San Diego Unified Port District
Document No. 66757
Filed 06/08/17

FINAL REPORT

Restoration and Enhancement Alternatives for the Chula Vista Bayfront Chula Vista, California

April 2017

Prepared for:

San Diego Unified Port District
Planning & Green Port Department
3165 Pacific Highway
San Diego, CA 92101
Contact: Eileen Maher

Prepared by:

Merkel & Associates, Inc.
5434 Ruffin Road
San Diego, California 92123
Phone: (858) 560-5465
Fax: (858) 560-7779
Project Manager: Holly Henderson

With:

Environmental Science Associates (ESA)
KTU+A
Ninyo & Moore
AMEC
Diego & Sons

FINAL REPORT

Restoration and Enhancement Alternatives for the Chula Vista Bayfront Chula Vista, California

April 2017

Prepared for:

San Diego Unified Port District
Planning & Green Port Department
3165 Pacific Highway
San Diego, CA 92101
Contact: Eileen Maher

Prepared by:

Merkel & Associates, Inc.
5434 Ruffin Road
San Diego, California 92123
Phone: (858) 560-5465
Fax: (858) 560-7779
Project Manager: Holly Henderson

With:

Environmental Science Associates (ESA)
KTU+A
Ninyo & Moore
AMEC
Diego & Sons

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Final Report for the Restoration and Enhancement Alternatives for the Chula Vista Bayfront

April 2017

1.0 INTRODUCTION

As part of the planning process for re-development of the Chula Vista Bayfront (Project), the District retained the Merkel & Associates, Inc. team (Team) to identify and develop alternatives to restore and enhance the functional values of the natural lands and waters of the Chula Vista Bayfront. These Restoration and Enhancement Alternatives for the Chula Vista Bayfront have been incorporated into this final report (Plan), which describes a range of restoration alternatives, identifies recommended alternatives, and identifies preliminary permitting and planning needs, engineering components, and capital and maintenance costs associated with alternatives. The following text describes the Project background, identifies the goals and objectives for development of this Plan, and defines the Plan report structure.

1.1 BACKGROUND

The San Diego Unified Port District (District), the City of Chula Vista (City), and Pacifica Companies, in conjunction with the community, are primary stakeholders in the re-development and restoration of 535 acres along the Chula Vista Bayfront located along the southeastern shoreline of San Diego Bay in San Diego, California (Figure 1-1). The multi-year planning process culminated on August 9, 2012 when the California Coastal Commission approved the Chula Vista Bayfront Master Plan (Master Plan). The objectives of the Master Plan are to:

- Create an active commercial harbor with public space at the water's edge;
- Redevelop underutilized and vacant areas in the city of Chula Vista and on Port tidelands with a variety of uses;
- Extend Chula Vista's east-west streets to the Bay to ensure pedestrian, vehicle, bicycle, and transit links;
- Provide a continuous shoreline pedestrian walkway, fully accessible to the public that connects the new Sweetwater, Harbor, and Otay Districts;
- Establish ecological buffers to protect adjacent environmentally sensitive resources.

The Master Plan includes a 21-acre Signature Park with connecting walking trails, overlooks, and picnic areas; 120,000 square feet of commercial recreation development; two campground/recreational vehicle parks; relocation of the Living Coast Discovery Center's parking lot; 1,500 mid-rise and high-rise residential units and 15,000 square feet of ground floor retail; 420,000 square feet of mixed-use commercial and office space; a 250-room hotel; and over 44 acres of parks, habitat buffers and open space. The Chula Vista Bayfront has been divided into three planning districts (Sweetwater District, Harbor District, and Otay District), each with unique development and restoration opportunities. Figure 1-2 provides a conceptual drawing of development and open space areas planned for the Chula Vista Bayfront, and identifies the three planning districts.

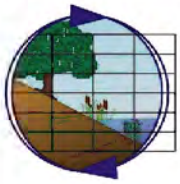
The Chula Vista Bayfront is surrounded by 3,000 acres of valuable natural resources, including the San Diego Bay National Wildlife Refuge (NWR) and the Chula Vista Wildlife Reserve (CVWR). This unique location provides opportunities to restore and enhance natural habitats as a primary Master Plan component. Protection and restoration of native habitats has been an integral part of the planning process for the Chula Vista Bayfront, as detailed in the controlling documents for the Master Plan.

1.2 CONTROLLING DOCUMENTS

The primary controlling documents for the Chula Vista Bayfront Master Plan include the Mitigation Monitoring and Reporting Program (MMRP) developed as part of the California Environmental Quality Act (CEQA) process (Dudek 2010), the Settlement Agreement (SDUPD 2010) entered into between the District , the City and the Bayfront Coalition, and the Chula Vista Bayfront Development Policies and Public Access Policies (SDUPD 2012a, 2012b), which bring together all conditions and policies that will guide development along the Chula Vista Bayfront. The Settlement Agreement further refines restoration and enhancement objectives for the Wildlife Habitat Areas within the Chula Vista Bayfront planning area, provides for management and protection of natural habitats through development of a Natural Resources Management Plan (NRMP), and identifies priorities for habitat restoration. The environmental protections identified in the Settlement Agreement go above and beyond those required by federal, state and local laws and regulations.

As a condition of the Settlement Agreement, a Wildlife Advisory Group (WAG) comprised of representatives from multiple environmental groups and resource and regulatory agencies was established. The WAG is tasked with advising the District and the City on natural resource management issues and restoration plans and priorities, initiating and supporting funding requests to implement restoration objectives, and partnering with the District and City to engage in education and volunteerism. A primary task of the WAG has been development of the NRMP to protect natural resources of the Chula Vista Bayfront. Objectives of the NRMP include:

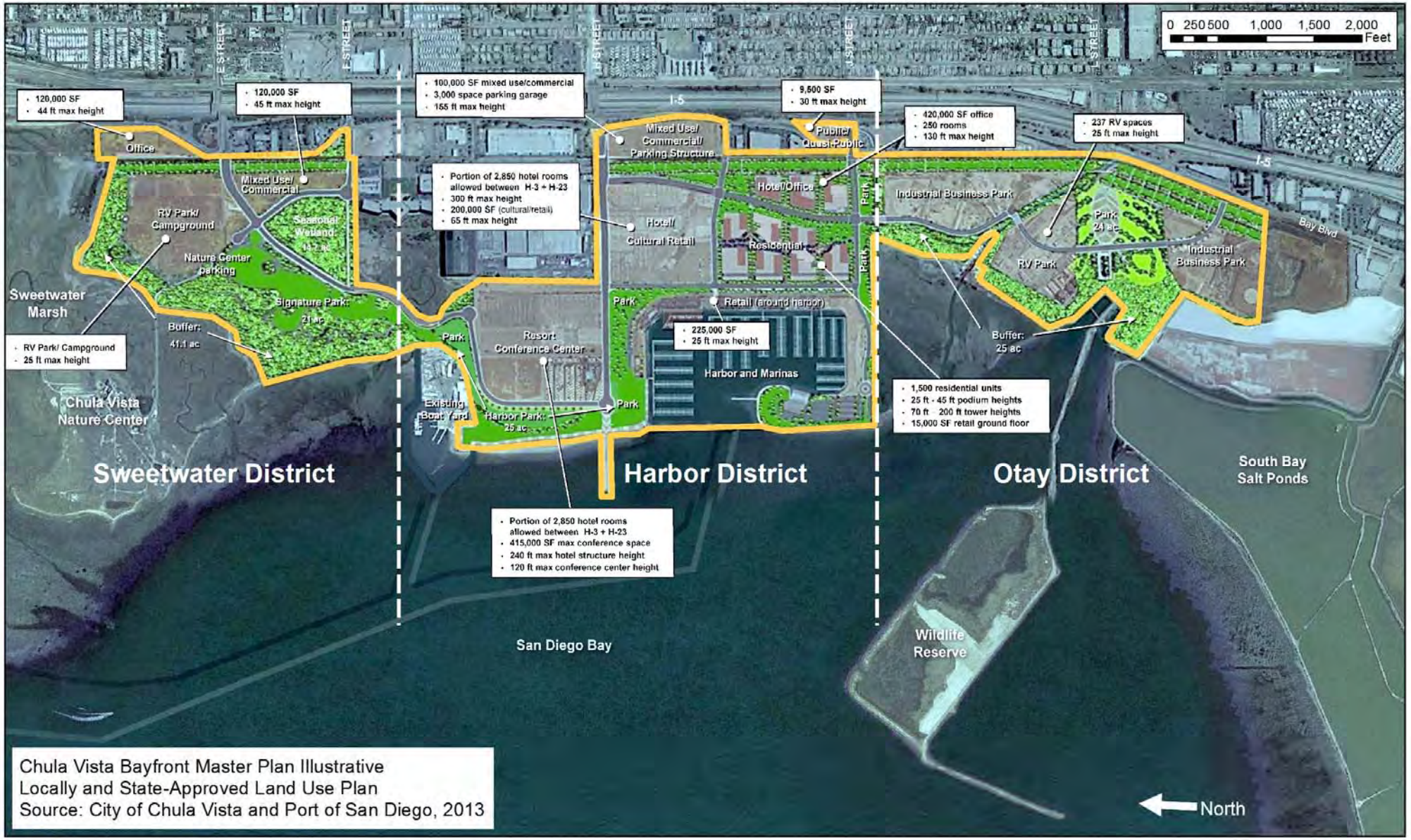
- Long term protection, conservation, monitoring and enhancement of wetland habitats, coastal sage and coastal strand vegetation, and upland natural resources;
- Preservation of the biological function of all bayfront habitats serving as breeding, wintering, or migratory rest stops for avifauna;
- Protection of nesting, foraging, and rafting wildlife from disturbance;
- Avoidance of actions within the Chula Vista Bayfront that would adversely impact or degrade the water quality of San Diego Bay;
- Maintenance and improvement of water quality where possible.



N W E S

Chula Vista Bayfront Planning Area
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 1-1



Chula Vista Bayfront Master Plan Illustrative
Locally and State-Approved Land Use Plan
Source: City of Chula Vista and Port of San Diego, 2013

Chula Vista Bayfront Planning Area Development and Open Space
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 1-2

Merkel & Associates, Inc.

The NRMP proposes to meet these objectives primarily through protective measures such as fencing, establishment of transitional and no-touch buffer areas (buffers between developed and natural habitats), active predator management, low impact lighting and landscaping, control of urban runoff, and public education. The NRMP was finalized in May 2016 (San Diego Unified Port District and City of Chula Vista 2016).

The goals and objectives for the Restoration and Enhancement Alternatives for the Chula Vista Bayfront (Plan) have been developed to satisfy MMRP mitigation measures, requirements of the Settlement Agreement, and the objectives of the NRMP, as well as to maximize the rich and diverse opportunities for habitat restoration and protection available in the south San Diego Bay environment.

1.3 RESTORATION AND ENHANCEMENT ALTERNATIVES GOALS AND OBJECTIVES

The primary goal for this Plan is to use a holistic approach to identify and develop alternatives to restore multiple habitats, stabilize shorelines and accommodate anticipated sea level rise, and enhance the functional values and connectivity of the lands and waters of the Chula Vista Bayfront.

In order to meet this goal, several restoration objectives have been identified, that identify restoration planning needs for multiple focus areas in south San Diego Bay within and adjacent to the Chula Vista Bayfront. The objectives associated with specific focus areas include:

1. Development of alternatives for feasibility of restoring tidal connection between F&G Street Marsh and the adjacent seasonal wetlands. The potential for constructing bridges or culverts to improve tidal connection are to be included in this analysis.

2. Development of alternatives for shoreline restoration and habitat connectivity along the Sweetwater District Shoreline and Signature Park.

3. Development of habitat restoration alternatives for the former South Bay Power Plant intake and discharge channels.

4. Development of enhancement options for Telegraph creek that improve habitat values while maintaining flood control functions.

5. Development of enhancement options for J Street Channel that provide additional salt marsh habitat and maintain or improve water quality.

Based on these objectives, and on the conditions of the controlling agreements, restoration and enhancement priorities within each of the focus areas include:

- Restoration of multiple habitats including but not limited to mudflat, eelgrass, and coastal salt marsh;
- Expansion and connection of natural habitats and physical processes;
- Stabilization of shorelines using natural approaches;

- Accommodation of anticipated sea level rise through shoreline stabilization, planned transgression, etc.;
- Protection of wetlands from storm surge and erosion;
- Protection of wetlands and baylands from urban runoff;
- Incorporation of transitional and no-touch buffers between developed lands and natural habitats;
- Development of viewing areas and habitat interface areas that encourage education opportunities and public enjoyment of natural resources while also protecting natural resources from damage or disturbance.
- Development of alternatives that protect and improve the function of existing wetlands, and that result in a net increase of wetlands.

1.4 Alternatives Development and Review Process

The work approach for this Plan has focused on developing and refining restoration and enhancement alternatives for the Chula Vista Bayfront in a manner that meets Master Plan objectives and ensures inclusion of the priorities defined above. The alternatives presented in this Plan have been prepared with input from the District, the City, and the WAG. The Plan Team presented alternatives and received feedback at set intervals throughout the design process. The meeting schedule was as follows:

- WAG Meeting 1- March 5, 2015: The purpose of this meeting was to introduce the Plan Team, to review project goals, objectives, and priorities, to define deliverables, and to describe the Team's approach to restoration design.

- WAG Meeting 2 - October 1, 2015: At this meeting, the Team presented between one and three restoration and enhancement alternatives for each of the focus areas. The Team provided conceptual renderings and indicated the pros and cons for each alternative. The Team then identified a recommended/preferred alternative for each focus area based on numerous considerations including habitat restoration opportunities, changes in hydrology, sea level rise predictions, human use elements, logistical constraints, and costs. The WAG provided feedback on each alternative in light of these considerations, and indicated which alternatives best met the goals and objectives of the project.

- WAG Meeting 3 - May 5, 2016: The Team presented the final recommended alternative for each of the focus areas, and presented the final holistic restoration and enhancement alternative for the entire Chula Vista Bayfront. The WAG provided final feedback and reached consensus on this design.

1.5 Document Structure

In the following text, the physical and biological setting of the Chula Vista Bayfront is described and data sources and assumptions utilized in this planning effort are detailed. Then, restoration and enhancement alternatives for the focus areas defined in the Plan objectives above (e.g. F&G Street Marsh and Seasonal Wetlands, Intake and Discharge Channels for the former South Bay Power Plant, etc.) are addressed. Focus areas have been grouped by planning districts along the Chula Vista Bayfront, specifically the Sweetwater District and the Otay District. These are the two districts

with bayfront undeveloped lands that provide the most restoration and enhancement opportunities. Planning efforts for each focus area are first described separately and the physical and biological conditions that affect restoration planning within each focus area are summarized. Multiple restoration alternatives along with a table of pros and cons of each alternative, are then provided for each focus area.

Following this analysis, the recommended restoration and enhancement alternative for each focus area is provided, along with conceptual plans and typical cross-sections. The recommended alternative for each focus area is the alternative found to best balance the multiple objectives and restoration priorities for the Plan based on the information evaluated in this study. It is important to note the other preliminary alternatives are not eliminated from consideration. However, only the recommended alternative for each focus area is carried forward in design and engineering.

At the end of the document, the holistic design for the entire Chula Vista Bayfront is presented as a recommended alternative for restoration. Predictions of how restored areas would transition under multiple sea level rise scenarios are presented and discussed. Quantities and cost estimates are provided for the recommended alternative. Finally, some of the Plan elements described in the following sections may be developed and constructed independently of or in parallel with other elements. However, many of the Plan elements must be completed serially, and require appropriate project phasing. Therefore, phasing considerations are described for each focus area at the end of this document.

2.0 SAN DIEGO BAY REGIONAL SETTING

2.1 PHYSICAL CONDITIONS

San Diego Bay is a nearly enclosed, naturally formed embayment (Figure 1-1). The Bay was formed from the alluvial floodplains of the Otay, Sweetwater, and San Diego Rivers, and was historically shallow. The re-direction and channelization of the San Diego River beginning in the 1940's along with multiple dredging and channel deepening projects have resulted in deep waters in the northern and central portion of the Bay (with deepest waters of 59 feet occurring at the mouth of the Bay), transitioning to shallow waters (less than 3 feet) at the south end of the Bay (U.S. Navy 2013) (Figure 2-1).

The District, along with the U.S. Navy, developed an Integrated Natural Resources Management Plan (INRMP) for San Diego Bay (U.S. Navy 2013). The INRMP divides the Bay into multiple depth categories including: deep [> -20 feet (ft) Mean Lower Low Water (MLLW)], moderately deep (-12 to -20 ft MLLW), shallow (-2.2 to -12 ft MLLW), and intertidal (-2.2 to +7.8 ft MLLW). Currently, deep and moderately deep waters account for more than 50% of total Bay surface area (U.S. Navy 2013). In contrast, shallow subtidal habitat accounts for approximately 28% of Bay surface area, primarily in south San Diego Bay. This represents a loss of shallow water and intertidal habitat of over 40% since the late 1800's. Similarly, intertidal habitat currently accounts for only 7% of the Bay surface area, representing a more than 90% loss since the late 1800's. The widest swaths of intertidal habitat in San Diego Bay occur adjacent to the Chula Vista Bayfront. Subtidal waters along the Chula Vista Bayfront are primarily shallow, but bisected by deeper excavated channels including the J Street Marina navigation channel and the former South Bay Power Plant intake channel.

Bathymetry of San Diego Bay
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 2-1

2.2 TIDAL DATUMS

Water level records for San Diego Bay are available from the National Oceanic and Atmospheric Administration (NOAA) San Diego Tide Station (NOAA NOS# 9410170) from 1906 to present. Tidal datums from this gauge are shown in Table 1. The greater diurnal tide range at the gauge is approximately 5.72 ft. The United States Geological Survey (USGS) collected additional tide data within the Sweetwater/E Street Marsh of the NWR, adjacent to the Chula Vista Bayfront, from September 23, 2011 to October 6, 2014 (~3 years) at two gauges (Takekawa et al 2013). The gauges were surveyed into North American Vertical Datum (NAVD) with RTK GPS at the time of deployment and water levels were corrected for local barometric pressure from a barometric logger. The gauges were located within marsh channels and dried out at low tides. Tidal datums were calculated from the USGS data and compared to the NOAA data (Table 2-1). Since low water was not captured by the USGS gauges, the low tide datums were not calculated.

The longer-term NOAA data is expected to provide more accurate tidal datums, although it is further from the site than the Sweetwater gauge. The tidal datums (i.e., MHHW, MLLW) from the NOAA station at the Broadway Pier are used for the conceptual design presented in this document. Of note, the highest observed water level at the NOAA gauge (measured on 11/25/2015) occurred after the Sweetwater gauge had been removed. The previous highest observed water level (measured on 12/13/2012) was recorded at both the NOAA gauge and the USGS Sweetwater/ E Street Marsh gauge. The higher water level at the USGS Sweetwater/ E Street Marsh gauge of 7.8 ft NAVD may indicate some tidal amplification between the NOAA San Diego gauge and the Chula Vista Bayfront.

Table 2-1 Observed Water Levels in San Diego Bay

Tidal Datum		San Diego (NOAA, Station 9410170)	Sweetwater/E Street Marsh (USGS)
Highest Observed (11/25/2015)		7.79	
Highest Observed (12/13/2012)		7.74 (8:12 am)	7.8 (9:24 am)
Highest Astronomical Tide	HAT	7.3	
Mean Higher High Water	MHHW	5.29	5.1
Mean High Water	MHW	4.56	4.5
Mean Tide Level	MTL	2.53	
Mean Sea Level	MSL	2.51	
Diurnal Tide Level	DTL	2.43	
Mean Low Water	MLW	0.51	
North American Vertical Datum	NAVD	0	
Mean Lower Low Water	MLLW	-0.43	
Lowest Astronomical Tide	LAT	-2.54	
Lowest Observed		-3.52	

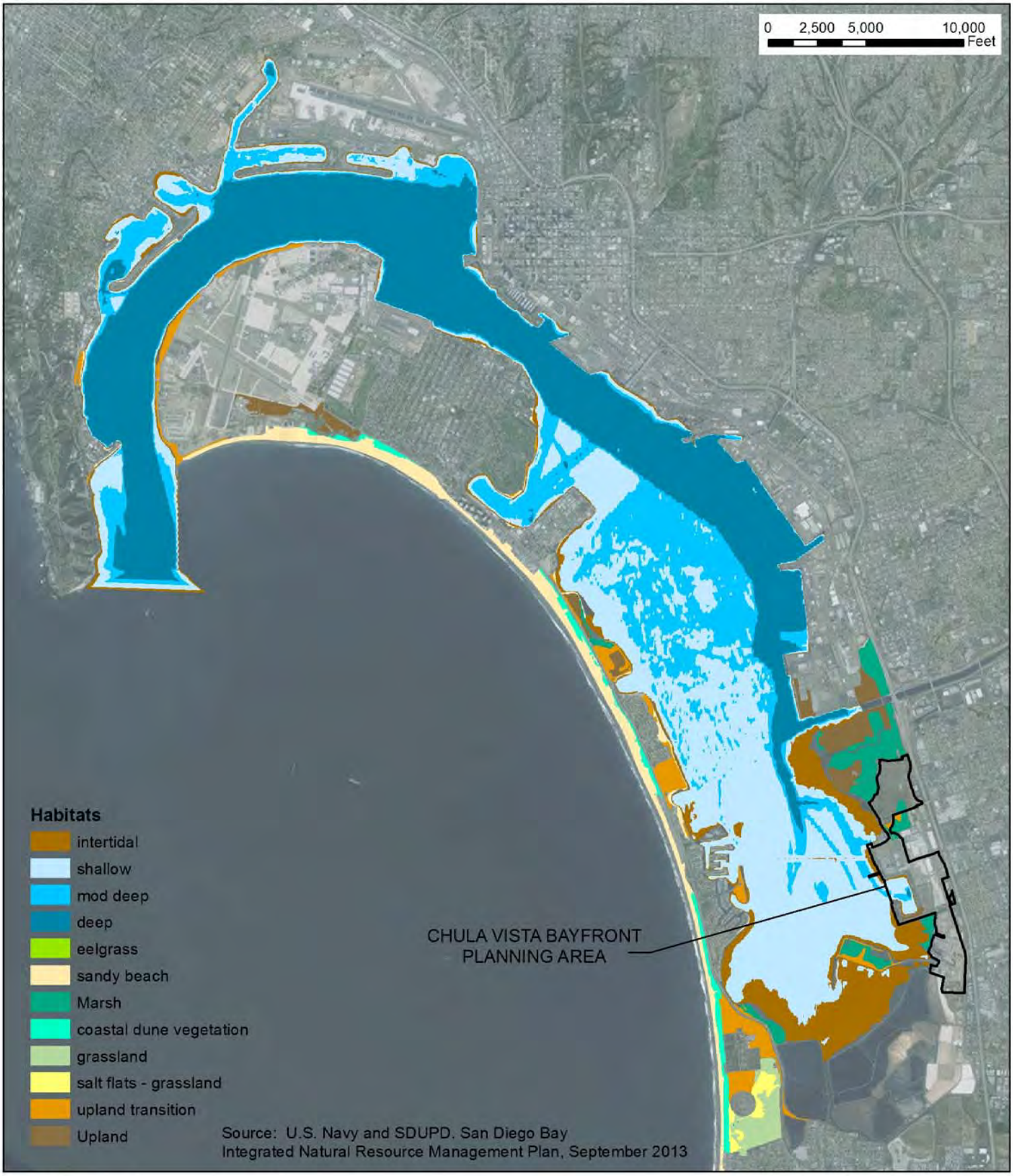
2.3 HABITATS

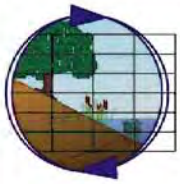
The habitats of San Diego Bay are reflective of water depth and presence or absence of shoreline structures. More than 70% of the shoreline (45.4 miles out of a total 64.4 miles) of San Diego Bay is currently armored (U.S. Navy 2013). Armoring is primarily rock rip rap, but also includes vertical bulkhead walls, boat launch ramps, earthen dikes, and wharves and pile walls. Additionally, there are over 130 acres of surface structures (piers, docks, etc.) within the Bay that currently shade intertidal and subtidal waters. The majority of the lands in the northern and central portion of the Bay are developed with a mix of commercial, recreational, and military use.

The largest unarmored areas occur in the southern portion of the Bay. As such, the majority of undeveloped habitat also occurs in the southern portion of the Bay, and much of this habitat is adjacent to the Chula Vista Bayfront. Habitats in the southern portion of the Bay include southern coastal salt marsh, intertidal sand and mudflats, salt flats, and southern coastal foredune (Figure 2-2). The dominant vegetated subtidal habitat in San Diego Bay is eelgrass (*Zostera marina*); the most recent baywide eelgrass survey, completed in 2014, found 1,996 acres of eelgrass (Merkel & Associates, Inc. 2014). This accounts for approximately 10.5% of the Bay surface area, with a majority of the total occurring in the shallow waters of the southern portion of the Bay. Salt marshes currently cover approximately 800 acres of San Diego Bay, representing a 70% decline since the late 1800's (U.S. Navy 2013). Nearly the entire salt marsh habitat in the Bay occurs in the southern portion of the Bay. The current network of marshes forms a non-contiguous patchwork in the south Bay (Figure 2-2). This fragmentation, along with channelization and re-direction of rivers and creeks that historically drained into marshlands, and the threat of sea level rise, puts the marshes at risk of decline. Many of the marshes in south San Diego Bay occur along unarmored shorelines, the largest of which is the E Street and Sweetwater Marsh complex located south of the Sweetwater River Channel along the southeastern shoreline of the Bay within the San Diego Bay National Wildlife Refuge. Other large marsh areas along unarmored shorelines include the J Street Marsh, and Emory Cove. Still other marshes (including the Chula Vista Wildlife Reserve, the D Street Fill, and within the South Bay Salt Ponds) have been restored and are currently protected from erosion by permeable dikes and rip rap armoring.

