,000	$ 143,000,000	$ 143,000,000
Additional Cost - Road Raising (Average of Options 1 and 2)	$ -	$ -	$ -	$ 171,500,000	$ 171,500,000	$ 171,500,000
Total acres to be restored (w/o Raised Roads)	201.3	148.6	52.6	201.3	148.6	52.6
Total acres to be Restored (with Raised Roads)	0	0	0	208.3	155.6	59.6
Total Cost per Restored Acre (with Raised Roads-Option 1)	***$ 908,208***	***$ 974,194***	***$ 2,574,966***	***$ 1,837,841***	***$ 2,215,715***	***$ 5,628,242***
Total Cost per Restored Acre (with Raised Roads-Option 2)				***$ 1,564,197***	***$ 1,849,391***	***$ 4,671,866***
Total Cost per Restored Acre (with Raised Roads-Options Averaged)				***$ 1,701,019***	***$ 2,032,553***	***$ 5,150,054***
Percent increase relative to Alternative without Raised Roads				***53%***	***48%***	***50%***

Table 1f. Land Acquisition Costs

Street Address		***Type***	***Building (SF)***	***Lot (SF)***	***List Price***	***Date***	***$/SF (lot)***
14 Mast Street	Marina del Rey	"low rise"	6,261	3,135	$ 4,995,000	6/14/2017	$ 1,593
318 Culver Blvd/333 Pershing	Playa del Rey	Retail/Residential	7,601	5,529	$ 5,000,000	6/14/2017	$ 904
165 Culver Blvd	Playa del Rey	Office	2,692		$ 3,400,000	6/14/2017	Not Available
6836 Esplanade	Playa del Rey	Multi-family		43,560	$ 1,600,000	6/14/2017	$ 37
100 Montreal Street	Playa del Rey	Multi-family	1,872	2,552	$ 1,500,000	6/14/2017	$ 588
7321 Vista del Mar	Playa del Rey	Single-family		4,210	$ 1,195,000	6/14/2017	$ 284
					Average $/SF		***$ 681***

References

Loopnet, 2017. [http://www.loopnet.com/for-sale/2/?bb=sqx4gvq7mNzku9sL] Accessed June 14, 2017.

APPENDIX B10
Conceptual Cost Analysis to Raise Culver and Jefferson Boulevards

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TECHNICAL MEMO

From: Michael J. Crehan, P.E., Psomas
Date: May 12, 2017
RE: Option to Raise Culver and Jefferson Boulevards in Area B – Conceptual Cost Analysis

PURPOSE:

This memo documents the analysis to estimate the rough order of magnitude cost to raise Culver Boulevard and Jefferson Boulevard onto a causeway west of Lincoln within the ownership limits such that the roadway will be above any potential flooding or tidal water surface elevation.

I. REQUIRED ROADWAY WIDTHS:

Per the City of Los Angeles Mobility Plan the street widths are required to be:

Street:	Classification:	Roadway Width:	Right-of-Way Width:
Jefferson	Boulevard II	80'	110'
Culver	Modified Avenue III	46' Street	72'

(Note, the "Modification" has not been defined, so this is the listed standard)

The existing roadways are:

Street:	Roadway Width:	Right-of-Way Width:
Jefferson	Varies from 50' to 80'	100'
Culver	Varies from 30' to 50'	65'

(Note, there as a section of one-way road at the transition from Culver to Jefferson east-bound where there is an 18' wide paved roadway and a much widened right-of-way)

The difference between Street width and R/W width is intended for sidewalks on each side. While the City's street classifications would normally call for the State to dedicate land for additional street R/W, at meetings with the Los Angeles Department of Transportation, they indicated that no formal request for such dedication should be expected. Therefore, the existing right-of-way width is the ultimate right-of-way width.