2.4 PREDICTED EFFECTS OF SEA LEVEL RISE

Climate change and sea level rise pose a threat to both developed lands and the remaining undeveloped habitats within San Diego Bay. Resource managers are challenged with protecting fragile ecosystems in the face of increased temperatures, weather extremes (including both drought and storm events), and rising oceans. The remaining marshlands in San Diego Bay face a potential for increased erosion from storm waves and rising tides, habitat conversion from changes in tidal inundation as water levels rise, and threat from continued shoreline armoring to protect adjacent developed lands.





Habitats of San Diego Bay
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 2-2

Predictions from the California Climate Change Center indicate that sea level in San Diego Bay could rise between 5 and 35 inches by 2100 (Cayan et al. 2006). Other recent projections suggest that sea level could increase by up to 6.5 ft (2 meter (m)) by the end of the 21st century (Gersberg et al. 2014). The National Research Council (NRC) performed an analysis of sea-level rise for the coasts of California, Oregon, and Washington (NRC 2012), which is currently considered the best available science on sea-level rise by and for the State of California, including the California Coastal Commission's Sea-Level Rise Policy Guidance (CCC 2015). The report evaluates each major contributing component to global sea-level rise and combines these contributions to provide values of sea level rise at various planning horizons for the West Coast. The report also discusses regional and local contributions to sea level rise. Four regional sea level rise estimates are reported for the West Coast. The values for Los Angeles (the closest station to San Diego for which data are available) are presented in Table 2-2. These values include an estimate for vertical land motion of -1.5 mm/year ± 1.3 mm/year (0.06 inches/year ±, 0.05 inches/year) which NRC uses for all of California south of Cape Mendocino and refers to as the "San Andreas" region. Note that these sea-level rise projections do not account for any local effects of subsidence in San Diego Bay or Chula Vista; data or evidence of local subsidence is not available or known.

Table 2-2. NRC 2012 Sea-Level Rise Projections[1]

Projection	2030	2050	2100
Low-range	2 in	5 in	17 in (1.4 ft)
Mid-range	6 in	11 in	37 in (3.1 ft)
High-Range	12 in	24 in	66 in (5.5 ft)

[1]Inches and feet of sea level rise since 2000

The 2100 estimates reflect the range in greenhouse gas emission scenarios, with low emissions resulting in 17 inches of sea level rise and high emissions resulting in 66 inches. To date, emissions have been tracking on the high scenario (Flint and Flint 2012). Assuming continuation of the high emissions trajectory, the higher range of sea level rise projections would apply.

Recent studies have attempted to apply sea level rise predictions in order to identify potential effects of sea level rise on local habitats. According to the recent integration of a Digital Terrain Model for San Diego Bay with the Sea Level Rise of Marshes model (SLAMM), researchers indicated that San Diego Bay would experience a nearly 100% loss of marshes using the two meter (6.6 ft) sea level rise benchmark (Gersberg et al. 2014). A USGS modeling effort performed specifically for the Sweetwater Marsh indicates that, under a 5.2 ft (1.6 m) sea level rise scenario similar to the high-range sea level rise NRC predictions, over 91% of the marsh would be lost and/or converted to mudflat by 2110 (Thorne et al. 2014).

3.0 DATA SOURCES AND ASSUMPTIONS

A number of data sources were utilized for the development of the restoration and enhancement alternatives described in this document. In addition to the regional data described in Section 2.0, the following site-specific data were utilized.

3.1 TOPOGRAPHY AND BATHYMETRY

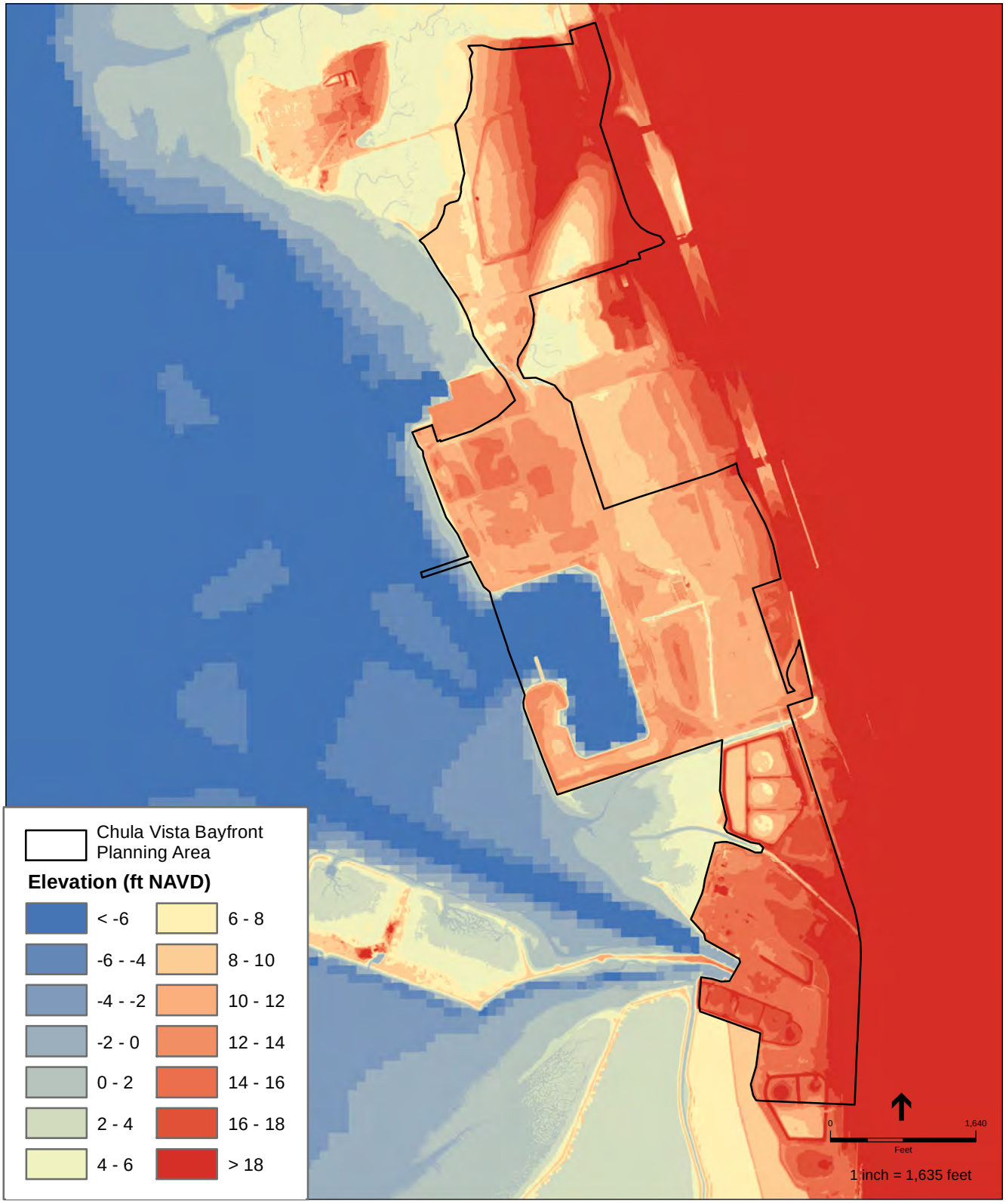
The topography used for the development of restoration and enhancement alternatives was composed of multiple topographic and bathymetric data sources. Existing topography was taken from the 2009-2011 NOAA and California Coastal Conservancy LiDAR data (NOAA et al. 2011) (Figure 3-1). This regional LiDAR data set provides coverage of the entire Chula Vista Bayfront and was used as the base for creating the composite topography. The LiDAR has a resolution of about 3.3 feet, and does not extend offshore below about the –1 foot NAVD contour. Bathymetric data was added in areas lower than the LiDAR extent (Merkel & Associates, Inc. 2014). The upland LiDAR data was supplemented with two topographic surveys made available from the District. These surveys were performed for the Chula Vista Bayfront design and provide more detailed and up-to-date topography. These surveys cover the Harbor District and Otay District areas. The extents of the LiDAR data and Harbor District and Otay District survey data used for this analysis are shown in Figure 3-2.

3.2 BERM ELEVATION

The Sweetwater District shoreline is subject to some of the highest wave power in San Diego Bay (Merkel & Associates, Inc. et al. 2015). Currently, the marsh within the NWR is protected by the presence of a berm that runs along the shoreline. The existing habitat within the NWR transitions from open water to tidal flats, to a narrow sandy beach, and finally to the marsh berm that is higher than the marsh plain behind it. The berm protects the marsh from waves except at the highest tides. Maintenance of this berm is integral to restoration planning for the Sweetwater District. Figure 3-3 shows a cross-section of the marsh berm and a photo showing an example of the habitat transitions to provide context for subsequent restoration and enhancement alternatives. The berm crest elevation is approximately +6.6 ft NAVD (+7.0 ft MLLW).

3.3 HABITATS

Habitat mapping for the Chula Vista Bayfront Planning Area was performed by Dudek as part of the CEQA analysis and Environmental Impact Report (EIR) prepared for the Master Plan (Dudek 2010). Dudek performed an updated biological survey and wetlands delineation for the Sweetwater District in 2015 (Dudek 2015). Within the Sweetwater District upland habitats consist primarily of disturbed and previously graded lands. Small patches of broom baccharis scrub and isocoma scrub occur primarily around the perimeter of the F&G Street Marsh and Seasonal Wetlands, and adjacent to roadways. A revegetated berm of coastal sage scrub runs along the center of the Sweetwater District area, and a grove of eucalyptus woodland occurs along the shoreline to the northwest of F&G Street Marsh. Similarly, within the Otay District, the majority of uplands are disturbed and graded, much of which was graded following removal of the former South Bay Power Plant (SBPP) in 2013. ICF International Inc. performed an updated biological survey of the Otay District in 2016 (ICF 2016). Remaining upland vegetation communities within the Otay District are dominated by disturbed habitat, with a small amount of baccharis-dominated Diegan coastal sage scrub. Wetland habitats include southern coastal salt marsh and coastal and valley freshwater marsh within the northwestern portion of the Otay District, adjacent to Telegraph Creek and the J Street Marsh.

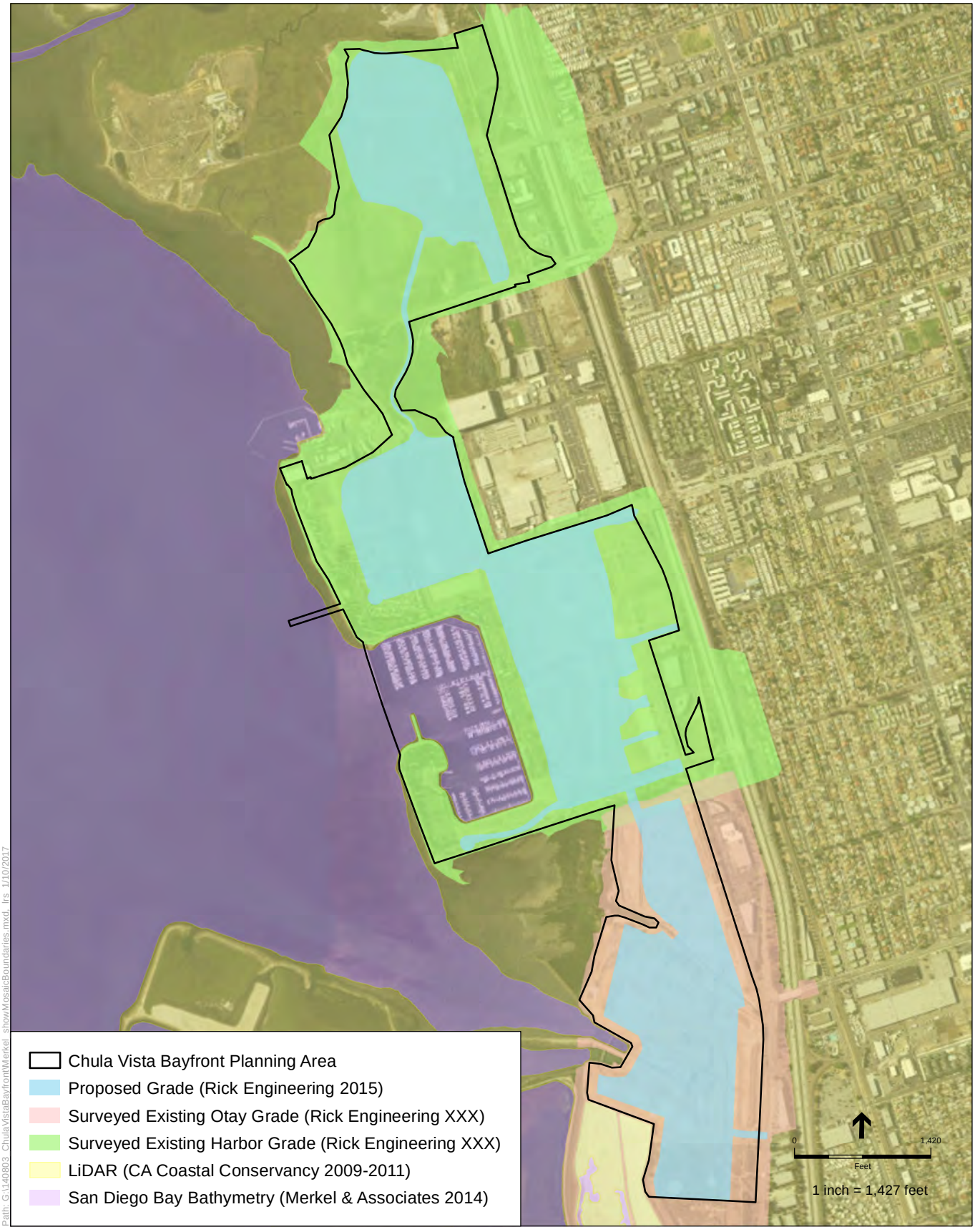


SOURCE: NOAA et al. 2011, M&A 2014

Chula Vista Bayfront Enhancement . 140803

Figure 3-1

Combined Topography and Bathymetry Surface for South San Diego Bay



SOURCE: Esri, Merkel, Tanera, Rick Engineering, California Coastal Conservancy

Chula Vista Bayfront Enhancement . 140803

Figure 3-2

Topography and Bathymetry Data Extents

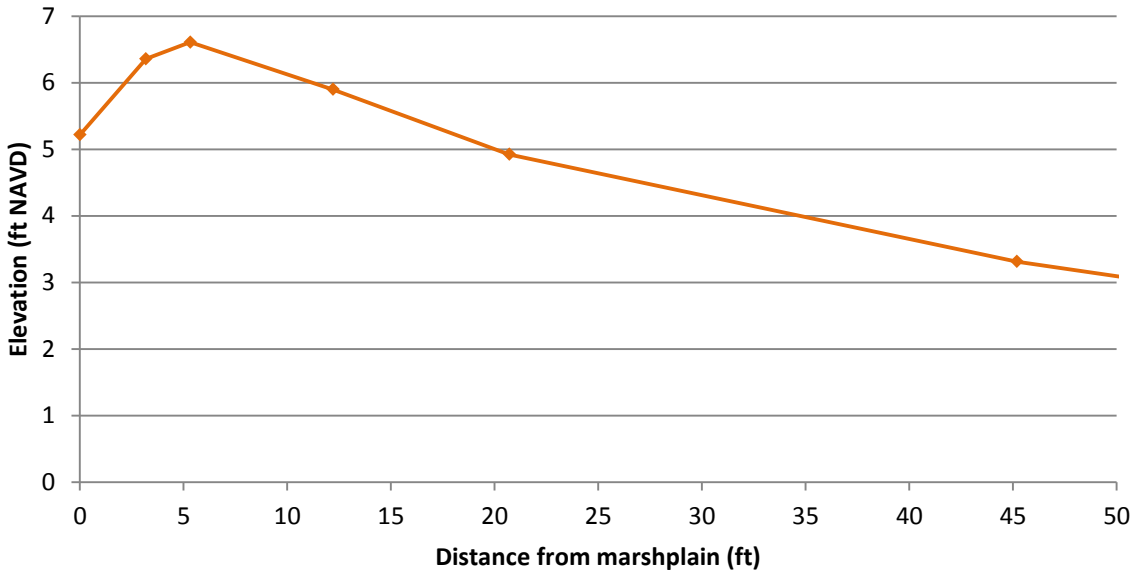


Figure 3-3
National Wildlife Refuge Beach Berm
Cross-Section and Typical Condition

As mapping of uplands communities was a priority for the Dudek and ICF reports, the reports identify coastal salt marsh habitat and delineate wetlands, but do not provide sufficient elevation and vegetation species details for restoration planning. Therefore, additional analysis of existing marsh habitat adjacent to the Chula Vista Bayfront Planning Area was performed as part of this current analysis to inform conceptual designs and target elevations for restoration of marshlands and tidal flats.

Within south San Diego Bay, unvegetated tidal flats occur between 0 feet MLLW and +2.3 feet MLLW (-0.4 to +1.9 feet NAVD). These flats contain abundant organic matter and microorganisms and provide valuable forage habitat and calm water refuge for numerous shorebird and waterfowl species. Marsh habitats within south San Diego Bay are typically found above tidal flats, at tidal elevations between +2.3 feet MLLW and +7.8 feet MLLW (+1.9 and +7.4 feet NAVD) (U.S. Navy 2013). Within this range of elevations, three distinctive zones of vegetation occur, related primarily to elevation and degree of tidal inundation. Low Marsh habitat is typically found between +2.3 and +4.5 feet MLLW (+1.9 to +4.1 feet NAVD), and is dominated by cordgrass (*Spartina foliosa*) [U.S. Fish and Wildlife Service (USFWS) 2006]. Other species that often occur in low marsh habitat include Pacific pickleweed (*Sarcocornia pacifica*) and saltwort (*Batis maritima*). Middle Marsh habitat it typically found between +4.5 and +6.0 feet MLLW (+4.1 and +5.6 feet NAVD). Middle marsh habitat is dominated by Pacific pickleweed, Bigelow's annual pickleweed (*Salicornia bigelovii*), estuary seablite (*Suaeda esteroa*), salty Susan (*Jaumea carnosa*), and western marsh rosemary (*Limonium californicum*). High Marsh habitat is typically found between +6.0 and +7.9 feet MLLW (+5.6 and +7.5 feet NAVD), with a band of transitional habitat occurring at the highest end of the intertidal zone. High Marsh habitat is dominated by Pacific pickleweed, Parish's pickleweed (*Arthrocnemum subterminale)*, alkali heath (*Frankenia salina*), alkali weed (*Cressa truxillensis*), salt grass (*Distichlis spicata*), and shoregrass (*Distichlis littoralis*). These species may continue into the transition area, and become intermixed with salt-tolerant upland species such as spearscale (*Atriplex* spp.). Additionally, wetlands in Southern California have historically included shallow ponds or salt pans that provided a variety of habitat within the marsh (Grossinger et al 2011).

For this study, the range of elevations summarized above and percent tidal inundation for marsh zones were confirmed through a combination of vegetation-inundation relationships measured at other reference sites [including Ballona Wetlands in Los Angeles (ESA 2015), and San Dieguito Lagoon (ESA unpublished)], as well as a brief point survey (n = 63) conducted within the Sweetwater/E Street Marsh of the adjacent NWR. Table 3-1 summarizes the percent inundations for each marsh zone and provides the corresponding transitional elevations based on the NOAA San Diego Bay gauge.

Table 3-1 Transition Elevation of Marsh Zones by Percent Inundation

Habitat Zone Transition	% Inundation[1]	Habitat Elevations (ft NAVD)
Upland to Transition Zone	~3yr tidal inundation	7.6
Transition Zone to High Marsh	1%	6.6
High Marsh to Mid Marsh	5%	5.7
Mid Marsh to Low Marsh	26%	4.1
Low Marsh to Tidal Flats	51%	2.9
Tidal Flats to Subtidal	MLLW	-0.4

[1]ESA 2015

3.4 FUTURE CONDITIONS WITH SEA LEVEL RISE

A primary restoration and enhancement priority for the Chula Vista Bayfront is accommodation of anticipated sea level rise through shoreline stabilization and planned transgression areas. In order to develop alternatives for each focus area that would meet this objective, future habitat elevations were estimated using the NRC sea level rise predictions shown in Table 2-2 and the current habitat elevations identified in Table 3-1. These elevations were used to guide the placement and grading of transitional and upland slopes within each focus area. It is intended that these transgression areas could develop into marsh habitat under future sea level rise conditions. Table 3-2 summarizes the change in transition elevations for marsh zones over time, assuming NRC 2012 prediction for high-range sea level rise. Models that visually illustrate the effects of sea level rise on wetlands restored or enhanced along the Chula Vista Bayfront are presented in Section 6.2 of this report.

Table 3-2 Changes in Transition Elevation of Marsh Zones with High Range Sea-Level Rise (ft NAVD)

Habitat Zone Transition	Current Transition Elevation	2030 Transition Elevations	2050 Transition Elevations	2070 Transition Elevations	2100 Transition Elevations
Upland to Transition Zone	7.6	8.6	9.6	10.8	13.1
Transition Zone to High Marsh	6.6	7.6	8.5	9.8	12.0
High Marsh to Mid Marsh	5.8	6.8	7.7	9.0	11.2
Mid Marsh to Low Marsh	4.1	5.1	6.1	7.3	9.6
Low Marsh to Tidal Flats	2.9	3.9	4.9	6.1	8.4
Tidal Flats to Subtidal	-0.4	0.6	1.6	2.8	5.0

3.5 DEVELOPMENT PLANS FOR ADJACENT PARCELS

Planning and engineering efforts are underway for multiple portions of the Chula Vista Bayfront Planning Area. A 90% grading plan has been prepared for the Sweetwater District (Rick Engineering 2016), however, the planning process for the adjacent Signature Park has only recently begun. Planning within the Harbor and Otay Districts of the Chula Vista Bayfront are also in preliminary stages.

The restoration and enhancement alternatives for the focus areas described below take into consideration the planning efforts associated with the adjacent development parcels. Alternatives have been designed to incorporate design elements of the adjacent development parcels and parklands. As an example, alternatives described below incorporate bio-retention basins planned to manage stormwater runoff in the Sweetwater District. Alternatives also identify potential locations of trails and bikeways and, for the Sweetwater District, include expansion of wetlands into adjacent parklands. Trail and bikeway design is not within the scope of this document; and trail alignments are considered conceptual. However, the best available information regarding adjacent development grading, upland mitigation areas, road alignments, bio-retention basins, and trails and bikeways has been included in this document in order to allow for a holistic interpretation and decision making process regarding restoration and enhancement of natural areas. The conceptual plans provided in this Plan may and should be modified to incorporate final development plans for adjacent parcels as the Project progresses into final design and engineering.

4.0 RESTORATION AND ENHANCEMENT ALTERNATIVES FOR THE SWEETWATER DISTRICT

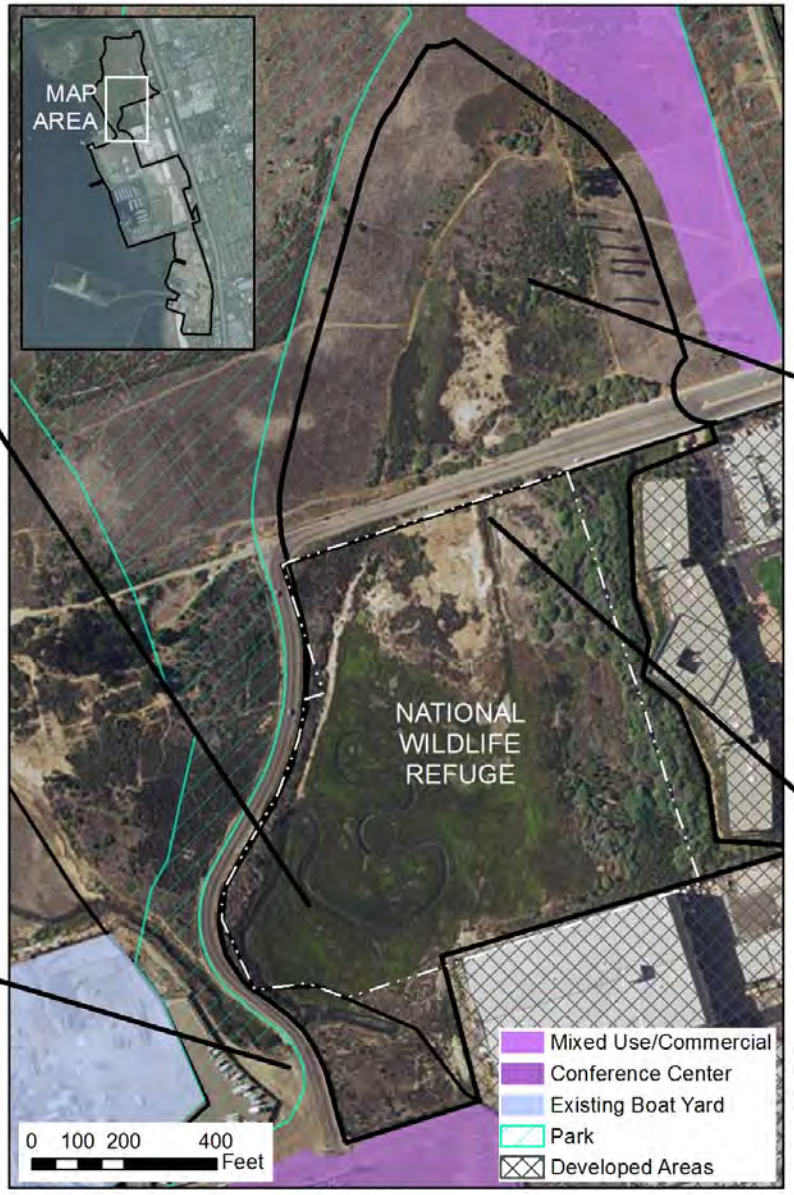
The Sweetwater District of the Chula Vista Bayfront includes lands bracketed by the Sweetwater/E Street Marsh of the National Wildlife Refuge to the north, and the F&G Street Marsh of the NWR to the south. Areas considered in the following Plan analysis include the San Diego Bay shoreline of the Sweetwater District extending into upland buffer areas, the Seasonal Wetlands, the Entrance Channel to F&G Street Marsh, and the connection of the Seasonal Wetlands to the F&G Street Marsh. These areas overlap in terms of hydrology, habitats, and planning and land use elements. Specific focus areas have been separated below; however, it is understood that, in many instances, design and restoration considerations for focus areas overlap. As such, while each focus area is discussed separately, graphics include the entire Sweetwater District to provide context for planning. While restoration and enhancement may progress independently within many focus areas, it is beneficial for design and engineering, for permitting, and for project phasing, to consider the entire District as a single project. Plan phasing and priorities are discussed at the end of this document (Section 6).

4.1 FOCUS AREA 1 - F&G STREET MARSH AND THE SEASONAL WETLANDS

4.1.1 Existing Conditions

The F&G Street Marsh is a tidal marsh located south of the larger Sweetwater/E Street Marsh adjacent to the Chula Vista Bayfront (Figure 4-1). F&G Street Marsh is a natural remnant of the marsh complex that originally occurred in south San Diego Bay at the mouth of the Sweetwater River (USFWS 2006). As upland fills were developed in the 1900s and the Sweetwater River mouth was channelized, the F&G Street Marsh became permanently isolated from the larger marsh

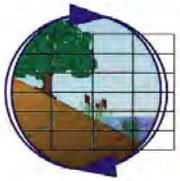
Existing coastal salt marsh within the F&G Street Marsh, part of the San Diego Bay National Wildlife Refuge



Existing disturbed coastal salt marsh within the Seasonal Wetlands

Twin 24-inch corrugated drains bring tidal waters to the F&G Street Marsh via a narrow entrance channel

An 18-inch concrete culvert connects F&G Street Marsh to the Seasonal Wetlands beneath Lagoon Drive



N
W E
S

Focus Area 1: F&G Street Marsh and the Seasonal Wetlands
Existing Conditions
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 4-1

Merkel & Associates, Inc.

complex. Presently, the Marsh is bordered to the south and east by commercial parks and marine-related industry, to the north by Lagoon Drive (the western portion of F Street), and to the west by Marina Parkway/E Street. It is connected to San Diego Bay via a narrow Entrance Channel and connector marsh in the southwest corner. Twin corrugated 24-inch drains carry water from the Entrance Channel and connector marsh under Marina Parkway/E Street and into the F&G Street Marsh. The sides of the connector marsh are steep sloped and the base of the Entrance Channel is filled with concrete rubble. This inadvertent armoring prevents the channel from deepening and the channel is, instead, getting wider as the sides of the channel slough and erode.

The F&G Street Marsh supports approximately 25 acres of coastal salt marsh and intertidal mudflat habitat and provides nesting habitat for the state endangered Belding's savannah sparrow (*Passerculus sandwichensis beldingi*). The majority of the coastal salt marsh habitat occurs in the southern portion of the Marsh adjacent to the Entrance Channel. Bay fills have resulted in increased surface elevations toward the northern portion of the Marsh, and habitat transitions to ruderal and weedy, salt-tolerant species in this area. The Seasonal Wetlands are disturbed wetlands exposed to intermittent high tides and are located adjacent to and north of the F&G Street Marsh (Figure 4-1). Lagoon Drive bisects the Seasonal Wetlands and an 18-inch concrete culvert provides the only tidal connection between the Seasonal Wetlands and the F&G Street Marsh. The Seasonal Wetlands are dry for a majority of the year and also contain bay fills. Vegetation in this area is similar to the ruderal species found in the adjacent, higher elevation filled portion of F&G Street Marsh.

The F&G Street Marsh is a part of the Sweetwater Unit of the San Diego Bay National Wildlife Refuge (NWR) and, as such, is not part of the planning area for the Chula Vista Bayfront Master Plan. However, the F&G Street Marsh has been included in restoration planning due to its adjacency to the Master Plan area, and its hydrologic connectivity with the Seasonal Wetlands that are a part of the planning area. Further, the Settlement Agreement for the Master Plan and the Development Policies specifically identify the investigation of the feasibility of restoring a meaningful tidal connection between the F&G Street Marsh and the Seasonal Wetlands.

4.1.2 Restoration and Enhancement Considerations

Table 4-1 summarizes habitat enhancement and restoration priorities for Focus Area 1: the F&G Street Marsh and the Seasonal Wetlands, and identifies opportunities and constraints unique to this focus area.

The restoration priority for this focus area is to reconnect the Seasonal Wetlands to the F&G Street Marsh. In order to accomplish this, the twin drains at the Entrance Channel under Marina Parkway/E Street, and the concrete culvert under Lagoon Drive restrict tidal access to F&G Street Marsh and the Seasonal Wetlands will require modification to increase tidal prism sufficiently to accommodate wetlands expansion. Further priorities are that wetlands restoration include shoreline stabilization and transgression areas for sea level rise, and a pedestrian and bike trail aligned either around the Seasonal Wetlands or along the existing Lagoon Drive alignment. This focus area provides unique opportunities to expand wetlands habitats including coastal salt marsh, brackish marsh and intertidal ponds and flats. The adjacency of the planned bikeway provides further opportunities for recreation, education, and passive wildlife viewing.

Table 4-1. Priorities, Opportunities, and Constraints for Focus Area 1: F&G Street Marsh and Seasonal Wetlands

Priorities	Opportunities	Constraints
• Reconnect Seasonal Wetlands to F&G Street Marsh • Increase tidal range through modification of twin drains at the Entrance Channel under Marina Parkway/E Street, and the concrete culvert under Lagoon Drive • Create wetland transgression habitat for sea level rise • Accommodate bikeway and/or pedestrian path around or over wetlands	• Create new marsh habitat in Seasonal Wetlands • Create new tidal flats and pond habitat for shore birds • Create brackish marsh habitat through freshwater input from bio-retention basins • Provide public access along bikeway • Create wildlife viewing locations with interpretive signage • Incorporate buffers, fences, and overlooks "softened" by natural features • Provide pedestrian and bikeway connection	• Avoid impacts to existing marsh • Protect habitats and wildlife through passive use • Avoid possible utilities under Lagoon Drive • Address possible contaminated sediment in Seasonal Wetlands • Evaluate potential increase in flood risks to properties to the south • Accommodate plans to extend "Future" E Street

Restoration alternatives for the F&G Street Marsh and Seasonal Wetlands must incorporate wetlands and wildlife protection measures, preferably using natural features such as upland transgression areas, berms, and tidal channels, as well as traditional fencing. Alternatives must also consider physical conditions of the area including potential presence of utilities adjacent to Lagoon Drive, and contaminated sediments (including excessive levels of lead, mercury, cadmium, zinc, dioxins, and total recoverable petroleum hydrocarbons) within the Seasonal Wetlands and F&G Street Marsh (Zeeman et al 2008). Additional studies may be required to update and amend information regarding physical and sediment conditions within this focus area.

While restoration of marshland within the NWR is not a project priority, it is understood that the F&G Street Marsh within the NWR will benefit from improved hydrology associated with restoration and enhancement of the adjacent Seasonal Wetlands. Any habitat and hydrology modifications completed within the NWR lands will require cooperation with and approval by the US Fish & Wildlife Service (USFWS). Improvement of tidal prism within F&G Street Marsh will accelerate the risk of flooding due to sea level rise. Therefore, the effects of sea level rise on the commercial properties to the east and south of the F&G Street Marsh must be evaluated during project development. This is discussed further in Section 4.2.2 below.

4.1.3 Preliminary Restoration Alternatives

Three preliminary restoration alternatives were prepared for the F&G Street Marsh and Seasonal Wetlands focus area. The following text describes key design, engineering, relative cost, and regulatory elements for each alternative. Each of the following alternatives assumes that Marina Parkway/E Street, which runs along the west side of F&G Street Marsh, would be extended northward to provide access to Signature Park, the RV Park, and any other re-development planned within the Sweetwater District of the Chula Vista Bayfront. Vehicular traffic would be diverted around the F&G Street Marsh on this roadway (called the future E Street Extension). This would provide opportunity to eliminate traffic along Lagoon Drive, which bisects the Seasonal Wetlands and F&G Street Marsh. The new roadway would be constructed at +13.5 feet NAVD (+13.9 feet MLLW) to protect the roadway from future flooding related to sea level rise.

Alternative 1: Roadway Converted to Bikeway

Figure 4-2 illustrates three conceptual alternatives for restoration and enhancement of the F&G Street Marsh and Seasonal Wetlands. The main elements of each alternative are presented graphically; however, concepts presented in this graphic have not been engineered and are considered preliminary designs. For Alternative 1, the Lagoon Drive roadbed that bisects the Seasonal Wetlands and F&G Street Marsh would be narrowed but left in place and utilized as a pedestrian path and bikeway (Figure 4-2). The culvert that runs beneath the roadway to feed the Seasonal Wetlands would be replaced and expanded. Sediment would be excavated from the Seasonal Wetlands to create a modest amount of coastal salt marsh and tidal flats. Modifications to the two drains at the Entrance Channel to F&G Street Marsh are described in the following section. A bio-retention basin along the northeastern boundary of the Seasonal Ponds (planned as part of adjacent Sweetwater District development to collect and treat stormwater runoff) would be incorporated into the wetlands restoration, allowing for creation of brackish marsh habitat, dominated by spiny rush (*Juncus acutus*) and bulrush (*Schoenoplectus* spp.), that would transition to coastal salt marsh habitat. The upland slopes within the Seasonal Ponds would be graded and planted with native maritime succulent scrub; species planted could include coast cholla (*Cylindropuntia prolifera*), and coast prickly pear (*Opuntia littoralis*), that would provide a natural barrier between upland and wetland habitats and would accommodate some of the upland mitigation needs associated with the Sweetwater District development.

The primary benefit of Alternative 1 is that it would be cost effective to leave the Lagoon Drive roadbed in place, and would require minimal excavation of sediment. Further, this alternative would allow for a modest increase in restored coastal salt marsh, brackish marsh, tidal channels, and tidal flats habitats within the Seasonal Ponds. While the culvert beneath Lagoon Drive could be replaced and enlarged, it would not be large enough to eliminate tidal muting to the Seasonal Wetlands, and the tidal prism would remain restricted by the presence of Lagoon Drive. . Additionally, bike and pedestrian traffic along the roadbed would likely lead to increased human disturbance within the adjacent wetlands of the F&G Street Marsh.

Alternative 1: Roadway Converted to Bikeway

Alternative 2: Roadway Replaced with Elevated Boardwalk/Bikeway

Alternative 3: Roadway Removed and Bikeway Routed around Wetlands

N W E S

Focus Area 1: F&G Street Marsh and the Seasonal Wetlands
Three Preliminary Alternatives

Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 4-2

Merkel & Associates, Inc.

Alternative 2: Roadway Replaced with Elevated Boardwalk/Bikeway

For Alternative 2, the Lagoon Drive roadbed would be removed and replaced with a wood boardwalk/bikeway that would extend over the F&G Street Marsh and Seasonal Wetlands (Figure 4-2). Similar elevated boardwalks that support pedestrian and non-motorized vehicles have been constructed along many California wetlands, as shown in the adjacent images. The removal of the roadbed would eliminate the need for a culvert, would allow for a true biological connection of F&G Street and Seasonal Pond wetlands, and would allow for more extensive wetland restoration.

Elevated boardwalks and bikeways have been constructed at the San Francisco Bay National Wildlife Refuge (top) and Crissy Field in San Francisco (middle). The foot bridge over the marsh at Tijuana National Estuarine Research Reserve (bottom) has excellent wildlife viewing opportunities.

Sediment within the Seasonal Ponds would be excavated to the marsh plain elevation to create coastal salt marsh, tidal channels, and tidal flat habitats that would be exposed to the full tidal. A tidal pond would be created within the restored Seasonal Wetlands; it would support a fringe of marsh habitat, along with tidal flats and shallow water that would provide foraging and loafing opportunities for shorebirds and waterfowl. The pond would also serve as a feature of interest for wildlife viewing from the adjacent elevated boardwalk/bikeway. The pond would be excavated to between +2 and +3 feet MLLW, and would flood regularly. A hardened sill would be placed at the mouth of the pond to prevent channel scour, and to maintain ponded conditions at low tides. These ponded conditions would allow for continued wildlife viewing opportunities at all tides, and would also preclude nesting by shorebirds such as black-necked stilt (*Himantopus himantopus*) and American avocet (*Recurvirostra americana*), as this wetland would not be isolated enough to provide safe nesting habitat for these species.

Modifications to the two drains at the Entrance Channel to F&G Street Marsh, required to achieve full tidal conditions, are described in the following section. Additional brackish marsh habitat would be created through incorporation of the bio-retention basin along the northeastern boundary of the Seasonal Ponds, and upland slopes would be graded and planted with maritime succulent scrub, as described for Alternative 1. The primary benefit of Alternative 2 is the ability to remove the roadbed and achieve full tidal, restored marsh habitat. Elevation of the boardwalk/bikeway over the marsh plain would allow for unique yet passive public enjoyment of adjacent wetland habitats, while minimizing human disturbance. However, Alternative 2 would be costly to implement, as it would require design, engineering, and construction of the boardwalk bikeway, as well as design and restoration of wetland habitats.

Alternative 3: Roadway Removed and Bikeway Routed Around Wetlands

For Alternative 3, the Lagoon Drive roadbed would be removed entirely and the bikeway would be re-routed around the northern edge of the Seasonal Ponds (Figure 4 -2). The eastern terminus and western terminus of Lagoon Drive would "dead end" at the edges of the F&G Street Marsh and would be converted to marsh overlooks. Overlooks could be designed to incorporate seating and interpretive signage, and would include railings made from natural materials. Sediment within the Seasonal Ponds would be excavated to the marsh plain elevation to create coastal salt marsh, tidal channels, and tidal flats habitats that would be exposed to the full tidal prism. A shallow tidal pond would be created at the terminus to the channel within the Seasonal Wetlands, as described for Alternative 2.

Examples of nature overlooks located in San Diego wetlands including (from top to bottom) San Elijo Lagoon, the San Diego Bay National Wildlife Refuge, and the Tijuana National Estuarine Research Reserve.

Modifications to the two drains at the Entrance Channel to F&G Street Marsh, required to achieve full tidal conditions, are described in the following section. Additional brackish marsh habitat would be created through incorporation of the bio-retention basin along the northeastern boundary of the Seasonal Ponds, and upland slopes would be graded and planted with native maritime succulent scrub, as described for Alternatives 1 and 2.

The primary benefit of Alternative 3 is that it would allow for restoration of the maximum amount of wetlands within the Seasonal Ponds and F&G Street Marsh. Removal of the roadbed would allow for maximum exposure of wetlands to the full tidal prism. Both the alignment of the bikeway, and the overlooks would allow for passive public enjoyment of adjacent wetland habitats, while minimizing human disturbance and encroachment into wetlands. The bikeway and overlooks would be sited and designed in a manner that would ensure safety for users, would allow for maximum upland habitat restoration, and would maximize sight lines to adjacent wetlands. This alternative would be more expensive than Alternative 1, due to roadbed removal and extensive wetlands restoration. However, it may be less expensive than Alternative 2, depending on design of construction costs for overlooks, as it would not require engineering and construction of an elevated boardwalk/bikeway.

4.1.4 Recommended Restoration Alternative for Focus Area 1

The features of each of the three preliminary alternatives considered for Focus Area 1 are compared relative to each other and summarized in Table 4-2. Based on this analysis, the recommended conceptual design alternative for Focus Area 1 is Alternative 3 which includes the removal of the existing roadbed at Lagoon Drive, and the re-routing of the bikeway around the wetlands and restored uplands. This alternative would provide the maximum habitat benefits and the most wetlands creation. It would also provide for excellent recreational and education opportunities through creation of wildlife viewing overlooks at the ends of the existing roadway alignment and along a dedicated bike and pedestrian trail located around the Seasonal Ponds.. Figures 4-3 through 4-5 provide the conceptual design overview, grading, and cross-sections for this recommended alternative. The following text describes specific design elements.

Marsh Design, Elevations, and Grading

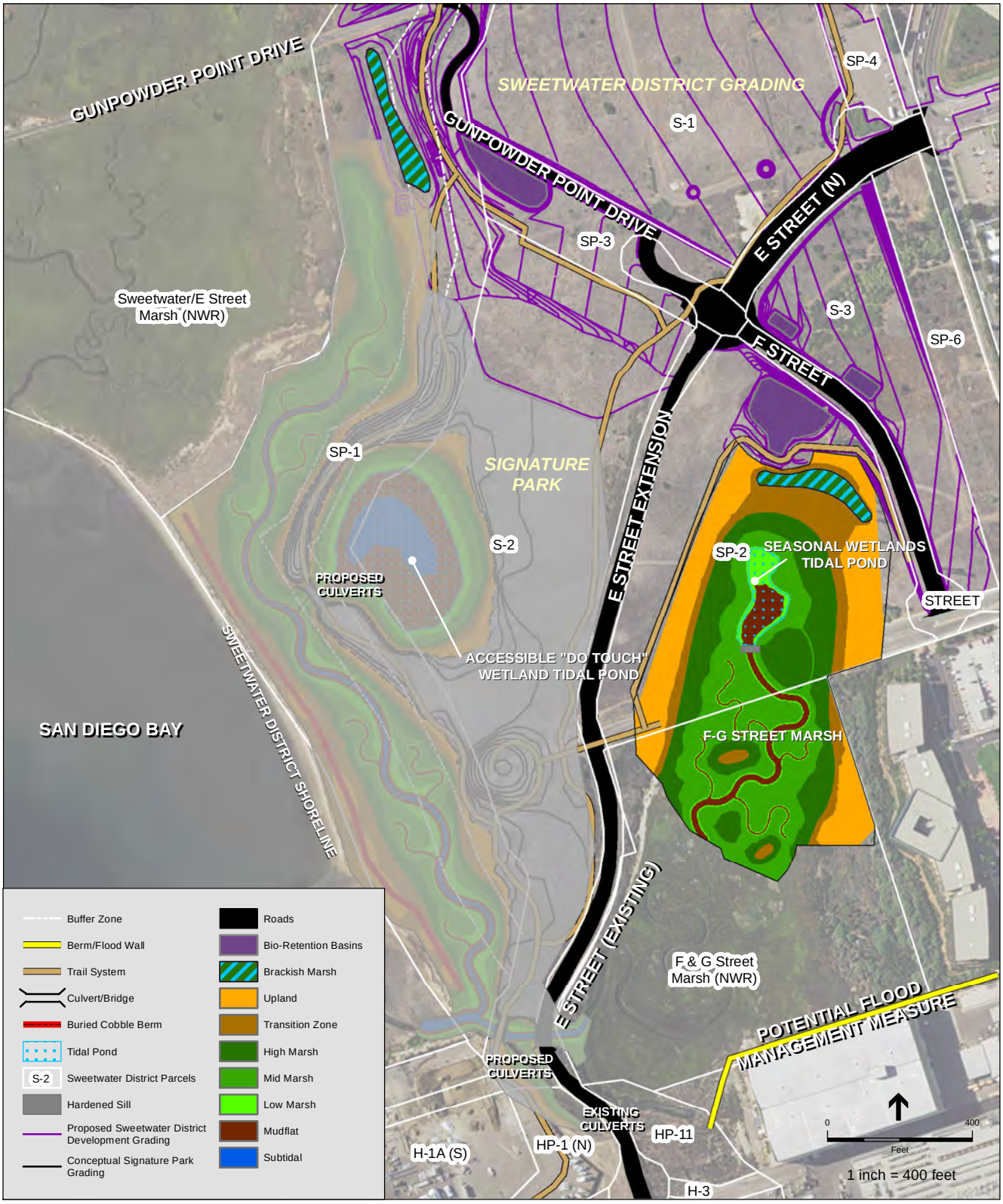
The recommended alternative for Focus Area 1 would support low, mid, and high coastal salt marsh habitat, as well as an upland boundary that would transition into maritime succulent scrub. The marsh zone elevations utilized for the F&G Street Marsh and Seasonal Wetlands recommended alternative were based on the habitat elevations described in Section 3.3. The grading at F & G Street Marsh was also designed with sea-level rise in mind, and it is anticipated that the habitats will transition as sea level rise progresses, with coastal salt marsh habitat moving upslope into planned transgression areas. Areas that currently support coastal salt marsh vegetation would transition to tidal flats and open water. This is described further in Section 6.3 of this report.

The tidal pond has been included in the recommended alternative for Focus Area 1 in order to provide an area of interest for wildlife (specifically shorebird and waterfowl viewing). The bottom of the pond would be set to +2.0 ft NAVD (+2.4 ft MLLW) while the channel entering the pond would be comprised of an elevated lip set at +2.5 ft NAVD (+2.9 ft MLLW), in order to maintain at least 0.5 ft of water depth within the pond, even at low tide. To prevent erosion of the tidal pond connector channel, a hardened sill would be installed to limit channel down-cutting. The sill would be installed under the lip at the end of the channel.

As indicated previously, the proposed Sweetwater District development would include a bio-retention basin along the northern edge of the Seasonal Wetlands. This basin would collect stormwater runoff from the adjacent development. Freshwater from the basin would spill over a hardened sill and into the adjacent marsh. A depression would be excavated adjacent to the bio-retention basin to collect water and to create brackish marsh habitat. The existing saline soils combined with occasional tidal inundation would increase water salinity of the freshwater from the bio-retention basin, allowing brackish marsh vegetation to develop.

Table 4-2. Summary of Restoration and Enhancement Alternatives for Focus Area 1: F&G Street Marsh and the Seasonal Wetlands.

PROJECT ELEMENT	PRELIMINARY RESTORATION ALTERNATIVE		
	Alternative 1: Roadway Converted to Bikeway	**Alternative 2: Roadway Replaced with Elevated Boardwalk / Bikeway**	**Alternative 3: Roadway Removed and Bikeway Routed around Wetlands**
Habitat Creation	Least wetlands restored. Most uplands restored along graded slopes and within Seasonal Wetlands.	Moderate amount of wetlands restored. Maximum uplands restored along graded slopes within Seasonal Wetlands.	Most wetlands restored. Moderate uplands restored as bikeway is routed through uplands within Seasonal Wetlands.
Hydrology	Least tidal flushing. Tides restricted by culverts under Lagoon Drive.	Moderate tidal flushing due to replacement of roadway with elevated bikeway.	Best tidal flushing due complete to roadway removal.
Protection of Natural Habitats	Least protection from people and predators as roadway bi-sects natural habitats.	Moderate protection from people as bikeway is elevated over habitats. No change to predator access.	Most protection from people as roadway is removed from wetlands. No change to predator access.
Recreation and Education	Bikeway routed across Lagoon Drive, affording excellent wildlife viewing.	Bikeway routed over wetlands, affording excellent wildlife viewing.	Bikeway removed from wetlands and overlooks installed outside of wetlands.
Relative Complexity of Regulatory/Permitting	Least complex. No sensitive species or wetlands impacts.	Most complex. No sensitive species or wetlands impacts, but hydrology modifications and elevated boardwalk/bikeway will require permitting.	Moderately complex. Hydrology modifications will require permitting.
Relative Costs	Lowest capital and maintenance costs.	Maximum capital and maintenance costs.	Maximum capital and maintenance costs.