II. CAUSEWAY DESCRIPTION:

Two possible causeway widths were reviewed. First, a roadway cross-section on the causeway to match the existing roadway width was reviewed. This would match the pavement lane widths and vehicular transitions which would maintain current vehicular traffic conditions, but not include vehicular shoulders, sidewalks, or bicycle lanes. Second, a more typical roadway cross section on the causeway to provide the same traffic lane conditions, but also include shoulder/bicycle lanes, and a sidewalk on one side within the existing right-of-way. This option would have a minimum 40' wide roadway width and a 6' wide sidewalk on both sides.

The causeway would essentially be an elevated bridge structure on pilings with the causeway above any flooding potential, possibly up to the top of the levee at approximately elevation 20. Whether at elevation 20 or lower will have little impact on the cost of the structure. The top of the causeway would include a roadway section for vehicular/bicycle traffic, and sidewalk and guardrail on each side. Lighting would typically be required, but may not due to the adjacent habitat area. Cost for a public street lighting system is included. There will also be a major graded transition at three locations (Lincoln/Jefferson, Culver south of the Ballona Channel, and Culver/Nicholson), and minor graded transitions at the Gas Company access roads and the new access points needed to drive onto the levee for maintenance.

III. CONSTRUCTION/COST ISSUES AND RISKS:

Staging – Construction staging would occur in a minimum of two phases in order to build the causeway while maintaining traffic flows during construction. Half of the causeway would be built per phase. For the narrower Culver Blvd sections, this will require expanding a temporary paving section on one side to move two way traffic to that half of the right-of-way while the causeway is built on the other half of the right-of-way. Sub-phasing would be needed at transitions and access points.

Existing Overhead Power Lines – With the raising of the causeway above the existing roadway elevations, the separation from the roadway to the wires on the overhead electrical poles may not meet safety requirements. If this is the case, these poles would need to be replaced with taller poles. If the wider causeway is constructed, the existing overhead power lines would be required to be relocated. If the poles have to be relocated, a significant additional cost above the costs noted below would be required. This cost range is estimated in the $3,000,000 to $4,000,000 per mile per pole line, or an additional five to six million dollars.

Jurisdiction – Both Culver and Jefferson are public roadways under the jurisdiction of the City of Los Angeles. Therefore, they must be built for, and inspected by, the City of Los Angeles for their acceptance.

IV. ROUGH ORDER OF MAGNITUDE COST FOR MAJOR ITEMS:

Item	Quantity	Unit Cost	Cost
Option 1 (Full causeway width)			
Transition Grade/Pave	40,000 sf	$15	$ 1,000,000
Causeway Deck	640,000 sf	$200	$128,000,000
Piles (Note – Assumed 5 pile rows on Jefferson, 4 on Culver, at 40' spacing per row)	900 each	$15,000	$ 14,000,000
Temporary Pavement (15' widening for 5,500 lf)	82,500 sf	$10	$ 1,000,000
Traffic Signal & Interconnect	1 each	Lump Sum	$ 1,000,000
Street Lights	90 each	$10,000	$ 1,000,000
Miscellaneous (Traffic control, erosion protection, misc. bridge equipment)	1 each	Lump Sum	$ 2,000,000
Sub-total			$148,000,000
Design/CM/Monitoring (6%)			$ 8,000,000
Inspection/Fees (15%)			$ 22,000,000
Contingencies (15%)			$ 22,000,000
		TOTAL	**$200,000,000**
Option 2 (Minimum causeway width)			
Transition Grade/Pave	36,000 sf	$15	$ 1,000,000
Causeway Deck (Assumes 40' roadway and sidewalk on one side, widened at intersections)	4,300,000 sf	$200	$ 86,000,000
Piles (Assumed 4 pile rows at 40' spacing per row)	840 each	$15,000	$ 13,000,000
Temporary Pavement (15' widening for 5,500 lf)	82,500 sf	$10	$ 1,000,000
Traffic Signal & Interconnect	1 each	Lump Sum	$ 1,000,000

Street Lights	90 each	$10,000	$ 1,000,000
Miscellaneous (Traffic control, erosion protection, misc. bridge equipment)	1 each	Lump Sum	$ 2,000,000
Sub-total			$105,000,000
Design/CM/Monitoring (6%)			$ 6,000,000
Inspection/Fees (15%)			$ 16,000,000
Contingencies (15%)			$ 16,000,000
		TOTAL	**$143,000,000**

V. COST REFERENCES:

Costs for bridge deck and piles are the more significant items driving the overall cost. Other costs are relatively incidental.