Chula Vista Bayfront Enhancement . 140803

Figure 4-3

Recommended Alternative for Focus Area 1: F&G Street Marsh and Seasonal Wetlands

Print Date: 1/10/2017

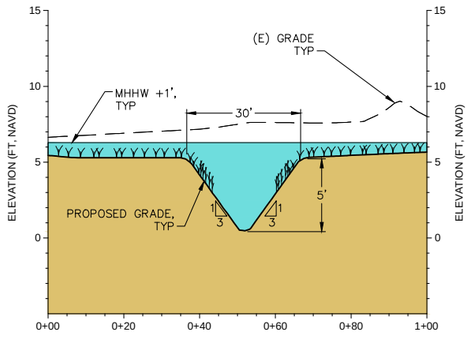
File: G:\D\4XX\D140803.00 - Chula Vista Bayfront Enhancement\10 CAD\Dwg\IPLAN.dwg

SOURCE: SOURCE:

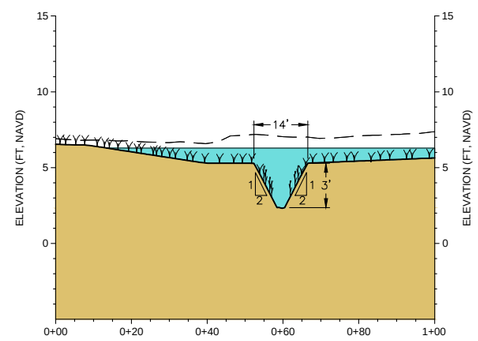
CHULA VISTA BAYFRONT ENHANCEMENT - D140803.00

Figure 4-4

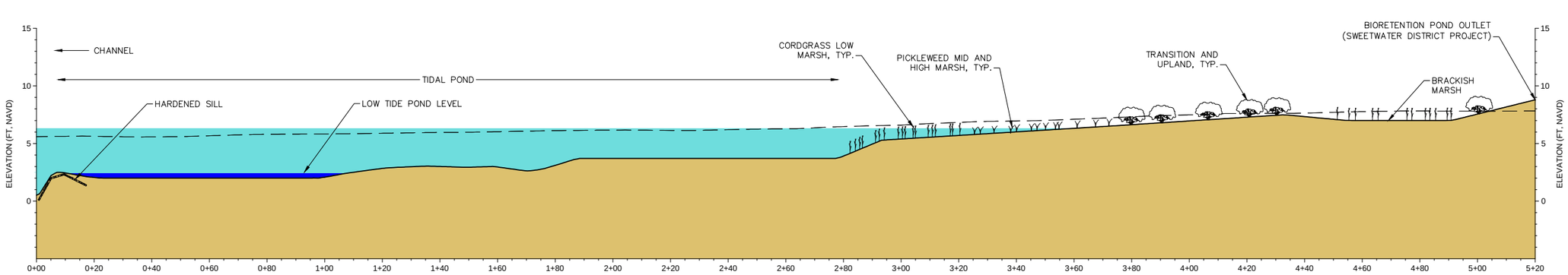
Grading Plan and Cross-section Locations for Restoration and Enhancement of the Sweetwater District



E MAIN TIDAL CHANNEL - GRADING SECTION
Scale:
H: 1" = 40'
V: 1" = 10'



F TRIBUTARY TIDAL CHANNEL - GRADING SECTION
Scale:
H: 1" = 40'
V: 1" = 10'



G TIDAL POND - GRADING SECTION
Scale:
H: 1" = 40'
V: 1" = 10'

SOURCE:

Figure 4-5
Cross-sections for Focus Area 1
F & G Salt Marsh and Seasonal Wetlands

Channel Layout and Dimensions

Using hydraulic geometry relationships, the channel system for Focus Area 1: F&G Street Marsh and Seasonal Wetlands would be sized to be third order for the area of marsh within upper F&G Street Marsh. A typical marsh with a bifurcation ratio of 3.5 would produce one third order channel, four second order channels, and 12 first order channels (Table 4-3). Because first order channels are often smaller than can be constructed with typical construction equipment, they are not included in this design and are expected to form on their own.

Table 4-3. Number and Length of Channels within Focus Area 1: F&G Street Marsh and Seasonal Wetlands

Channel Order	Number of Channels	Length per Channel (ft)
3	1	2,500
2	4	800
1	12	400

Ideal channel dimensions were determined for each order of channel. These dimensions are based on parabolic cross-sections, which form in nature, but are difficult to construct by excavation. For feasibility purposes, a trapezoidal or V-shaped channel with side slopes no steeper than 2 or 3:1 [Height:Volume (H:V)] is planned to be constructed. Table 4-4 presents the channel dimensions based on the hydraulic geometry relationships in combination with engineering judgment for channel constructability. Natural channel scour and sediment deposition would adjust the channel side slopes and cross sectional geometry over time to more closely match the hydraulic geometry estimates. Figure 4-4 shows the location of cross-sections, and Figure 4-5 provides cross-section views within the tidal pond (Section G), and across second and third order channels (Sections F and E) within the restored area.

Table 4-4 Channel Dimensions within Focus Area 1: F&G Street Marsh and Seasonal Wetlands

	Depth (ft)	Top Width (ft)	Bottom Width (ft)	Slope	Cross Sectional Area (ft^2)
3rd Order Channels	4.6	30	2	3:1	74
2nd Order Channels	2.9	14	1	2.2:1	22

4.2 FOCUS AREA 2 - F&G STREET MARSH ENTRANCE CHANNEL

4.2.1 Existing Conditions

As described previously, the F&G Street Marsh is connected to San Diego Bay via a narrow Entrance Channel and connector marsh. Two 24-inch corrugated drains are in place beneath Lagoon Drive to bring tidal waters into the F&G Street Marsh. A small band of coastal salt marsh habitat occurs along the slopes of the Entrance Channel toward San Diego Bay, and adjacent uplands consist of disturbed lands, and disturbed baccharis scrub. Replacement and modification of the drains and Entrance Channel is required as an essential component of the overall restoration and enhancement of F&G Street Marsh and Seasonal Wetlands. However, restoration options for the Entrance Channel are included here as a separate focus area as there are several alternatives for placement of the planned bikeway, fencing and buffer areas. The existing conditions of the F&G Street Marsh Entrance Channel focus area are illustrated in Figure 4-6.

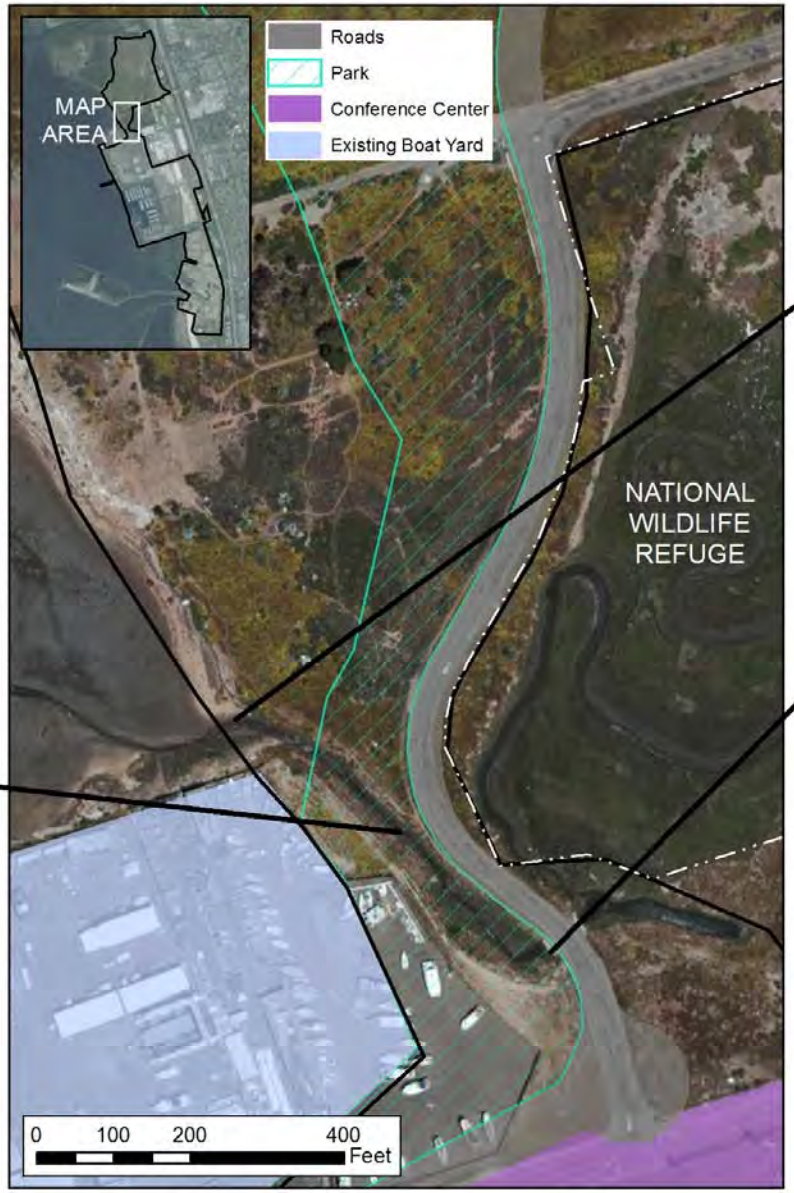
4.2.2 Restoration and Enhancement Considerations

Table 4-5 summarizes habitat enhancement and restoration priorities for Focus Area 2: the F&G Street Marsh Entrance Channel, and identifies opportunities and constraints unique to this focus area.

As described previously, the culverts that connect the Entrance Channel are insufficient to support the expansion of wetlands within the F&G Street Marsh and Seasonal Wetlands. Further, the sides of the Entrance Channel are steep sloped and the base of the channel is filled with concrete rubble. This inadvertent armoring prevents the channel from deepening and it is, instead, getting wider and as the sides slough and erode. This problem will only accelerate as sea levels rise. Opportunities exist, therefore, to stabilize, and/or re-contour channel slopes to prevent further erosion, and to provide wetlands transgression areas. Further opportunity exists to utilize the Entrance Channel to provide tidal connection to a constructed marsh along the Sweetwater District shoreline to the north (discussed in the following section).

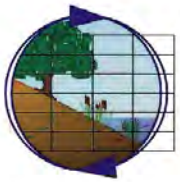
Restoration of the Entrance Channel must consider tidal requirements of both F&G Street Marsh and any newly constructed wetlands, and a 16-foot wide multipurpose trail must be accommodated across the channel (SDUPD 2012b). Wildlife viewing would be excellent along the bikeway crossing. However, restoration and the trail route must accommodate buffers, fences, and other means to restrict access into protected adjacent wetlands. Reconstruction of Marina Parkway/E Street to accommodate culverts added to increase tidal prism within the F&G Street Marsh could accommodate sea level rise. While restoration of marshland within the NWR is not a project priority, it is understood that the F&G Street Marsh within the NWR will benefit from improved hydrology associated with Entrance Channel improvements. Additionally, a new connection to the F&G Street Marsh Entrance Channel is required for creation of tidal wetlands within the Sweetwater District (see Focus Area 3). Any habitat and hydrology modifications completed within the NWR lands will require cooperation with and approval by the USFWS.

Looking east at the steeply sloped entrance channel. Concrete rubble is visible and the channel is eroding as it widens over time.



Looking west at the entrance channel as it meets San Diego Bay.

Twin 24-inch corrugated drains bring tidal waters to the F&G Street Marsh via a narrow entrance channel.



N
W E
S

Focus Area 2: F&G Street Marsh Entrance Channel
Existing Conditions
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 4-6

Merkel & Associates, Inc.

Table 4-5. Priorities, Opportunities, and Constraints for Focus Area 2: F&G Street Marsh Entrance Channel

Priorities	Opportunities	Constraints
• Increase tidal range to support expansion of wetlands in F&G Street Marsh and Seasonal Wetlands • Accommodate a 16-foot wide multipurpose trail across the Entrance Channel and between the channel and the existing Boat Yard. • Stabilize eroding channel banks • Provide transgression area for sea level rise	• Provide tidal connection to Sweetwater District Shoreline wetlands restoration (described in next report section) • Create wildlife viewing from bikeway bridge • Incorporate buffers, fences, and overlooks "softened" by natural features. May use bikeway bridge to securely tie into fencing	• Avoid impacts to existing marsh • Protect habitats and wildlife through passive use • Evaluate potential increase in flood risks to properties to the south • Accommodate plans to extend "Future" E Street • Narrow corridor between Marina Parkway/E Street and the existing Boat Yard.

Further, as described in Section 4.1.2 above, the commercial properties immediately to the south of F&G Street marsh are at risk of flooding in the future due to sea level rise. The currently muted tidal conditions within F&G Street Marsh slow the risk of flood. Improvement of tidal prism within F&G Street marsh created as a result of Entrance Channel modifications (such as the installation of a new, larger culvert) will likely accelerate the risk of flooding east of Marina Parkway/E Street. The properties to the south of F&G Street Marsh are at elevations of approximately +10.7 ft NAVD (+11.1 ft MLLW). Under two feet of sea level rise (a high sea level rise scenario predicted as early as 2050, NRC 2012), the properties would flood in a 500-year storm event. Therefore, the effects of sea level rise on the commercial properties adjacent to the F&G Street Marsh should be evaluated during project development. The graphics included in this Plan for Focus Areas 1 and 2 identify a "potential flood management measure" in this area. However, the design of any new flood management measures would require coordination with the adjacent land owners.

4.2.3 Preliminary Restoration Alternatives

Three restoration alternatives were prepared for the F&G Street Marsh Entrance Channel. The following text describes key design, engineering, relative cost, and regulatory elements for each alternative. Each of the following alternatives assumes that Marina Parkway/E Street would be extended northward to provide access to the Signature Park, the RV Park, and any other re-development planned within the Sweetwater District of the Chula Vista Bayfront. This extension would eliminate traffic along Lagoon Drive as the only connector to F Street. The new roadway would be constructed at +13.5 feet NAVD (+13.9 feet MLLW) to protect the roadway from future flooding related to sea level rise.

Alternative 1: Stabilize Slopes and Construct Bridge for Multipurpose Trail/Bikeway

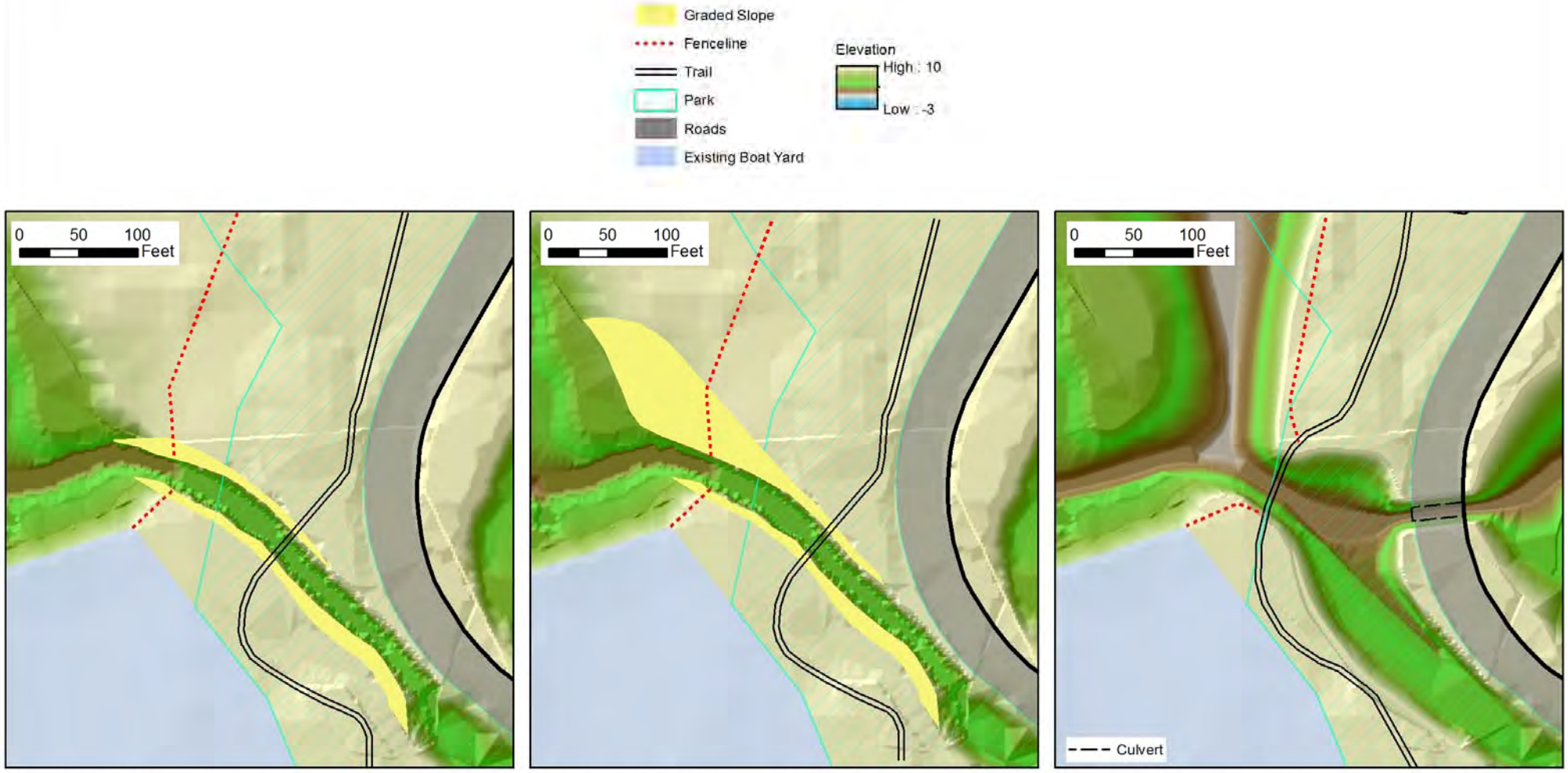
Figure 4-7 illustrates three conceptual alternatives for restoration and enhancement of the F&G Street Marsh Entrance Channel. The main elements of each alternative are presented graphically; however, concepts presented in this graphic have not been engineered and are considered preliminary designs. For Alternative 1, the two corrugated drains that currently connect F&G Street Marsh to the Bay beneath Marina Parkway/E Street would remain in place (Figure 4-7). A 16-foot wide multipurpose bike and pedestrian trail would be constructed outside of the Marina Parkway/E Street road alignment. A bridge would be constructed over the Entrance Channel to accommodate the trail. The slopes of the Entrance Channel would be minimally graded for immediate stabilization of eroding areas. A fence would be constructed along the Entrance Channel, away from the trail/bikeway. However, the bikeway could be aligned further to the west to connect with the fence.

The primary benefit of Alternative 1 is that it would be the most cost-effective and readily implementable alternative for bikeway construction. This alternative would include simple grading improvements to stabilize the eroding slopes of the Entrance Channel. However, it would not maximize opportunities to increase the tidal prism and improve tidal flushing with the F&G Street Marsh and Seasonal Wetlands. Additionally, the fence location away from the bikeway would make it difficult to secure the adjacent wetlands and beach from encroachment by predators and people.

Alternative 2: Deepen Channel, Grade Slopes, and Construct Bridge for Multipurpose Trail/Bikeway

For Alternative 2, the Entrance Channel would be excavated slightly to remove existing concrete rubble that currently prevents natural channel deepening. The two corrugated drains that currently connect F&G Street Marsh to the Bay beneath Marina Parkway/E Street would be replaced in the same location with a larger culvert (Figure 4-7). The bike and pedestrian trail alignment, trail bridge, and fence alignment would remain the same as contemplated for Alternative 1. More extensive grading would occur along both sides of the Entrance Channel. The slopes would be graded back from the channel to reconfigure the existing steeply-sloped eroding channel walls, and to provide a band of marsh habitat that would connect the Entrance Channel to adjacent restored wetlands planned along the Sweetwater District Shoreline (discussed in the following section). The upper limits of grading would transition to native upland habitat, such as maritime succulent scrub, that would provide further protection of wetlands from encroachment by predators and people. These slopes would also serve as a transgression area for sea level rise.

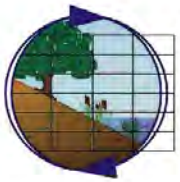
Alternative 2 would provide a modest improvement to the hydrology and tidal flushing of the F&G Street Marsh, and would allow for some restoration of tidal conditions within the adjacent Seasonal Wetlands. The increased grading of the channel slopes would provide a wetland to upland transition area and would serve as a transgression area for sea level rise. This alternative would protect natural resources as the deepened Entrance Channel would serve as a barrier “moat” preventing access of predators and people to adjacent beaches and marshlands. However, some access would still likely be possible where the fence terminates at the channel. Alternative 2 would be more costly to implement than Alternative 1.



Alternative 1: Stabilize Slopes and Construct Bridge for Multipurpose Trail/Bikeway

Alternative 2: Deepen Channel, Grade Slopes, and Construct Bridge for Multipurpose Trail/Bikeway

Alternative 3: Expand and Deepen Channel, Add Additional Culvert, and Construct Bridge for Multipurpose Trail/Bikeway



N W E S

Focus Area 2: F&G Street Marsh Entrance Channel
Three Preliminary Alternatives
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 4-7

Merkel & Associates, Inc.

Alternative 3: Expand and Deepen Channel, Add Additional Culvert, and Construct Bridge for Multipurpose Trail/Bikeway

For Alternative 3, the two corrugated drains that currently connect F&G Street Marsh to the Bay beneath Marina Parkway/E Street would remain in place. However, unlike the other alternatives, the Entrance Channel would be excavated and deepened, and an additional culvert would be added beneath the roadway to the north of the existing corrugated drains (Figure 4-7). This additional culvert would increase tidal flushing, improve the hydrology of the F&G Street Marsh, and allow for restoration of the Seasonal Wetlands to a more consistent tidal condition (as described above).

For Alternative 3, a standalone 16-foot wide multipurpose bike and pedestrian trail/bikeway would be constructed adjacent to but outside of the Marina Parkway/E Street road alignment, and a bridge would be constructed over the Entrance Channel to accommodate the bikeway. The bridge location would be bayward of the alignment proposed for Alternatives 1 and 2 in order to accommodate the additional culvert described above. The fenceline would be aligned to the northwest (bayward) of the trail and the ends of the fence would be secured to the bridge. This would secure the ends of the fence and would restrict access around the fence and into adjacent wetlands. The deepened Entrance Channel, along with this fence alignment, would restrict access to adjacent wetlands. Similar to Alternative 2, the steeply-sloped eroding channel walls would be reconfigured to a more gentle slope to provide marsh and upland habitat, and to provide a transgression area for sea level rise.

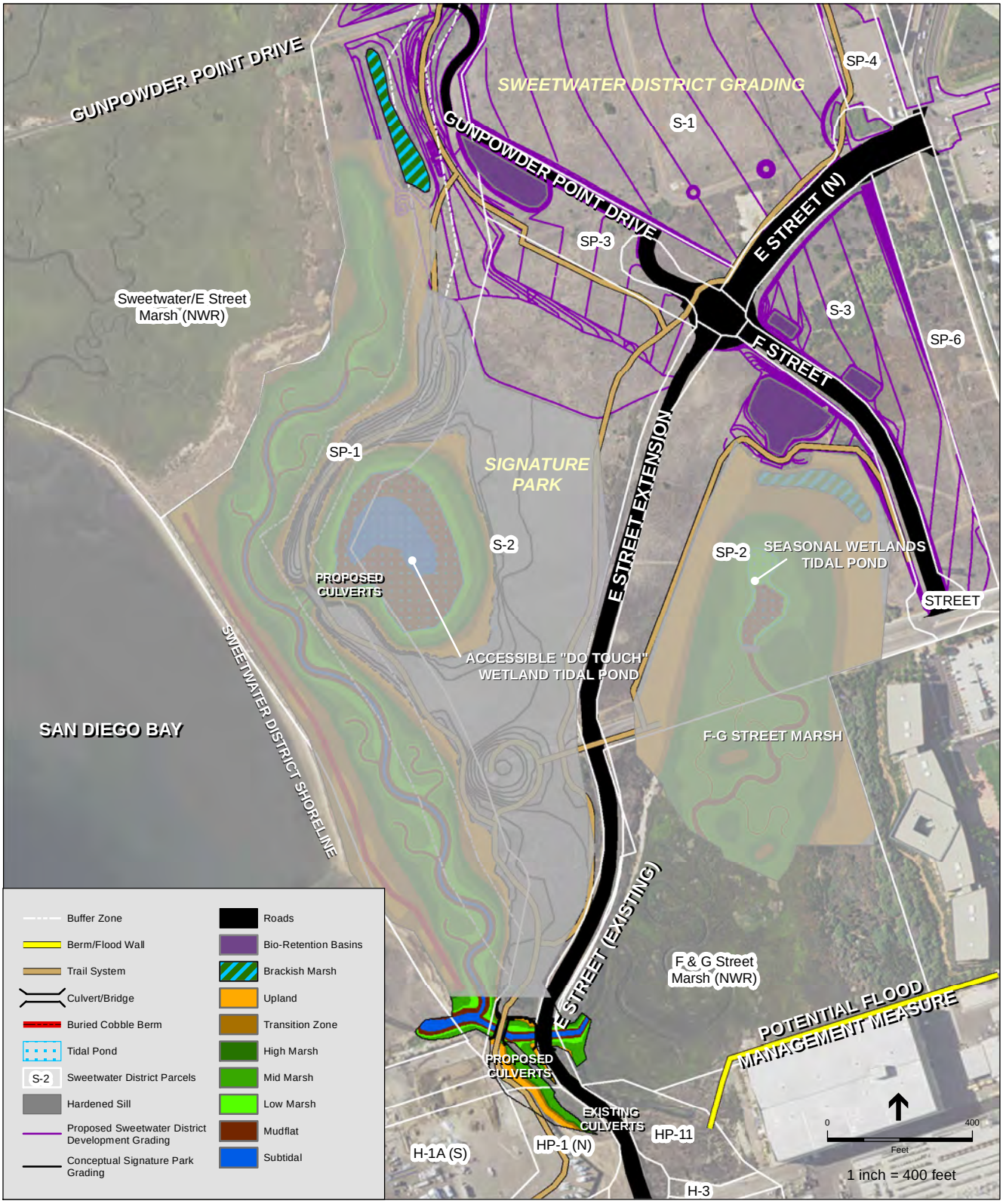
Alternative 3 would greatly improve hydrology and tidal flushing, allowing for restoration of the maximum amount of wetlands within the Seasonal Ponds. Further, the realignment of the multipurpose trail to the northwest (bayward) of the new culvert, and the tie in of the fenceline to the bikeway bridge would provide the best protection for adjacent natural resources. This alternative would provide for upland transition and transgression areas along the slopes of the Entrance Channel.