Bridge – Caltrans "Comparative Bridge Costs" has a wide range of unit costs per square foot (sf). $200 per sf was chosen as an approximate average of costs listed.

Piles – Drilled piles must be used due to proximity to a 230 kV underground transmission line, and safer installation next to an active roadway. Drilled piles are generally more expensive than driven piles. Pile costs can range significantly. A unit cost of $15,000 was used.

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
STRUCTURE DESIGN - OFFICE OF STRUCTURE OFFICE ENGINEER

COMPARATIVE BRIDGE COSTS

JANUARY 2016

The following tabular data provides some **general guidelines** for structure type selection and its relative cost. These costs should be used only for **preliminary estimates** until more detailed information is developed. The following factors must be taken into account when determining a price within the cost range:

Factors for Lower End of Cost Range	Factors for Higher End of Cost Range
Short Spans, Low Structure Height, No Environmental Constraints, Large Project, No Aesthetic Issues, Dry Conditions, No Bridge Skew	Long Spans, High Structure Height, Environmental Constraints, Small Project, Aesthetic Issues, Wet Conditions (cofferdams required), Skewed Bridges
Urban Location	Remote Location
Seat Abutment	Cantilever Abutment
Spread Footing	Pile Footing (Large Diameter Piling)
No Stage Construction	2-Stage Construction

Factors that will increase the price from 25% - 150% over the high end of the cost range

Structures with more than 2 construction stages	Unique substructure construction
Widenings less than 15 Ft.	

STRUCTURAL SECTION	(STR. DEPTH / MAX SPAN) SIMPLE	CONTINUOUS	COMMON SPAN RANGE (feet)	* COST RANGE (price/sqft)	REMARKS
RC SLAB	0.06	0.045	16 - 44	120-400	CAST-IN -PLACE CONCRETE BRIDGES ACCOUNT FOR APPROXIMATELY 65% OF BRIDGES BUILT ON CALIFORNIA STATE HIGHWAYS
RC T-BEAM	0.07	0.065	40 - 60	115-260	
RC BOX	0.06	0.055	50 - 120	160-250	
CIP/PS SLAB	0.03	0.03	40 - 65	120-250	
CIP/PS BOX	0.045	0.04	100 - 250	110-350	
PC/PS SLAB	0.03 (+3" AC)	0.03 (+3" AC)	20 - 50	270 - 500	NO FALSEWORK REQUIRED
PC/PS T, TT, ⊥	0.06 (+3" AC)	0.055 (+3" AC)	30 - 120	No Current Cost Data	
BULB TEE GIRDER	0.05	0.045	90 - 145	120 - 300	
WIDE FLANGE GIRDER	0.045	0.04	90 - 180	140 -250	
PC/PS I	0.055	0.05	50 - 120	150 - 400	
PC/PS BOX	0.06	0.045	120 - 200	125 - 280	
STRUCT STEEL I GIRDER	0.045	0.04	60 - 300	250 - 500	NO FALSEWORK REQUIRED

NOTE: Removal of a box girder structure costs from $10 - $20 per square foot.

* "Price/SQFT" is calculated using "Bridge Costs Only" as defined by the Federal Highway Administration. The "Bridge Cost Only" is the sum of the "Superstructure" and "Substructure" bridge items, listed in Chapter 11 of the Bridge Design Aids Manual, multiplied by the bid item price. The "Superstructure" and "Substructure" bridge items do not include items such as: time related overhead, mobilization, bridge removal, approach slabs, slope paving, soundwalls, or retaining walls.

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