4.2.4 Recommended Restoration Alternative for Focus Area 2

The features of each of the three preliminary alternatives considered for Focus Area 2 are compared relative to each other and summarized in Table 4-6. Based on this analysis, the recommended conceptual design alternative for Focus Area 2 is Alternative 3 which includes deepening of the Entrance Channel, construction of a 16-foot multipurpose trail/bikeway adjacent to but outside of the existing Marina Parkway/E Street alignment, construction of a bikeway bridge over the Entrance Channel, construction of a fence that ties into the bridge, and recontouring of the steeply eroding channel slopes. This alternative improves the hydrology of the F&G Street Marsh and allows for full tidal restoration of the Seasonal Wetlands. It also restricts access to adjacent natural resources by connecting the fence to the bikeway bridge and deepening the Entrance Channel to serve as a “moat” that is not easily crossed by predators and people. Finally, this alternative provides for excellent recreational and education opportunities through creation of a dedicated bikeway that would serve as an important linking piece of the San Diego Bayshore Bikeway that runs from downtown, around San Diego Bay and into Coronado. Wildlife viewing would occur at safe locations along the bikeway bridge and alignment. Figures 4-8 and 4-9 provide the conceptual design overview, and cross-sections for this recommended alternative. The following text describes specific design elements.

Table 4-6. Summary of Restoration and Enhancement Alternatives for Focus Area 2: F&G Street Marsh Entrance Channel.

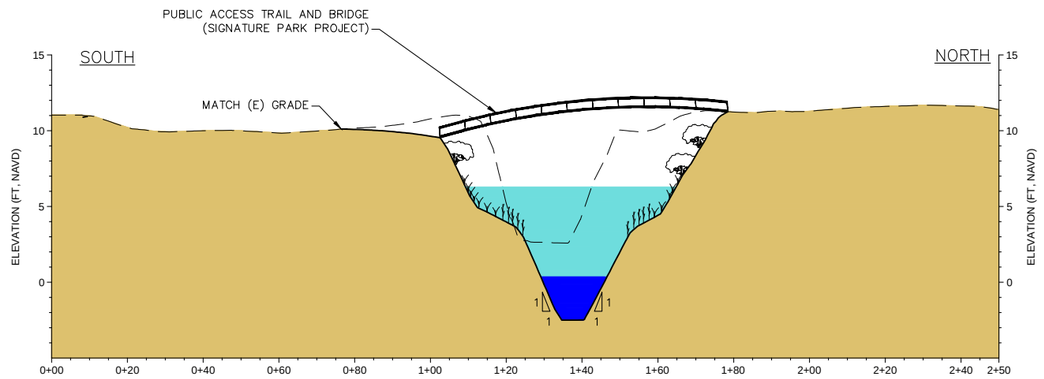
PROJECT ELEMENT	PRELIMINARY RESTORATION ALTERNATIVE		
	Alternative 1: Stabilize Slopes and Construct Bridge for Multipurpose Trail/Bikeway	**Alternative 2: Deepen Channel, Grade Slopes, and Construct Bridge for Multipurpose Trail/Bikeway**	**Alternative 3: Expand and Deepen Channel, Add Additional Culvert, and Construct Bridge for Multipurpose Trail/Bikeway**
Habitat Creation	Minor uplands restored along graded channel slopes. No wetlands restored.	Moderate amount of uplands restored along graded channel slopes. Some wetlands restored along graded channel slopes.	Moderate amount of uplands restored along graded channel slopes. Some wetlands restored along graded channel slopes.
Hydrology	No change to existing conditions.	Deepened channel and new culvert increases tidal prism allowing for moderate wetlands restoration in F&G Street Marsh and Seasonal Wetlands.	Deepened channel and additional culvert maximizes tidal prism allowing for maximum wetlands restoration in F&G Street Marsh and Seasonal Wetlands.
Protection of Natural Habitats	Minor protection. Some access to beach and wetlands where fence terminates at channel, and some access through channel at lowest tides.	Moderate protection. Some access to beach and wetlands where fence terminates at channel, but deepened Entrance Channel creates a less passable “moat”.	Maximum protection. Fence tied into trail/bikeway bridge and deepened Entrance Channel creates a less passable “moat”.
Recreation and Education	Bikeway routed over Entrance Channel allows for recreation and wildlife viewing.	Bikeway routed over Entrance Channel allows for recreation and wildlife viewing.	Bikeway routed over Entrance Channel allows for recreation and wildlife viewing.
Relative Complexity of Regulatory/Permitting	Moderately complex. No sensitive species impacts. Minor wetlands impacts in channel. Trail/bikeway bridge would require regulatory approval.	Moderately complex. No sensitive species impacts. Minor wetland impacts in channel. Trail/bikeway bridge would require regulatory approval.	Most complex. No sensitive species impacts. Minor wetland impacts in channel. Trail/bikeway bridge and new culvert would require regulatory approval.
Relative Costs	Lowest capital and maintenance costs.	Moderate capital and maintenance costs.	Maximum capital costs and maintenance costs.



Chula Vista Bayfront Enhancement . 140803

Figure 4-8

Recommended Alternative for Focus Area 2:
F&G Street Marsh Entrance Channel

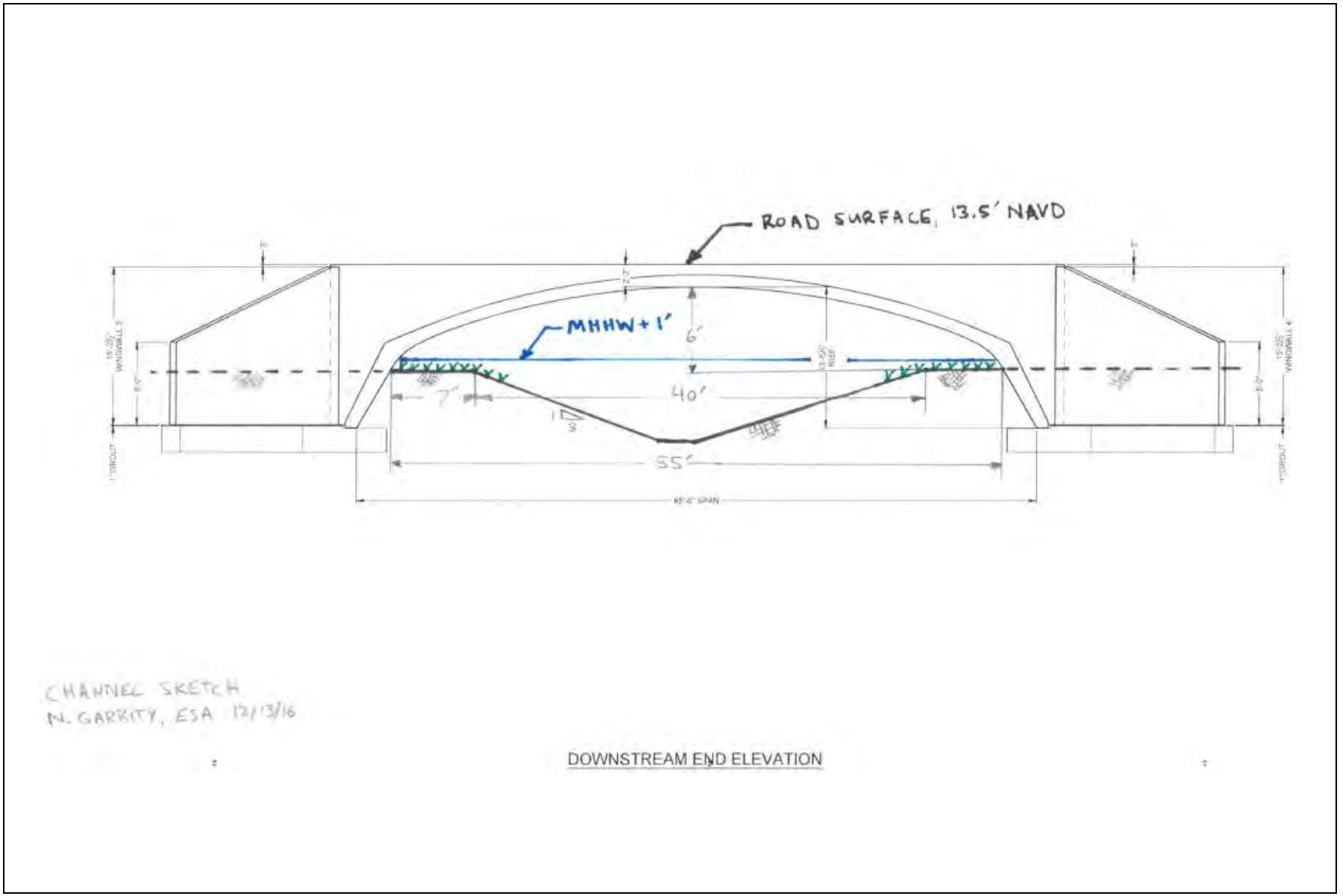


C F&G STREET MARSH ENTRANCE CHANNEL

Scale:
H: 1" = 40'
V: 1" = 10'

SOURCE:

Figure 4-9a
Cross-sections for Focus Area 2
F&G Street Marsh Entrance Channel



Source: Contech, ESA

Chula Vista Bayfront Enhancement . D140803

Figure 4-9b

Cross-Section D: E Street Culvert Crossing, Example Section

Culvert Design

The new connector channel would be cut under E Street to the north of the existing culverts. This would avoid impacts to the smaller channel where the existing culverts are located, which is constrained by the road on the east and the boat yard on the west. The new culvert would connect F&G Street Marsh to the Entrance Channel at a second location, and the existing corrugated drains would be left in place at their current location. The new culvert would consist of a pre-cast concrete bottomless arch, with buried footings. The top of the culvert would be constructed at +13.5 feet NAVD (+13.9 feet MLLW) to protect the roadway from future flooding related to sea level rise and to tie into plans to extend the existing Marina Parkway/E Street, with the new portion of the roadway to be constructed at this higher elevation. This design would allow for persistence of natural channel conditions, including fringe marsh habitat that would improve connectivity between the bayfront, and the F&G Street Marsh. Figure 4-4 shows the location of cross-sections, and Figure 4-9 provides cross-section views within the Entrance Channel (Section C), and for the new culvert (Section D).

Channel Size and Dimensions

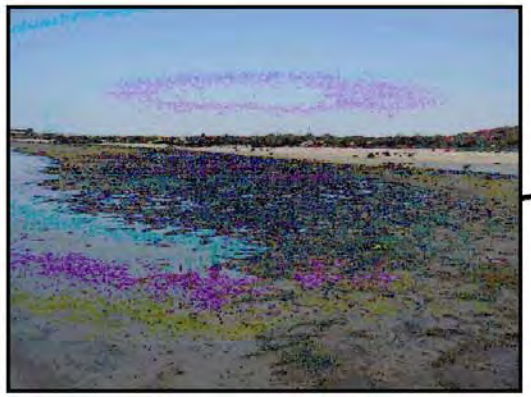
The modified Entrance Channel was sized using hydraulic geometry relationships and considering the marsh area of both the F&G Street Marsh and the Sweetwater District Marsh (described in the following section). The main Entrance Channel and new connector channel excavated to accommodate the new culvert would be smaller than the portion of the Entrance Channel extending to the Bay; however, the larger channel size was used to ensure the multipurpose trail/bikeway crossing and culvert were sized to allow flow under both existing conditions and future increased capacity. The channel would be 57 ft wide at marsh plain elevation near the shoreline and would narrow to 40 ft wide at the culvert. The channel would be 7.8 ft deep with a bottom width of 6 ft.

4.3 FOCUS AREA 3 - SWEETWATER DISTRICT SHORELINE

4.3.1 Existing Conditions

The Sweetwater District Shoreline of the Chula Vista Bayfront is bordered to the north by the Sweetwater/E Street Marsh, part of the Sweetwater Unit of the NWR. The shoreline is bordered to the south by the connector marsh that feeds into F&G Street Marsh, and by the adjacent marine-related industry. Vegetation along the shoreline has been mapped primarily as disturbed lands dominated by non-native invasive plant species, such as black mustard (*Brassica nigra)* and crown daisy (*Chrysanthemum coronarium*) (Dudek 2010 and 2015). Other habitat types include Diegan coastal sage scrub, located along the upland berm that runs near the edge of the Sweetwater/E Street Marsh, and disturbed broom baccharis scrub and eucalyptus woodland located just north of the F&G Street Marsh Entrance Channel. Along the bayward edge of this area, these habitats terminate at a rocky scarp that runs the length of the shoreline and drops to a narrow beach and adjacent intertidal mudflats. The existing conditions within Focus Area 3 are illustrated in Figure 4-10. The Sweetwater District portion of the Chula Vista Bayfront is planned to include mixed use commercial areas, an RV park and campground, and Signature Park - a planned recreational parkland that will run along the shoreline. Signature Park and the adjacent developed areas are envisioned to include buffers between developed and natural habitats. The primary restoration and enhancement opportunities occur within these buffer areas.

Looking north at disturbed upland vegetation within the Sweetwater District parcel.



An eroding scarp separates uplands from adjacent beach and tidal flats.

Looking south at disturbed upland vegetation within the Sweetwater District Parcel.

N
W E
S

Focus Area 3: Sweetwater District Shoreline
Existing Conditions
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 4-10

Merkel & Associates, Inc.

4.3.2 Restoration and Enhancement Considerations

Table 4-7 summarizes habitat enhancement and restoration priorities for Focus Area 3: Sweetwater District Shoreline, and identifies opportunities and constraints unique to this focus area.

Table 4-7. Priorities, Opportunities, and Constraints for Focus Area 3: Sweetwater District Shoreline

Priorities	Opportunities	Constraints
• Protect adjacent shoreline and wetlands from adjacent human activity • Increase habitat connectivity between NWR lands and other wetlands of south San Diego Bay • Provide a natural interface between wetlands and parkland • Create wetland transgression habitat for sea level rise	• Create new marsh and tidal flats habitat along shoreline • Create an accessible "do touch" wetland in parkland that provides unique educational and wildlife viewing opportunities • Incorporate buffers, fences, and overlooks "softened" by natural features. • Create brackish marsh habitat through freshwater input from bio-retention basins • Incorporate bikeways and trails planned for adjacent parkland to enrich passive enjoyment of wetlands	• Avoid impacts to existing marsh • Protect habitats and wildlife through passive use • Alternatives may not preclude mitigation needs for Diegan coastal sage scrub within the Sweetwater District • Creation of tidal wetlands will require modification of F&G Street Marsh Entrance Channel

The priority for restoration and enhancement along the Sweetwater District Shoreline focus area is to create additional habitat and to improve connectivity of marshlands and natural habitats. Created or enhanced habitat within the designated buffer areas should seek to incorporate elements that discourage and prevent human encroachment into natural habitats while also maintaining the appearance of the natural landscape. Natural features that accomplish this may include channels, berms, ponds, etc. Due to the adjacency of planned parkland at Signature Park, the Sweetwater District allows for unparalleled educational and enrichment opportunities, including interpretive areas, overlooks, trails, and signage. Opportunity also exists to create marsh and intertidal habitat within the park itself, which would be accessible to visitors, educators, researchers, and school groups.

Creation of tidal habitat within the Sweetwater District would require a tidal connection to San Diego Bay. The best way to achieve this is through modification of the F&G Street Marsh Entrance Channel to the south. Further, restoration alternatives should incorporate planned bio-retention basins associated with Sweetwater District development, and should not preclude upland mitigation needs associated with the development (described previously in Section 4.1). Finally, to the greatest extent possible, restoration alternatives should accommodate predicted sea level rise utilizing shoreline stabilization and planned transgression areas.

4.3.3 Preliminary Restoration Alternatives

Two initial restoration alternatives were prepared for the Sweetwater District Shoreline. The following text describes key design, engineering, relative cost, and regulatory elements for each alternative.

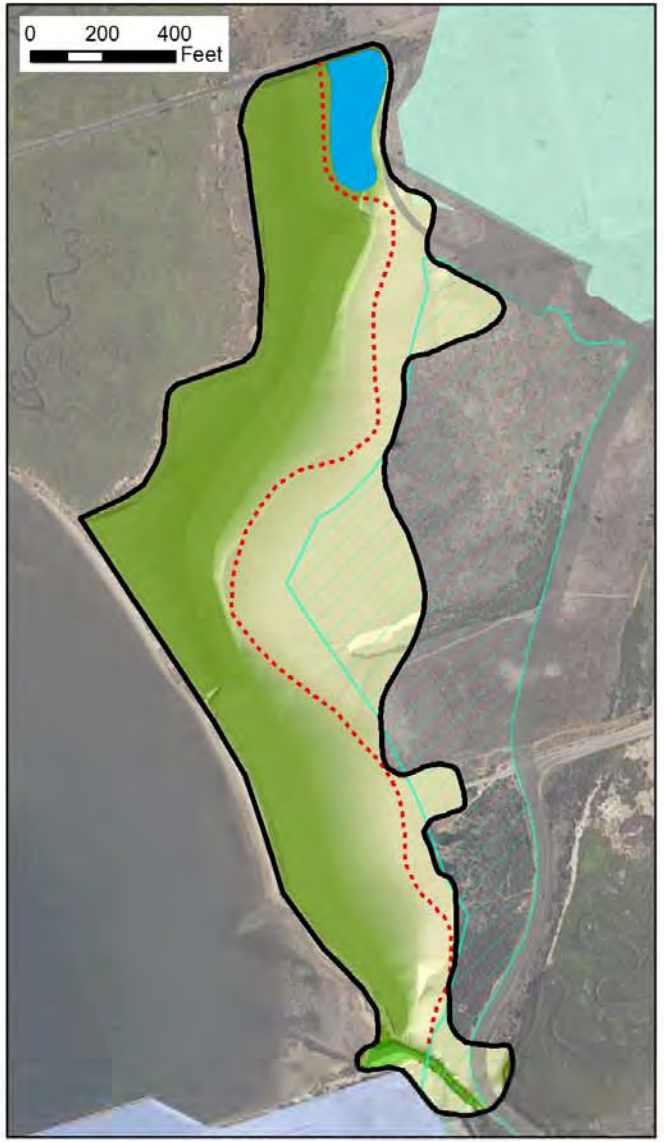
Alternative 1: Construction of Full "Moat" Barrier with Interpretive Wetland Area

For Alternative 1, a tidal channel would be excavated within the buffer area, along the length of the Sweetwater District Shoreline, extending from the F&G Street Marsh Entrance Channel in the south to Gunpowder Point Drive in the north (Figure 4-11). The main channel, along with smaller second and third order branching channels, would connect to San Diego Bay via the F&G Street Marsh Entrance Channel. The slopes of the main channel would be graded to support a transition from low- to mid- to high-marsh habitat. This channel would serve two primary purposes. First, it would serve as a barrier, or "moat", restricting access of people and predators to the wetlands adjacent to the parkland of the Sweetwater District. Second, it would provide connectivity between the E Street and Sweetwater Marsh complex to the north and the F&G Street Marsh to the south. The buffer area to the north of Gunpowder Point Drive would be graded to provide a transgression area for sea level rise. This slope would be seeded with a mix of Diegan coastal sage scrub and maritime succulent scrub species, which would accommodate some of the upland mitigation needs of the Sweetwater District development.

For this alternative, the rocky berm that separates the upland portion of the Sweetwater District Shoreline from the adjacent tidal flats would be left in place to protect the restored channel and marsh habitat from the higher energy, open-bay waters. The berm would be lowered slightly from its existing upland elevation to be slightly higher than the elevation of the berm that runs along the shoreline of the adjacent Sweetwater/E Street Marsh in the NWR. The berm would overtop only during the highest tides of the year. For this alternative, two bio-retention basins planned for the RV park would feed into the constructed wetlands, providing brackish marsh habitat along the northern end of the channel (similar to that described for Focus Area 1 above).

In order to provide unique educational and recreational opportunities, a tidal pond would be excavated along the central portion of the main restored channel (Figure 4-11). This ponded area, called the "do touch wetland", would connect to the main channel via an narrow, excavated tidal channel, and the pond itself would extend outside of the planned buffer area for the Sweetwater District and into the adjacent Signature Park. The pond would support a fringe of marsh habitat, along with tidal flats and shallow water that would provide foraging and loafing opportunities for shorebirds and waterfowl. The pond would also serve as a feature of interest for wildlife viewing from the adjacent boardwalk/bikeway and overlooks. The pond would be excavated to between 0 and +2 feet MLLW, and would flood regularly. A hardened sill would be placed at the mouth of the pond to prevent channel scour, and to maintain ponded conditions at low tides. These ponded conditions would allow for continued wildlife viewing opportunities at all tides, and would also preclude nesting by shorebirds, as this wetland would not be isolated enough to provide safe nesting habitat for these species.

Alternative 1: Construction of Full "Moat" Barrier with Interpretive Wetland Area



Alternative 2: Construction of Alkali Flats and Sea Level Rise Transgression Area

Focus Area 3: Sweetwater District Shoreline
Two Preliminary Alternatives

Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 4-11

Merkel & Associates, Inc.

Overlooks with interpretive signage would be constructed along the shoreline. In contrast to the main channel and wetlands created along the Sweetwater District Shoreline within the buffer areas, the tidal pond "do touch wetland" created within Signature Park would be accessible to school groups, birding groups, RV park visitors, and other interested public. A trail would be aligned along the edge of the pond, with a bridge over the small channel that connects the pond to the main channel. Overlooks, bird blinds, interpretive signage, and elevated viewing berms could be constructed along the trail to provide passive viewing opportunities of adjacent wetlands. The shoreline of the "do touch wetland" would be gradually sloped to allow access and could include a beach area. A fence would be installed between the main channel "moat" and the adjacent parkland. However, the tidal pond would not be fenced.

Alternative 1 would provide a balance between habitat restoration, natural resource protection, and recreational and educational opportunities within the Sweetwater District. It would greatly improve the connection between the currently isolated F&G Street Marsh and the E Street and Sweetwater Marsh complex to the north. While this alternative would not create the maximum possible acreage of coastal salt marsh habitat, the long "moat" configuration of the constructed channel would support a moderate amount of marsh habitat and would serve as a natural barrier between wetlands and the adjacent parklands. Alternative 1 would also provide excellent educational and recreational opportunities through incorporation of the tidal pond "do touch wetland" extending into adjacent parkland, a new trail system along the created wetlands, overlooks, and interpretive signage. This alternative would be costly to implement and would not maximize transgression areas for sea level rise.

Alternative 2: Construction of Alkali Flats and Sea Level Rise Marsh Transgression Area

For Alternative 2, the full length of the buffer areas within the Sweetwater District would be graded to accommodate a large transgression area for sea level rise (Figure 4-11). This slope would be seeded with a mix of coastal sage scrub and maritime succulent scrub species, which would also accommodate the upland mitigation needs of the Sweetwater District development. Alkali flats would occur along the toe of the slope, which would provide loafing and nesting habitats for shorebird species such as black-necked stilt, killdeer (*Charadrius vociferous*), and American avocet. A fence would be installed along the top of the slope. A trail, overlooks, bird blinds, interpretive signage, and elevated viewing berms could be constructed along the top of the slope to provide passive viewing opportunities of adjacent wetlands. A fence would be installed between the graded slope and the adjacent parkland.

Alternative 2 would provide a cost effective upland restoration within the buffer areas of the Sweetwater District. The graded slopes within the buffers would serve as a transgression area for marshlands affected by continued sea level rise. This alternative would not immediately increase wetland or provide connectivity between wetlands to the north and south of the Sweetwater District. While this alternative would incorporate a trail system along with wildlife viewing areas, there would be a significant distance between parklands and shoreline wetlands, and educational opportunities to explore and observe the natural wetlands of San Diego Bay would not be maximized.

4.3.4 Recommended Restoration Alternative for Focus Area 3

The features of each of the two preliminary alternatives considered for Focus Area 3 are compared relative to each other and summarized in Table 4-8. Based on this analysis and feedback received from the WAG, the recommended conceptual design alternative for Focus Area 3 is a modified version of Alternative 1. For this modified Alternative 1, the tidal channel would be excavated within the buffer area, along the Sweetwater District Shoreline, extending from the F&G Street Entrance Channel but terminating midway to Gunpowder Point Drive. Between the channel and Gunpowder Point Drive, slopes within the buffer area would be graded to provide a sea level rise transgression area, and would be seeded with a mix of Diegan coastal sage scrub and maritime succulent scrub species. This would result in less total wetlands created, but would provide a good balance between wetlands creation and sea level rise upland transgression area. The tidal channel would not extend all the way along the Sweetwater District, but would, in conjunction with fencing, still provide substantial habitat protection. The tidal pond "do touch wetland" contemplated within Signature Park would remain, as would the trail system, interpretive and educational elements, and the fence alignment. Figures 4-12 and 4-13 provide the conceptual design overview, grading, and cross-sections for this recommended alternative. The following text describes specific design elements.

Marsh Design, Elevations, and Grading

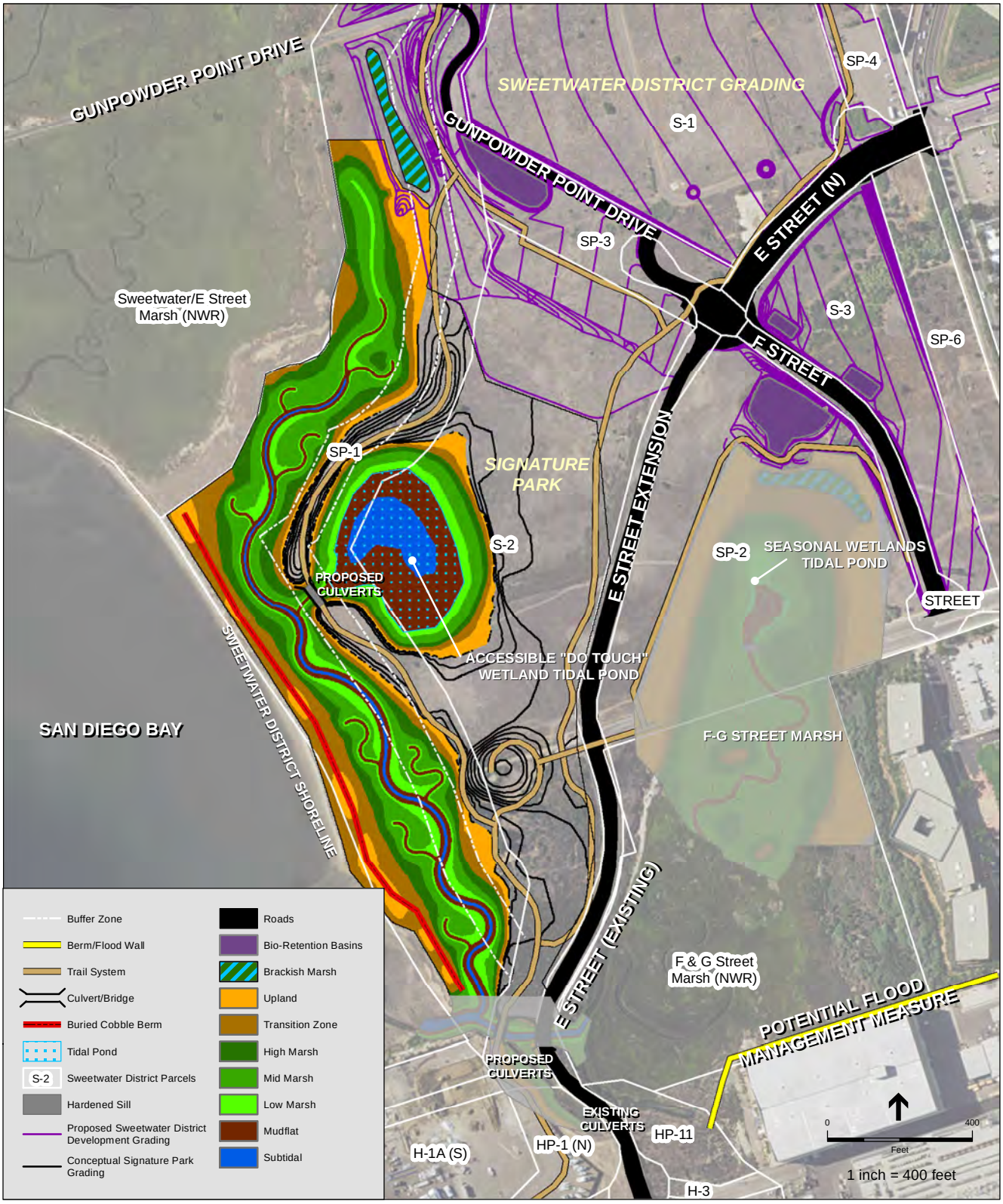
The recommended alternative for Focus Area 3 would include a linear tidal channel that would serve as a "moat" along the length of the Sweetwater District Shoreline, south of Gunpowder Point Drive. The restored area would support tidal flats, low, mid, and high coastal salt marsh habitat, as well as an upland boundary that would transition into maritime succulent scrub. The marsh zone elevations utilized for the Sweetwater District recommended alternative are based on the habitat elevations described in Section 3.3. Unvegetated tidal flats would occur along the banks of the main channel. Low marsh benches would be graded along the inside bends of the channel system to support cordgrass habitat. Mid and high marsh habitat would occur in bands along the sides of the main channel. North of Gunpowder Point Drive, slopes within the buffer would be graded and seeded with maritime succulent scrub vegetation (Figure 4-14). Design and engineering for the buffer adjacent to the RV Park is planned to occur simultaneous with RV Park development.

Figure 4-4 shows the grading plan for the Sweetwater District Shoreline. The grading is designed with sea-level rise in mind, and it is anticipated that the habitats will transition as sea level rise progresses, with coastal salt marsh habitat moving upslope into planned transgression areas. Areas that currently support coastal salt marsh vegetation would transition to tidal flats and open water.

As indicated previously, the proposed Sweetwater District development would include a bio-retention basin along the northern edge of the planned marsh creation area. This basin would collect stormwater runoff from the adjacent development. Freshwater from the basin would spill over a hardened sill and into the adjacent marsh. A depression would be excavated adjacent to the bio-retention basin to collect water and to create brackish marsh habitat. The existing saline soils combined with occasional tidal inundation would increase water salinity from the stormwater bio-retention basin, allowing brackish marsh vegetation to develop along the northern boundary of the main tidal channel.

Table 4-8. Summary of Restoration and Enhancement Alternatives for Focus Area 3: Sweetwater District Shoreline.

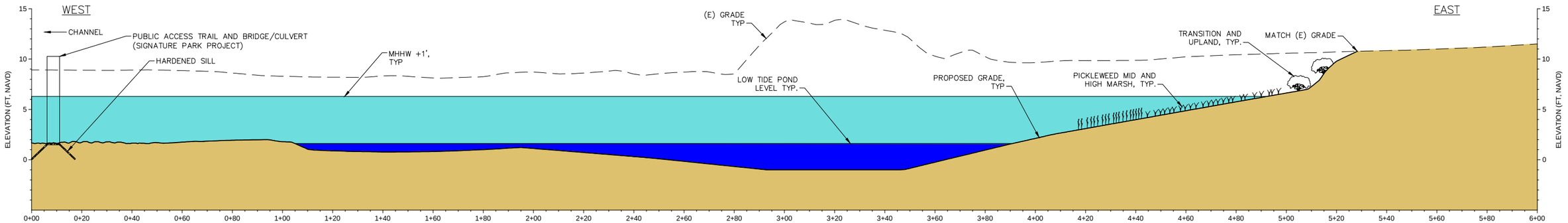
PROJECT ELEMENT	PRELIMINARY RESTORATION ALTERNATIVE		
	Alternative 1: Construction of Full "Moat" Barrier with Interpretive Wetland Area	**Alternative 2: Construction of Alkali Flats and Sea Level Rise Marsh Transgression Area**	**Modified Alternative 1: Construction of Partial "Moat" Barrier with Interpretive Wetland Area**
Habitat Creation	Maximum wetlands restored as constructed channel and tidal pond would extend the length of the focus area. Minor uplands restored north of Gunpowder Pt. Dr.	Maximum uplands restored along graded slopes throughout focus area. No wetlands restored.	Moderate wetlands restored as constructed channel and tidal pond would extend midway to Gunpowder Pt. Dr. Moderate uplands restored along slopes adjacent to wetlands and north of Gunpowder Pt. Dr.
Hydrology	Maximum increase in tidal prism in restored wetlands, via new connection at F&G Street Marsh Entrance Channel.	No changes to existing conditions.	Maximum increase in tidal prism in restored wetlands, via new connection at F&G Street Marsh Entrance Channel.
Protection of Natural Habitats	Maximum protection as tidal channel would create a less passable "moat", along length of focus area, and fencing would be installed in buffers.	Moderate protection from fencing installed in buffers.	Moderate/maximum protection as tidal channel would create a less passable "moat" along much of focus area, and fencing would be installed in buffers.
Recreation and Education	Bikeway and trails routed adjacent to restored wetlands, "do touch wetland" tidal pond would allow direct access to natural habitats.	Bikeway and trails routed within buffers.	Bikeway and trails routed adjacent to restored wetlands, "do touch wetland" tidal pond would allow direct access to natural habitats.
Relative Complexity of Regulatory/Permitting	Most complex. Minor wetlands impacts at F&G St. Marsh Entrance Channel, and new tidal connection would require regulatory approval.	Minimally complex. No wetlands impacts. Restoration focused in disturbed uplands.	Most complex. Minor wetlands impacts at F&G St. Marsh Entrance Channel, and new tidal connection would require regulatory approval.
Relative Costs	Maximum capital and moderate maintenance costs.	Minor capital and moderate maintenance costs.	Moderate/maximum capital and moderate maintenance costs.



Chula Vista Bayfront Enhancement . 140803

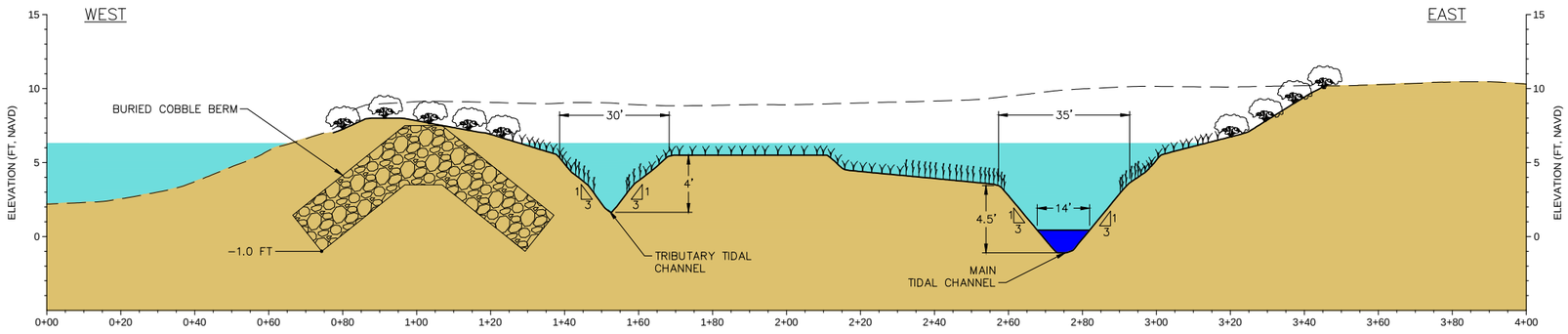
Figure 4-12

Recommended Alternative for Focus Area 3: Sweetwater District Shoreline



A "DO TOUCH" WETLAND TIDAL POND

Scale:
H: 1" = 40'
V: 1" = 10'

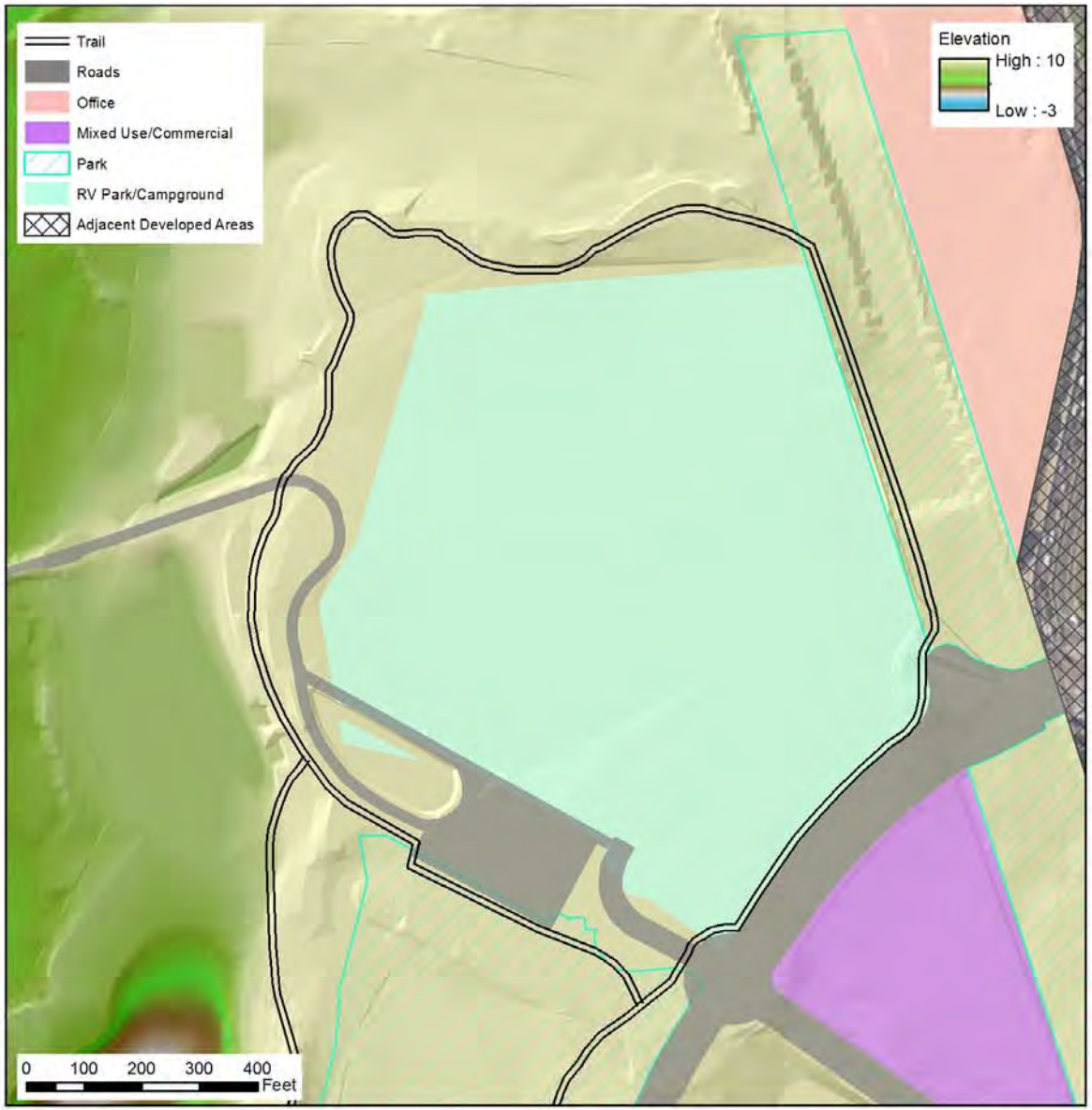


B SWEETWATER SHORELINE

Scale:
H: 1" = 40'
V: 1" = 10'

SOURCE:

Figure 4-13
Cross Sections for Focus Area 3
Sweetwater District Shoreline



N
W E
S

Focus Area 3: Sweetwater District Shoreline, Preliminary Alternative for Area North of Gunpowder Point Drive

Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 4-14

Merkel & Associates, Inc.

Tidal Pond and "Do Touch Wetland"

The tidal pond has been designed to provide shallow intertidal and subtidal habitat for shorebirds and other species and to support a fringe of low and mid marsh vegetation. The bottom of the pond would be set to -1.0 ft NAVD (-0.6 ft MLLW) while the channel entering the pond would have a base elevation of +1.0 ft NAVD (+1.4 ft MLLW), in order to provide a minimum of approximately two feet of water depth within the pond, even at low tide. To prevent erosion of the channel, a hardened sill would be installed to limit channel down-cutting. The sill would be installed under the public access trail, beneath the culverts or bridge designed at the opening to the tidal pond (Figure 4-12).

Using hydraulic geometry relationships, the channel feeding the tidal pond (Section 3.6) can be sized based on the tidal prism in the pond. The channel bottom would be set to +1.0 ft NAVD (+1.4 MLLW) to maintain water in the pond even during low tides (see Section 3.6). To achieve the appropriate channel cross-section, the channel would need to be wider than the predicted channel dimensions with a top width of 45 ft. Public access plans include a trail crossing over the tidal pond channel (Figure 6). This crossing could be achieved using a precast concrete bottomless arch culvert to provide habitat through the culvert and connectivity between the inboard and outboard marsh, similar to the conceptual design for the F&G Street Marsh Entrance Channel described in Section 4.2. The crossing could also be achieved with box culverts or a bridge.

Channel Layout and Dimensions

Channel cross-section dimensions and layouts were determined by using regional empirical relationships and mimicking historic or nearby reference channels, such as those in the adjacent Sweetwater/E Street Marsh. Hydraulic geometry relationships are empirical relationships between tidal prism or marsh area and channel geometry (e.g., channel depth, width, cross-sectional area). hydraulic geometry relationships have previously been developed for coastal salt marshes based on survey data collected in relatively undisturbed marshes in San Diego Bay and San Francisco Bay [ESA (formerly PWA) 1995].

Using these hydraulic geometry relationships, the channel system was sized to be third order for the area of marsh planned along the Sweetwater District Shoreline. A typical marsh with a bifurcation ratio of 3.5 (calculated as the number of channels at one order compared to the next higher order within the stream network) would produce one third order channel, four second order channels, and 12 first order channels within the proposed marsh area (Table 4-9). However, due to the area constraints of the marsh (long and narrow), the marsh was configured to include one third order channel and ten shorter second order channels. Table 4-9 provides a comparison of the designed and predicted channel lengths. Because first order channels are often smaller than can be constructed with typical construction equipment, they are not included in this design and are expected to form on their own.

Table 4-9. Number and Length of Channels within Focus Area 3: Sweetwater District Shoreline

Channel Order	Predicted Number of Channels	Predicted Length per Channel (ft)	Designed Number of Channels	Designed Length per Channel (ft)
3	1	2,500	1	2,300
2	4	800	10	200
1	12	400	n/a	n/a

Ideal channel dimensions were determined for each order of channel based on hydraulic geometry relationships. These dimensions are based on parabolic cross-sections which form in nature, but are difficult to construct by excavation. For feasibility purposes, a trapezoidal or V-shaped channel with side slopes no steeper than 2 or 3:1 (H:V) is typically constructed. Table 4-10 presents the channel dimensions based on the hydraulic geometry relationships in combination with engineering judgment for channel constructability. Natural channel scour and sediment deposition will adjust the channel side slopes and cross sectional geometry over time to more closely match the hydraulic geometry estimates. Figure 4-4 shows the location of cross-sections, and Figure 4-13 provides cross-section views within the tidal pond (Section A), and across the berm (Section B) within the restored area.

Table 4-10. Channel Dimensions within Focus Area 3: Sweetwater District Shoreline

	Depth (ft)	Top Width (ft)	Bottom Width (ft)	Slope	Cross Sectional Area (ft^2)
3rd Order Channels	6.1	58	6	3.2:1	253
2nd Order Channels	3.4	22	1	3:1	39

Marsh Berm

As described previously, the existing Sweetwater Shoreline within the NWR has a marsh berm at the edge of the shoreline. This feature has been simulated in recommended alternative for the Sweetwater District Shoreline, but the berm has been designed at a slightly higher elevation than the adjacent natural berm in order to provide additional wave protection and future sea level rise transgression habitat. During construction, the backside of the berm would be excavated, lined with cobble, and recontoured. This would help to minimize erosion and to maintain the integrity of the berm over time. It is anticipated that the berm would erode overtime due to overtopping at high tides, and from storm-driven waves. The cobble, when exposed over time as sediment erodes from the berm, would help reduce wave energy on the shoreline and be a natural reef-like feature. A cross-section of the berm is provided in Figure 4-13 (Section B).

Other Human Use Elements

The public access proposed for Signature Park adjacent to the Sweetwater Shoreline includes a trail system that would run along the edge of constructed wetlands and would cross over the channel leading to the tidal pond ("do touch wetland"). Preliminary concepts for the park also include a raised overlook located just south of the tidal pond within Signature Park. This would afford visitors an elevated, non-obstructed view of natural habitats. The tidal pond itself would provide accessible "do-touch" habitat for visitors to experience. The pond could be planned to include interpretive signage, overlooks, and a coarse grain beach facilitate access and educational opportunities. This wetland area would encourage visitors to experience wetlands without encroaching into adjacent natural habitats. The design of the trail system and overlooks for Signature Park is preliminary and has been included in this document to show the interface between the natural lands and park elements. The recommended alternative for Focus Area 3 should be modified as park design progresses to ensure continued integration of the two areas.

5.0 RESTORATION AND ENHANCEMENT ALTERNATIVES FOR THE OTAY DISTRICT

The Otay District of the Chula Vista Bayfront includes lands from the J Street Channel to the north, extending along the J Street Marsh to the former South Bay Power Plant intake and discharge channels, and continuing along the shoreline to the South Bay Salt Ponds. Areas considered in the following Plan analysis include the J Street Channel and Marsh, the Telegraph Creek Channel that terminates in the J Street Marsh, the deepwater portions and the shoreward terminus of the intake and discharge channels, the Chula Vista Wildlife Access Area dike, and the southern buffer extending to the salt ponds. These areas overlap in terms of hydrology, habitats, and planning and land use elements. Specific focus areas have been separated below; however, it is understood that, in many instances, design and restoration considerations for focus areas overlap. As such, while each focus area is discussed separately, graphics include the entire Otay District to provide context for planning. While restoration and enhancement may progress independently within many focus areas, it is beneficial for design and engineering, for permitting, and for project phasing, to consider the entire District as a single project. Plan phasing and priorities are discussed at the end of this document (Section 6).

5.1 FOCUS AREA 4 - SOUTH BAY POWER PLANT INTAKE AND DISCHARGE CHANNELS

5.1.1 Existing Conditions

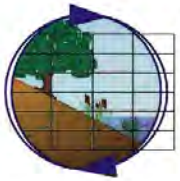
The South Bay Power Plant (SBPP) operated in south San Diego Bay for more than forty years. In support of plant operations, cooling water was drawn from San Diego Bay, circulated through the power plant's steam condensers, and discharged back into the Bay. An earthen dike constructed in the 1950s separated the cooling water intake channel to the north from the discharge channel to the south (Figure 5-1). The 300-foot wide intake channel was originally excavated through shallow bay and mudflat environments of the south Bay to a floor elevation of approximately -11.4 to -12.4 ft NAVD (-11.0 to -12.0 feet MLLW). Maintenance dredging was undertaken in 1992 to maintain channel depth; however, the channel has subsequently accreted approximately 3 feet of unconsolidated sediment in the channel bottom, resulting in current channel bottom depths of -8.4 to -9.4 ft NAVD (-8.0 to -9.0 feet MLLW). The SBPP was decommissioned in 2010 and removed in 2013.

Looking east at the terminus of the intake channel basin. A storm drain enters the north side of the basin midway down the rip rap.

Looking east at the terminus of discharge chanel basin. A storm drain enters the south side of the basin at the toe of the rip rap.

Looking south from discharge channel basin toward salt ponds.

Looking north from the intake basin toward the J Street Marsh.



Focus Area 4: South Bay Power Plant Intake and Discharge Channels, Existing Conditions

Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 5-1

Merkel & Associates, Inc.

The marine habitat within the intake and discharge channels consists of shallow subtidal unvegetated soft bottom habitat, subtidal vegetated habitat consisting of eelgrass (*Zostera marina*), and intertidal mudflats. The former SBPP intake channel is surrounded by eelgrass on both long axis sides and at the west end of the channel. Along the channel margins, eelgrass has extended down the channel slopes slightly to depths that generally extend to around -5.4 ft NAVD (-5.0 feet MLLW). Within the discharge channel, eelgrass occurs in small patches, becoming denser toward the bayward edge of the channel (Figure 5-1).

The former SBPP intake and discharge channels support a population of eastern Pacific green sea turtles (*Chelonia mydas*). Turtles were likely originally attracted to the area due to the above ambient water temperatures associated with discharge of warm water from the former SBPP into the Bay, and the abundance of eelgrass, a primary food source for green sea turtles. Water temperatures declined following closure of the SBPP; however, a resident turtle population of approximately 50 to 60 individuals continues to utilize the intake and discharge channels and adjacent south San Diego Bay eelgrass meadows (Eguchi et al. 2010, Madrak 2016).

Recently, 6.7 acres of the western section of the former SBPP intake channel were filled with sediment excavated to deepen waters within the BAE shipyard in central San Diego Bay. The dredged sediment was transported to south San Diego Bay and placed within the former SBPP intake channel in order to raise the channel bottom to an elevation appropriate for eelgrass mitigation. The bottom elevation was raised from approximately -9.4 ft NAVD (-9 feet MLLW) to -4.4 ft NAVD (-4 feet MLLW). Construction was completed in September 2016. Following a settlement period, the area will be planted with eelgrass in the spring of 2017.

The District's Chula Vista Wildlife Reserve (CVWR), an approximately 60 acre reserve constructed as a re-use of dredge material from the creation of the J Street Marina in Chula Vista, sits between the intake and discharge channels and is accessible only via the constructed earthen dike/roadway that separates the channels. The roadway is necessary to provide vehicle and equipment access to the CVWR for maintenance and resource management activities. The CVWR consists of southern coastal salt marsh habitat that intermittently supports the federal and state endangered Ridgway's rail (*Rallus obsoletus levipes*) and state endangered Belding's savannah sparrow (*Passerculus sandwichensis beldingi*), upland transition areas, and sandy nesting habitat for the federal and state endangered California least tern (*Sternula antillarum browni*).

5.1.2 Restoration and Enhancement Considerations

Table 5-1 summarizes habitat enhancement and restoration priorities for Focus Area 4: former SBPP Intake and Discharge Channels, and identifies opportunities and constraints unique to this focus area.

The intake and discharge channels were originally dredged to accommodate the cooling water needs for the SBPP. The primary restoration opportunity in this area would include filling the channels and raising the bottom to an elevation capable of supporting eelgrass habitat. This has recently been implemented for approximately 6.7 acres along the western end of the intake channel and could be accomplished for the remaining deep portions of the channel. Fill material could additionally be placed toward the terminus of the intake and discharge channels to create

Table 5-1. Priorities, Opportunities, and Constraints for Focus Area 4: South Bay Power Plant Intake and Discharge Channels

Priorities	Opportunities	Constraints
• Increase habitat connectivity between J Street Marsh and South Bay Salt Ponds • Create wetland transgression habitat for sea level rise • Protect shoreline and wetlands from adjacent human activity	• Substantially expand shallow subtidal habitat and eelgrass habitat through filling of channels. • Expand marsh habitat along shoreline and CVWR access road. • Utilize oyster reefs and living shorelines to protect adjacent marshes and intertidal habitats from coastal erosion and sea level rise. • Protect CVWR access road from erosion and effects of sea level rise	• Avoid impacts to population of green sea turtles that utilize the channels. • Must maintain CVWR access road. • Shoreline is a high wind wave energy environment. • Accommodate sea level rise without need to encroach on adjacent development pads. • Accommodate existing storm drains at terminus of intake and discharge channels with some modifications. • Future “blue technologies” considered by the District could require access to marine waters.

tidal flats and marsh habitat. This would allow for a marsh connection between the J Street Marsh to the north and the South Bay Salt Ponds to the south. Oyster reefs could be constructed along the tidal flats to provide natural protection from erosion and storm surge associated with climate change and sea level rise.

Any restoration and enhancement of the intake and discharge channels must not impact (directly or through habitat modification) the population of green sea turtles that have historically utilized and continue to utilize the channels.

There are several physical site considerations. Grading and habitat restoration within the upland buffers should be designed and accomplished in a manner to accommodate sea level rise transgression areas without the need to encroach into adjacent development pads. Further, multiple storm drains enter the sides and terminus of the intake and discharge channels. These should be incorporated into restoration design, rather than removed or re-located. Finally, the District has considered the development of “blue technologies”, such as aquaculture or marine laboratories within adjacent development. These would require access to marine waters and restoration alternatives should seek to incorporate this access.

5.1.3 Preliminary Restoration Alternatives

Figure 5-2 illustrates two conceptual alternatives for restoration and enhancement of the former South Bay Power Plant Intake and Discharge Channels. The main elements of each alternative are presented graphically; however, concepts presented in this graphic have not been engineered and are considered preliminary designs. The following text describes key design, engineering, cost, and regulatory elements for each alternative.

Alternative 1: Partial Eelgrass and Marsh Restoration

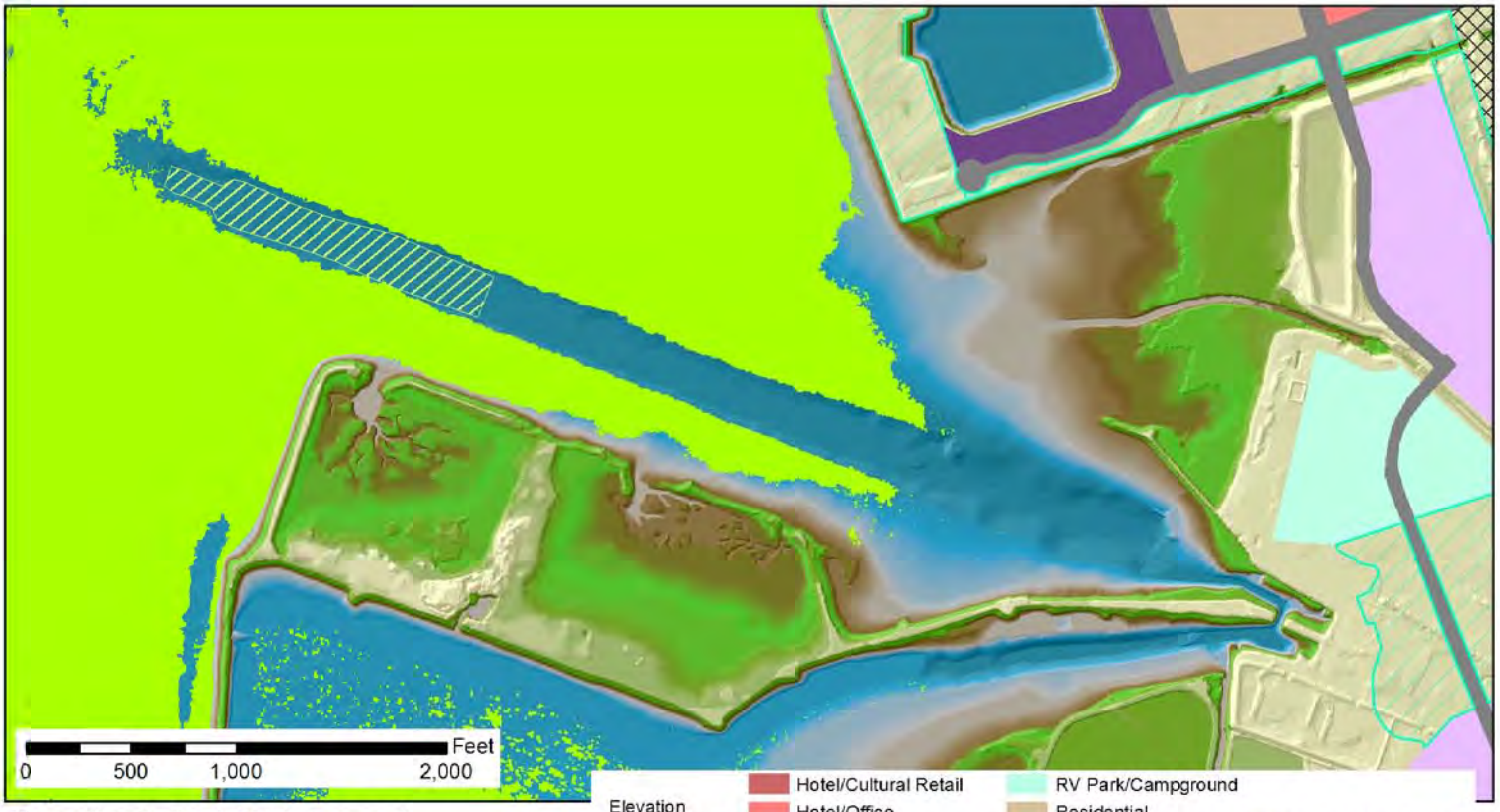
For Alternative 1, the former SBPP intake channel would be partially filled to raise the bottom elevation to a depth sufficient to support eelgrass restoration [between -4.4 and -5.4 ft NAVD (-4.0 and -5.0 ft MLLW)] (Figure 5-2). This has already been implemented, as described above, in order to mitigate eelgrass impacts associated with the Pier 1 Drydock project within the BAE Systems shipyard. No further fills would be implemented within the cooling water discharge channel.

Within the blind shoreward basins at the eastern edge of the intake and discharge channels, a modest amount of marsh habitat would be created by filling Bay waters. The marsh habitat would be constructed as a narrow fringe along the shoreline, and the existing storm drains would remain in place to feed into the marsh. Existing rip rap shoreline would be removed and the slopes would be cut back and graded to create high marsh and transitional habitat. The adjacent upland buffers would be graded and planted with native coastal sage scrub and maritime succulent scrub species. The slopes within the buffer would be graded in a manner to accommodate sea level rise without the need for future seawall construction or grading within the adjacent development parcels.

The primary benefit of Alternative 1 is that it would provide a cost effective means to increase eelgrass habitat by up to 7 acres within south San Diego Bay, and would modestly improve connectivity of the marsh at J Street and Telegraph Creek, and with the NWR salt ponds to the south. However, this alternative would not provide the maximum intertidal marsh habitat and connectivity would consist of a small marsh fringe. An additional benefit of Alternative 1 is that it would maintain a large portion of the intake and discharge channels as deeper water habitat for sea turtles, which are known to congregate within the channels.

Alternative 2: Full Eelgrass and Marsh Restoration

For Alternative 2, the entire intake channel would be filled and raised to between -4 and -5 feet MLLW to allow up to 30 acres of eelgrass restoration (Figure 5-2). The intake and discharge channel basins would be filled to create coastal salt marsh and intertidal habitat. Within the intake channel basin, the fill would extend along the CVWR earthen access dike to the south, and along the rip rap dike that protects the J Street Marsh to the north in order to allow for maximum connectivity between marshes. Within the discharge channel basin, fill would be confined to the basin itself, with minimal additional habitat added along the CVWR access dike. Oyster reef modules would be constructed along the intertidal shorelines of both the intake and discharge basins, and along the intertidal flats of J Street Marsh. These reefs would provide habitat for native Olympia oyster (*Ostrea lurida*), and would provide shoreline protection via wave and storm surge attenuation. Reef design would draw from lessons learned as part of the San Diego Bay Native Oyster Restoration Program, currently underway (Merkel and Associates et al. 2015).



Alternative 1: Partial Eelgrass and Marsh Restoration

Alternative 2: Full Eelgrass and Marsh Restoration

Focus Area 4: South Bay Power Plant Intake and Discharge Channels, Two Preliminary Alternatives

Restoration and Enhancement of the Chula Vista Bayfront, Chula Vista, CA

Figure 5-2

The created channel system in both the intake and discharge basins would tie into the existing storm drains. As with Alternative 1, the existing rip rap within the basins would be removed and the slopes would be cut back and graded to create high marsh and transitional habitat. Adjacent upland buffers would be graded and planted with native coastal sage scrub and maritime succulent scrub species.

The primary benefit of Alternative 2 is that it would maximize habitat creation of shallow subtidal eelgrass habitat, as well as of coastal salt marsh and intertidal habitat. The restored habitat would greatly improve connectivity of the marsh at J Street and Telegraph Creek with the NWR South Bay Salt Ponds to the south. This alternative would be costly to implement and may require both land-side construction and more costly water-side construction, including placement of a temporary earthen dike across the intake and discharge channels during project construction to contain and consolidate fill material. Further, this alternative would fill the entire intake channel, which is known to support a population of green sea turtles. This alternative would also fix restoration options for the cooling water intake and discharge basins, as restoration would encompass the basins in their entirety, precluding any future restoration planning.

5.1.4 Recommended Conceptual Design Alternative for Focus Area 4

The features of each of the two preliminary alternatives considered for Focus Area 4 are compared relative to each other and summarized in Table 5-2. Based on this analysis and feedback received from the WAG, the recommended conceptual design alternative for Focus Area 4 is a modified version of Alternative 1. For this modified Alternative 1, the western portion intake channel would be filled to create eelgrass habitat. This has already been completed, as described above. The remainder of the intake channel would remain unfilled in order to provide habitat for green sea turtles that are known to currently occupy this area. Because no additional fills or work is planned for the deep water portions of the intake and discharge channels, the figures provided below only illustrate restoration and enhancement recommended for the shoreward terminus (basins) of the intake and discharge channels and do not include the outer bayward portions of the channels.

The terminus basins of the intake and discharge channels would receive fill material to create a moderate amount of intertidal flats and marsh habitat. However, extensive tidal flats would not be created along the CVWR access dike, as contemplated in the preliminary conceptual Alternative 2. Existing rip rap shoreline would be removed and the slopes of the terminus basins would be cut back and graded to create high marsh and transitional habitat. Existing storm drains would be incorporated into the design to feed into created marshlands. As a substantial slope reconfiguration is considered within the terminus of the intake and discharge channels, some of the storm drains (particularly those along the northeastern end of the intake channel) may require modification (Figure 5-3). If it is not possible to leave the storm drain pipes in place, the pipes would be cut to grade, so that they do not extend into created marshlands. Upland habitat within the buffer areas would be graded and planted with native coastal sage scrub and maritime succulent scrub species as described for preliminary conceptual Alternative 1. Oyster reefs would be placed along both shorelines of the intake channel basin, to protect created intertidal habitats from waves and storm surge. Additional reefs would be placed along the tidal flats of the J Street Marsh. As described above, the design and construction of reefs would draw from lessons learned as part of the San Diego Bay Native Oyster Restoration Program.

Table 5-2. Summary of Restoration and Enhancement Alternatives for Focus Area 4: South Bay Power Plant Intake and Discharge Channels.

PROJECT ELEMENT	PRELIMINARY RESTORATION ALTERNATIVE		
	Alternative 1: Partial Eelgrass and Marsh Restoration	**Alternative 2: Full Eelgrass and Marsh Restoration**	**Modified Alternative 1: Partial Eelgrass and More Extensive Marsh Restoration**
Habitat Creation	Moderate eelgrass restored in former SBPP intake channel. Moderate marsh habitat created via fill of intake and discharge channels. Minor uplands restored along buffer slopes.	Maximum eelgrass restored in former SBPP intake channel. Maximum marsh habitat created via fill of intake and discharge channels. Minor uplands restored along buffer slopes.	Moderate eelgrass restored in former SBPP intake channel. Moderate marsh habitat created via fill of intake and discharge channels. Minor uplands restored along buffer slopes.
Hydrology	Moderate change due to fill of bay waters to create shallow subtidal eelgrass beds and tidal wetlands.	Maximum change due to fill of bay waters to create shallow subtidal eelgrass beds and tidal wetlands.	Moderate change due to fill of bay waters to create shallow subtidal eelgrass beds and tidal wetlands.
Protection of Natural Habitats	Restored wetlands would be protected by fencing installed in buffers of Otay District.	Restored wetlands would be protected by fencing installed in buffers of Otay District.	Restored wetlands would be protected by fencing installed in buffers of Otay District.
Recreation and Education	Unknown. Future planning within Otay District should incorporate educational and recreational opportunities.	Unknown. Future planning within Otay District should incorporate educational and recreational opportunities.	Unknown. Future planning within Otay District should incorporate educational and recreational opportunities.
Relative Complexity of Regulatory/Permitting	Moderate complexity. Fill of tidal waters would require regulatory approval. Potential impacts to sea turtles must be addressed.	Maximum complexity. Fill of tidal waters would require regulatory approval. Potential impacts to sea turtles must be addressed.	Moderate complexity. Fill of tidal waters would require regulatory approval. Potential impacts to sea turtles must be addressed.
Relative Costs	Moderate capital and maintenance costs.	Maximum capital and moderate maintenance costs.	Moderate capital and maintenance costs.

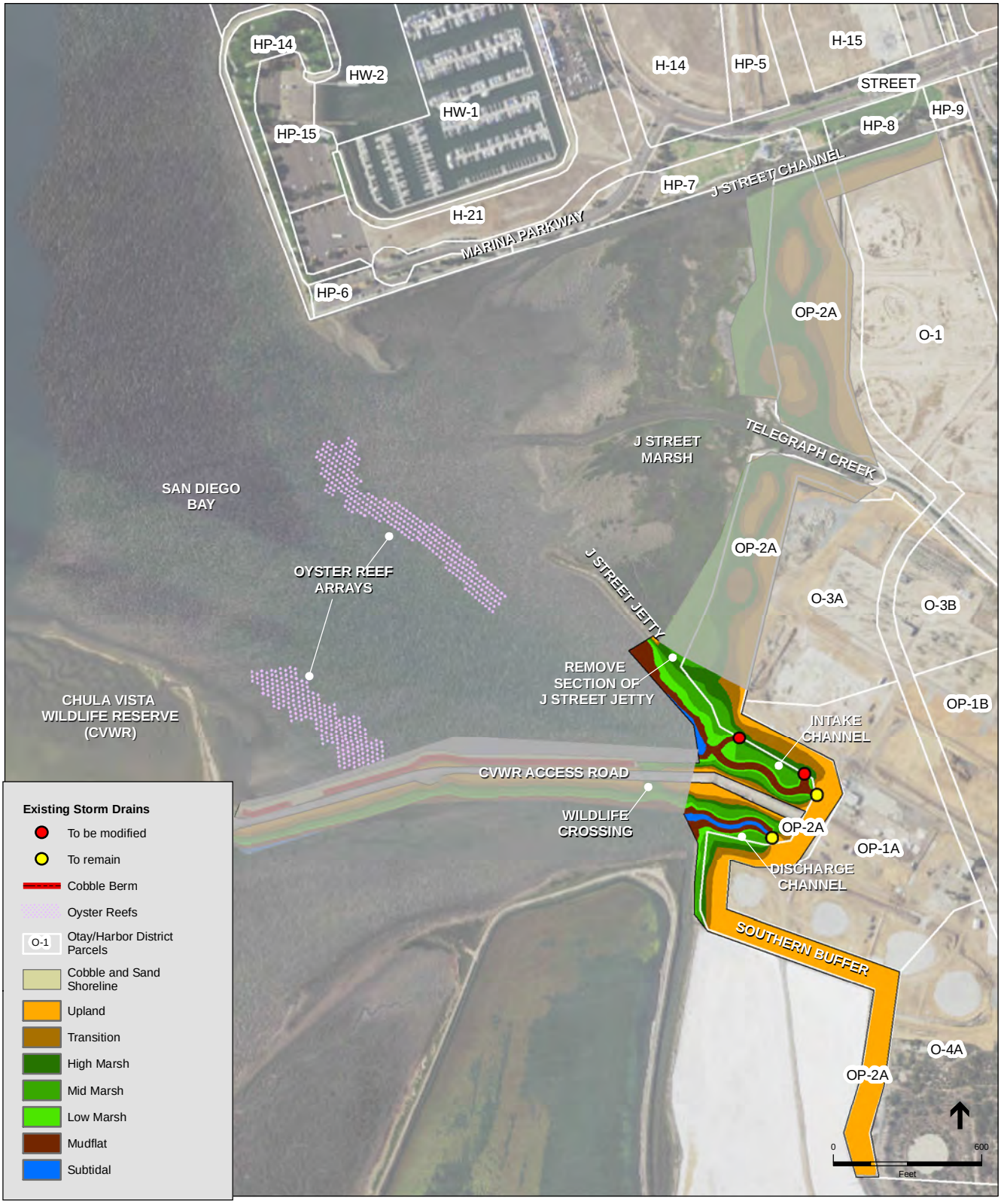


Figure 5-3

Recommended Alternative for Focus Area 4:
South Bay Power Plant Intake and Discharge Channels

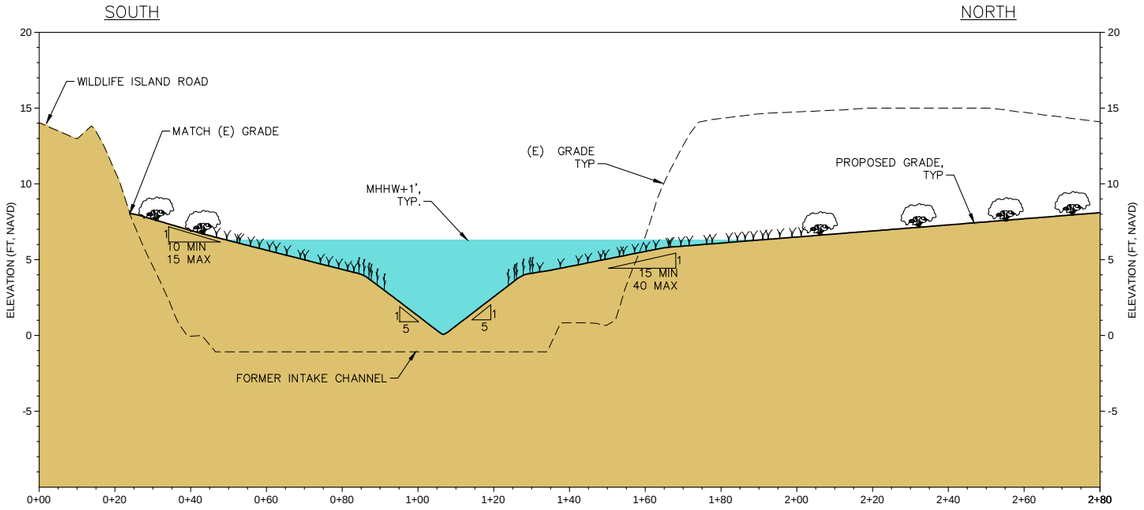
Print Date: 1/10/2017

File: G:\D14XXX\D140803.00 - Chula Vista Bayfront Enhancement\10 CAD\Dwgs\Sheets_Otay\PLAN.dwg

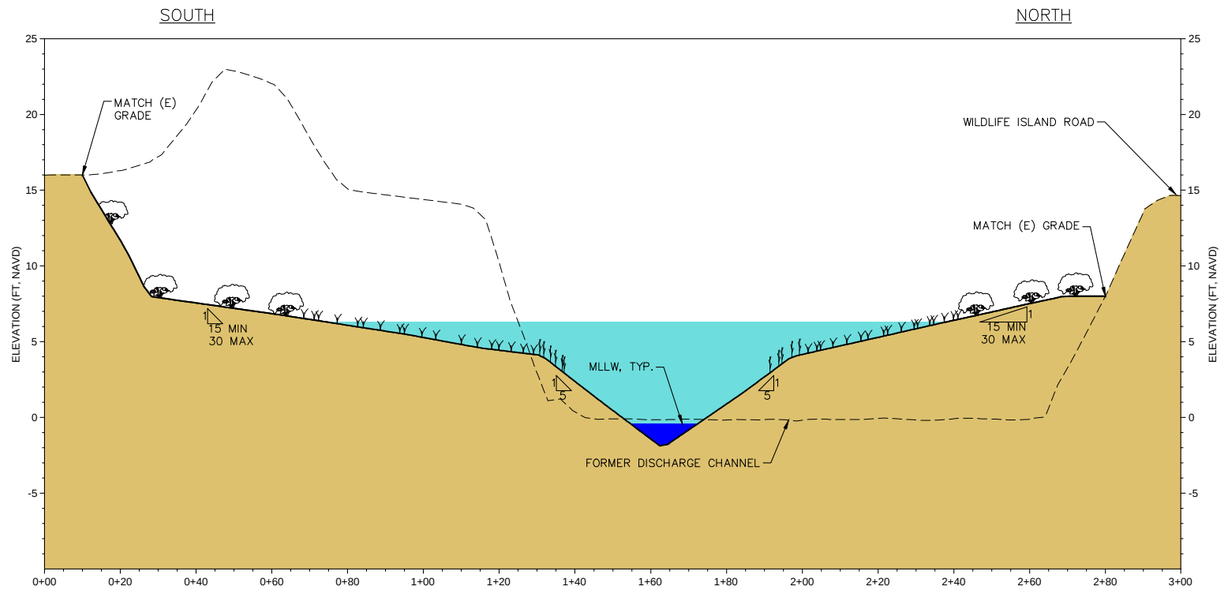
SOURCE: SOURCE:

Figure 5-4

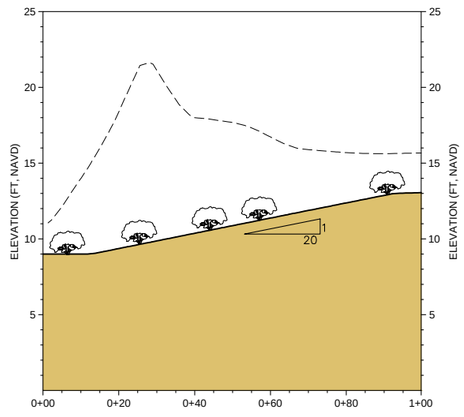
Grading Plan and Cross-section Locations for Restoration and Enhancement of the Otay District



E INTAKE CHANNEL - GRADING SECTION
Scale:
H: 1" = 40'
V: 1" = 10'



F DISCHARGE CHANNEL - GRADING SECTION
Scale:
H: 1" = 40'
V: 1" = 10'



G SOUTHERN BUFFER - GRADING SECTION
Scale:
H: 1" = 40'
V: 1" = 10'

SOURCE:

Figure 5-5
Cross-sections for Focus Area 4
South Bay Power Plant Intake and Discharge Channels

This modified alternative would allow for a moderate amount of habitat creation (both eelgrass, tidal flats, and marsh habitats), but would still retain deeper water habitat within the intake and discharge channels for use by sea turtles, and would accommodate water draw for potential "blue technology" within adjacent development parcels. Project costs for this modified alternative would fall between estimated costs for original Alternatives 1 and 2. Figures 5-3 through 5-5 provide the conceptual design overview, grading, and cross-sections for this recommended alternative. The following text describes specific design elements.

Marsh Design, Elevations, and Grading

The marsh zone elevations utilized for the recommended alternative for Focus Area 4 are based on the habitat elevations described in Section 3.3. Channels within the restored marshland were aligned to accommodate existing storm drains such that storm drains would drain into adjacent marshland. Figure 5-3 shows locations of existing storm drains. However, detailed culvert and drainage information was unavailable for this planning process, and future design and engineering revisions should optimize channel size and location to provide sufficient drainage. As indicated above, the cut and re-grading of slopes within the terminus of the intake and discharge channels could require modifications to some storm drains. Modifications might include reducing length of storm drain pipes to meet design grades.

Figure 5-4 shows the location of cross-sections, and Figure 5-5 provides cross-section views of the restored intake (Section E) and discharge (Section F) channels. Within the intake (northern) channel, the marsh would slope at a 5:1 (H:V) ratio from approximately 0 ft NAVD (+0.4 ft MLLW) to +4.0 ft NAVD (+4.4 ft MLLW), and would then flatten to a 10 to 15:1 (H:V) slope on the south side and a 15 to 40:1 (H:V) slope on the north side. The discharge (southern) channel would slope at a 5:1 (H:V) ratio from approximately -2.0 ft NAVD (-1.6 ft MLLW) to +4.0 ft NAVD (+4.4 ft MLLW) and then flatten to a 15 to 30:1 (H:V) slope along the north and south sides of the channel. The slopes south of the discharge channel stretching toward the South Bay Salt Ponds would be set back to slope from +9.0 to +13.0 ft NAVD (+9.4 to +13.4 MLLW) with a 20:1 (H:V) slope (Figure 5-4, Section G). These upland areas, called the Southern Buffer, would serve as buffers between restored wetlands and adjacent development parcels, and would also serve as marsh transgression areas for sea level rise.

Within the Focus Area 4, sediment excavated from slopes would be placed to fill the shoreward terminus basins of the former SBPP intake and discharge channels to create intertidal flats and marsh habitat. Sediment would be excavated and placed using land-side equipment as this would provide the most flexibility for construction, would eliminate tidal restrictions for work, and would be cost effective. Shoreline armoring would be removed so that upland slopes could be graded.

Oyster Reefs

To help reduce erosion along the restored former SBPP intake and discharge channels, as well as along the adjacent J Street Marsh and the CVWR access road, oyster reef arrays would be constructed within the SBPP intake channel along the J Street Marsh jetty as well as along to the north of the CVWR access road (Figure 5-3). The arrays would be placed at a base elevation of between the -1.4 and -0.4 ft NAVD (between -1.0 ft and 0 ft MLLW) contours to maximize habitat protection and wave energy reduction. Reef design and placement elevations would draw from

lessons learned as part of the San Diego Bay Native Oyster Restoration Program, currently underway (Merkel and Associates et al. 2015).

5.2 Focus Area 5. Chula Vista Wildlife Reserve Access Area

5.2.1 Existing Conditions

As described above, the Chula Vista Wildlife Reserve (CVWR) sits between the former SBPP intake and discharge channels and is bordered along its southern boundary by the earthen dike created to separate the channels (Figure 5-6). The CVWR is accessed through a chain link gate on the decommissioned SBPP property via a roadway along the dike. The dike, which was originally constructed to separate former SBPP intake and discharge channels, is comprised of undocumented fill material including sandy soils and cobble. The dike is bordered by intertidal mudflat and shallow subtidal habitat within the adjacent SBPP intake and discharge channels.

The dike is not uniformly armored along its length. The eastern portion of the dike that serves as the access roadway onto the CVWR from the Chula Vista Bayfront is intermittently armored with rip rap and concrete rubble; however, portions of dike in this area are eroding, and are susceptible to overtopping during high spring, or king, tides. As the dike continues to erode, the roadway will become narrower, with vertical drop offs to the adjacent intertidal mudflats. Further, the chain link gate provides the only protection from terrestrial predators for the federal and state endangered California least terns.

This area has been included as a separate focus area due to its unique condition and because multiple restoration alternatives are possible for this area, independent of the adjacent restoration and enhancement of the former SBPP intake and discharge channels.

5.2.2 Restoration and Enhancement Considerations

Table 5-3 summarizes habitat enhancement and restoration priorities for Focus Area 5: the CVWR Access Area, and identifies opportunities and constraints unique to this focus area.

Table 5-3. Priorities, Opportunities, and Constraints for Focus Area 5: Chula Vista Wildlife Reserve Access Area

Priorities	Opportunities	Constraints
• Increase habitat connectivity between J Street Marsh and South Bay Salt Ponds • Protect CVWR access road from erosion and effects of sea level rise	• Expand marsh habitat along CVWR access road. • Create a marsh connection via a bridge or culvert along CVWR access road. • Restrict predator access to CVWR via installed bridge or culvert. • Accommodate marine water intake along modified roadway to support "blue technologies"	• Must maintain roadway access to CVWR. • Avoid impacts to population of green sea turtles that utilize the intake and discharge channels. • Shoreline is a high wind wave energy environment. • Current roadway does not accommodate current sea level rise predictions

The primary restoration enhancement priority for the CVWR Access Area is to provide a direct habitat linkage between the J Street Marsh and South Bay Salt Ponds. Currently, these marshlands are not connected due to presence of the deepwater SBPP intake and discharge channels and the CVWR access dike/roadway. An additional priority is to maintain a roadway connection to the CVWR in order to conduct maintenance and resource management activities.

Opportunity exists to install a bridge or culvert along the CVWR access road that would allow for a marsh connection along the bayfront, and that would reduce and control access of land-based predators to the CVWR. If possible, modifications to the roadway should accommodate a marine water intake pipe that could be used to draw water from the bay for "blue technologies" (e.g. aquaculture and marine laboratories) contemplated by the District on adjacent development parcels of the Otay District. There is further opportunity to stabilize and widen the roadway as protection from erosion and sea level rise. Restoration and enhancement within this focus area must consider and protect the population of green sea turtles known to utilize the adjacent SBPP intake and discharge channels.

5.2.3 Preliminary Restoration Alternatives

Two initial restoration alternatives were prepared for the CVWR Access Area. The following text describes key design, engineering, relative cost, and regulatory elements for each alternative. Figure 5-7 illustrates preliminary conceptual alternatives for this focus area. For continuity, this figure also illustrates potential restoration of the terminus of the former SBPP intake and discharge channels. However, the following text describes specifically the alternatives considered for the CVWR Access Area. The main elements of each alternative are presented graphically; however, concepts presented in this graphic have not been engineered and are considered preliminary designs.

Looking east toward the decommissioned SBPP along the constructed dike that serves at the roadway access to CVWR. The roadbed is not uniformly armored and is eroding.

Looking west along the same portion of roadway. Presence of marine wrack is indicative of overtopping of the dike/ roadway during king tides.

N W E S

Focus Area 5: Chula Vista Wildlife Reserve Access Area, Existing Conditions

Restoration and Enhancement of the Chula Vista Bayfront, Chula Vista, CA

Figure 5-6

Merkel & Associates, Inc.

Alternative 1: Partial Marsh Restoration and Construction of CVWR Access Bridge

Alternative 2: Full Marsh Restoration and Installation of Grated Crossing to CVWR

Focus Area 5: Chula Vista Wildlife Reserve Access Area, Two Preliminay Alternatives

Restoration and Enhancement of the Chula Vista Bayfront, Chula Vista, CA

Figure 5-7

Merkel & Associates, Inc.

Alternative 1 Partial Marsh Restoration and Construction of CVWR Access Bridge

For Alternative 1, a narrow band of tidal flats and marsh habitat would be created along the shoreline of the CVWR access road (Figure 5-7). This habitat would extend and connect to habitat created within the terminus of the intake and discharge channels. While this marsh fringe would not provide breeding habitat for sensitive avian species, it would provide a passable marsh connection between J Street Marsh to the north and the South Bay Salt Ponds, to the south.

A section of the CVWR access road would be removed and replaced with a bridge. Shoreline armoring would be installed along the bridge footings and adjacent CVWR roadway to stabilize and protect the roadway and constructed bridge from erosion. The area immediately underneath the bridge would be excavated to create a shallow subtidal channel with fringing tidal flats and marsh habitat. Fencing would be tied into the eastern side of the bridge. The subtidal channel would restrict access of land-based predators (e.g. coyote, raccoons, feral cats, etc.) to adjacent CVWR lands, but would still provide a tidal and marsh connection for shorebirds and marsh birds.

The primary benefit of Alternative 1 is that it would improve connectivity of wetlands within south San Diego Bay. It would also afford predator protection for nesting California least terns on the CVWR. However, the bridge would be costly to build, and would not address the long-term erosion and sea level rise flooding that could de-stabilize the CVWR road in the future.

Alternative 2 Full Marsh Restoration and Installation of Grated Crossing to CVWR

For Alterative 2, the shoreline of the CVWR access road would receive a greater amount of fill to create expanded tidal flats and marshland (Figure 5-7). This created marsh habitat would provide a wider, higher quality marsh habitat connection between J Street Marsh, the terminus of the former SBPP intake and discharge channels, and the South Bay Salt Ponds.

Instead of an elevated bridge, a section of the CVWR access road would be removed and replaced with a series of box culverts with a cattle guard surface. This surface would allow for light penetration to marsh habitat at the bottom of the culverts. Fencing would be tied to the ends of the box culverts along the southern side of the CVWR access road.

Like Alternative 1, the primary benefits of Alternative 2 are that it would provide a habitat connection between J Street Marsh and the South Bay Salt Ponds, and would restrict access of land-based predators to the CVWR. Further, installation of the box culverts would be more cost effective than bridge construction. This alternative would require a geotechnical analysis for final design and engineering prior to installation in order to address any

Example of a bridge crossing (top) and box culvert with cattle guard (bottom) that could be used to control predators and provide a marsh connection along the CVWR access road.

issues related to sediment conditions, and erosion/scour. Alternative 2 would result in a more extensive fill of the intake and discharge channels along the CVWR access road, which is known to support a population of green sea turtles. Further, this alternative would not address the long-term erosion and sea level rise flooding that could de-stabilize the CVWR road in the future.

5.2.4 Recommended Conceptual Design Alternative for Focus Area 5

The features of each of the two preliminary alternatives considered for Focus Area 5 are compared relative to each other and summarized in Table 5-4. Based on this analysis, and feedback received from the WAG, the recommended conceptual design alternative for Focus Area 5 is a modified version of Alternative 2.

Figures 5-8 and 5-9 provide the conceptual design overview, grading, and cross-sections for this recommended alternative. Figure 5-4 provides the locations of cross-sections. Figure 5-9 provides cross-section views of the restored CVWR access road (Section A) and wildlife passage culvert (Section B). For this modified Alternative, a narrow band of tidal flats and marsh habitat would be created along the shoreline of the CVWR access road. This would transition to maritime succulent scrub habitat toward the top of the slope (indicated in the figure as "transition and upland" and represented by low relief shrub icons). The road itself would be widened to approximately 32 feet wide at its current elevation of approximately +10.0 ft NAVD (+10.4 ft MLLW). A cobble and sand berm would be installed on the north side of the road (similar to the berm described in Section 4.3 for Sweetwater Shoreline). The berm would reduce wave energy reaching the road along the higher energy side of the shoreline, and would reduce erosion. If the road access is to be maintained to the CVWR into the future, the road will likely need to be raised to accommodate sea level rise. Elevating the roadway is not a part of the current design; however, stabilizing and widening the existing roadway, as designed for this recommended alternative, will provide the road base necessary to add fill and elevate the roadway in the future. Further, a marine water intake pipe could be installed and buried within the widened roadway to support "blue technologies" contemplated by the District on adjacent development parcels of the Otay District.

Tidal flats and marsh habitat would be created along the south side of the CVWR access road within the former SBPP discharge channel using fill material generated from excavation along the Southern Buffer and J Street Marsh (as described in Sections 5.1 and 5.3). Sediment would be placed to create habitat using land-side equipment as this would provide the most flexibility for construction, would eliminate tidal restrictions for work, and would be cost effective. Typical land-side construction equipment has a reach of approximately 60 ft; so to create the most habitat, a 3:1 (H:V) slope would be built from the road surface down to and elevation of +7.0 ft NAVD (+7.4 ft MLLW), where a 12 ft wide bench would be constructed (Figure 5-9, Section A). From this bench, excavators could reach 60 ft out to place additional material, resulting in a 15:1 (H:V) slope from the bench down to approximately +4.0 ft NAVD (+4.4 ft MLLW). The bench and upper slope would be vegetated with transition zone species, and the habitat below the bench would support mid and low marsh habitat.

Table 5-4. Summary of Restoration and Enhancement Alternatives for Focus Area 5: Chula Vista Wildlife Reserve Access Area.

PROJECT ELEMENT	PRELIMINARY RESTORATION ALTERNATIVE		
	Alternative 1 Partial Marsh Restoration and Construction of CVWR Access Bridge	**Alternative 2 Full Marsh Restoration and Installation of Grated Crossing to CVWR**	**Modified Alternative 2: Partial Marsh Restoration, Stabilization of CVWR Road, and Installation of Grated Crossing to CVWR**
Habitat Creation	Moderate marsh habitat restored via fill of intake and discharge channels along CVWR access road. No uplands restored.	Maximum marsh habitat restored via fill of intake and discharge channels along CVWR access road. No uplands restored.	Moderate marsh habitat restored via fill of intake and discharge channels along CVWR access road. No uplands restored.
Hydrology	Moderate change due to fill of bay waters to create tidal wetlands.	Maximum change due to fill of bay waters to create tidal wetlands.	Moderate change due to fill of bay waters to create tidal wetlands.
Protection of Natural Habitats	Restored wetlands would be protected by fencing installed in buffers of Otay District and along CVWR roadway. Subtidal channel beneath access bridge would serve as "moat" to restrict access to CVWR.	Restored wetlands would be protected by fencing installed in buffers of Otay District and along CVWR roadway. Intertidal channel beneath grated crossing would serve as "moat" to restrict access to CVWR.	Restored wetlands would be protected by fencing installed in buffers of Otay District and along CVWR roadway. Intertidal channel beneath grated crossing would serve as "moat" to restrict access to CVWR.
Recreation and Education	No public access to CVWR area.	No public access to CVWR area.	No public access to CVWR area.
Relative Complexity of Regulatory/Permitting	Moderate complexity. Fill of tidal waters and bridge construction would require regulatory approval. Potential impacts to sea turtles must be addressed.	Maximum complexity. Fill of tidal waters and grated culvert crossing would require regulatory approval. Potential impacts to sea turtles must be addressed.	Moderate complexity. Fill of tidal waters and grated culvert crossing would require regulatory approval. Potential impacts to sea turtles must be addressed.
Relative Costs	Maximum capital and moderate maintenance costs.	Moderate capital and maintenance costs.	Moderate/maximum capital and moderate maintenance costs.

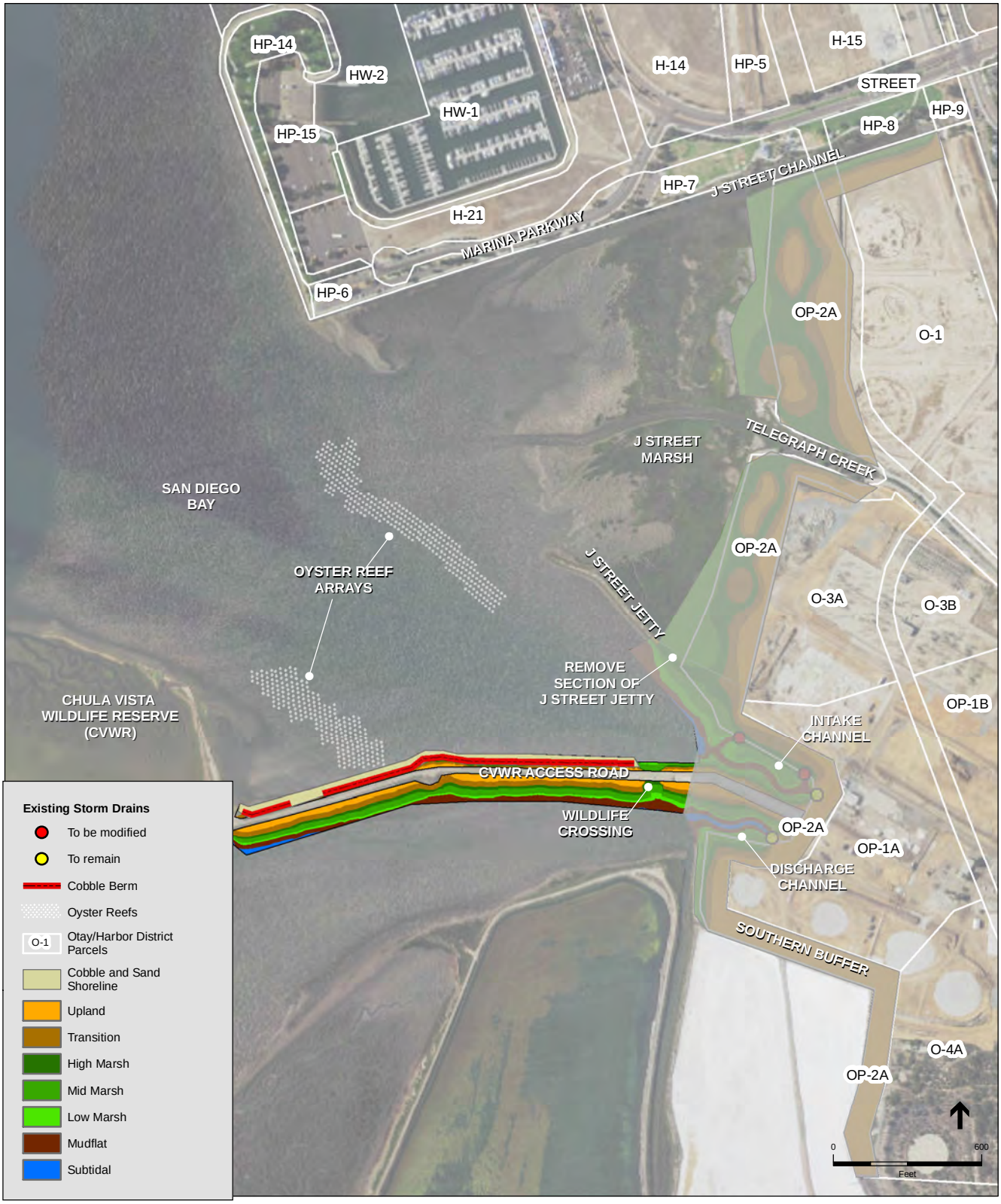
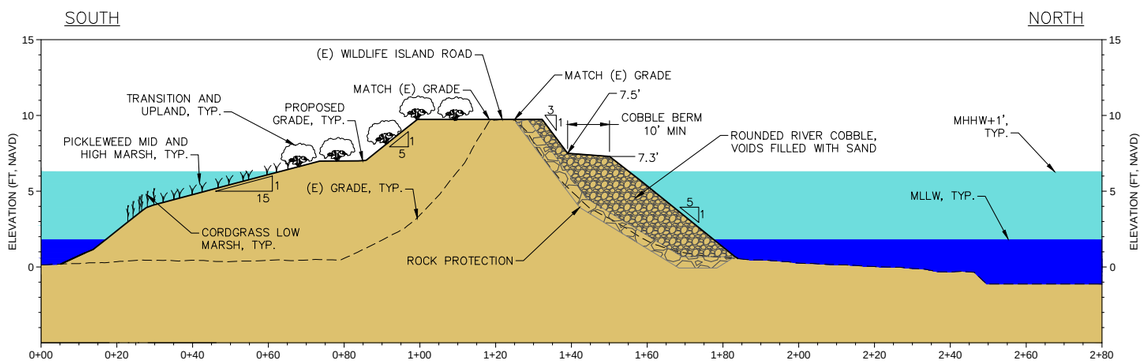
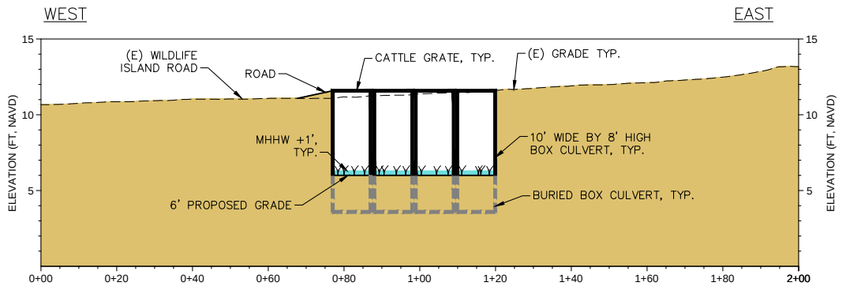


Figure 5-8
Recommended Alternative for Focus Area 5:
Chula Vista Wildlife Reserve Access Area



A CHULA VISTA WILDLIFE RESERVE ACCESS ROAD

Scale:
H: 1" = 40'
V: 1" = 10'



B CHULA VISTA WILDLIFE RESERVE ACCESS ROAD - GRATED CULVERTS

Scale:
H: 1" = 40'
V: 1" = 10'

SOURCE:

To provide habitat connectivity, a part of the road would be excavated and replaced with culverts to allow wildlife passage beneath the road (Figure 5-9, Section B). The culverts would be topped with cattle grates that would allow light penetration to marsh habitat beneath the road. The area in the vicinity of the culverts would be graded to high marsh elevations to minimize erosive tidal flows through the area, and four 10-ft box culverts would be installed. While this would not be as effective as a subtidal channel at reducing access to predators, it would be more effective than an unbroken roadway. The grates would also serve to restrict access of land-based predators to the CVWR.

5.3 Focus Area 6. J Street Channel and Marsh

5.3.1 Existing Conditions

The J Street Marsh is located immediately south of the J Street Marina, and north of the former SBPP intake channel (Figure 5-10). The marsh is partially protected by the rip rap jetty constructed along the north side of the former SBPP intake channel. The primary sources of freshwater and sediment to the marsh are the J Street Channel and Telegraph Creek.

The J Street Channel is a concrete-lined channel that runs along Interstate 5 in Chula Vista. The channel makes a ninety degree turn just south of J Street and then heads west to the San Diego Bay along the southern edge of the J Street Marina. The lined portion of the channel is unvegetated. The concrete liner terminates west of Bay Boulevard, and the final approximately 0.5 miles of the channel runs along the northern edge of the J Street Marsh to San Diego Bay.

5.3.2 Restoration and Enhancement Considerations

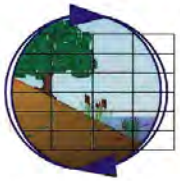
Table 5-5 summarizes habitat enhancement and restoration priorities for Focus Area 6: the J Street Channel and Marsh, and identifies opportunities and constraints unique to this focus area.

The primary restoration priority for Focus Area 6 is to increase wetland habitat and improve water quality by removing concrete channel lining along J Street Channel. A further priority is to expand marsh habitat and provide sea level rise transgression areas within the buffers of the Otay District that abut J Street Marsh. While opportunities exist to achieve some of these objectives, downstream modifications cannot increase flood risk along the J Street Channel. Further, the J Street Channel is constrained by development along its length, including the development within the Harbor District of the Chula Vista Bayfront Planning Area. Finally, grading and habitat restoration within the upland buffers must be designed and accomplished in a manner to accommodate sea level rise transgression areas without the need to encroach into adjacent development pads.

Looking upstream (east) along the J Street Channel, which is unlined in this area and bordered by the J Street Marsh to the south.

Looking southeast at the sandbar and mudflat at the bayward terminus of the J Street Channel. The J Street Marsh is visible in the background.

Looking west along the concrete lined portion of the J Street Channel.



Focus Area 6: J Street Channel and Marsh, Existing Conditions
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 5-10

Merkel & Associates, Inc.

Table 5-5. Priorities, Opportunities, and Constraints for Focus Area 6: J Street Channel and Marsh

Priorities	Opportunities	Constraints
• Remove the concrete; channel armoring to widen the J Street Channel • Create additional marsh habitat within J Street Channel and Marsh • Create sea level rise transgression areas in buffers of Otay District	• Expand marsh habitat by grading slopes along south side of J Street Channel • Expand marsh habitat and provide sea level rise transgression areas for J Street Marsh	• Must maintain flood control function of J Street Channel and cannot increase risk of flooding. • J Street Channel is constrained by J Street and Marina View Park to the north • Buffers should accommodate sea level rise without need to encroach on adjacent development pads.

5.3.3 Preliminary Restoration Alternatives

Alternative 1: Grade Southern Slopes of J Street Channel and Marsh Buffers to Create Marsh Habitat and Sea Level Rise Transgression Areas

Due to the development constraints described above, only a single restoration and enhancement alternative was developed for Focus Area 6: J Street Channel and Marsh (Figure 5-11). For this alternative, the southern slopes of the J Street Channel and the buffer slopes along the J Street Marsh would be excavated and graded to create additional marsh, transitional, and upland habitat. The north side of the J Street Channel would not be modified as it is steeply sloped and armored to protect the adjacent road and parklands to the north of the channel.

5.3.4 Recommended Conceptual Design Alternative for Focus Area 6

The features of the preliminary alternative considered for Focus Area 6 are summarized in Table 5-6. Based on this analysis and feedback received from the WAG, the recommended conceptual design alternative for Focus Area 6 is Alternative 1. The following text describes specific design elements.

Table 5-6. Summary of Restoration and Enhancement Alternative for Focus Area 6: J Street Channel and Marsh.

PROJECT ELEMENT	PRELIMINARY RESTORATION ALTERNATIVE		
	Alternative 1: Grade Southern Slopes of J Street Channel and Marsh Buffers to Create Marsh Habitat and Sea Level Rise Transgression Areas		
Habitat Creation	Maximum wetlands restored along southern shore of J Street Channel and in buffers adjacent to J Street Marsh. Minor uplands restored on graded slopes.		
Hydrology	Minor change. Increase in tidal prism within restored wetlands. Restored wetlands may make maintenance of the drainage channel more challenging.		
Protection of Natural Habitats	Restored wetlands would be protected by fencing installed in buffers of Otay District.		
Recreation and Education	Unknown. Future planning within Otay District should incorporate educational and recreational opportunities.		
Relative Complexity of Regulatory/Permitting	Moderate complexity. No sensitive species impacts. Minor impacts to wetlands or non-wetland waters during excavation. Restoration of wetlands would require regulatory approval.		
Relative Costs	Moderate capital and maintenance costs.		

N
W
E
S

Focus Area 6: J Street Channel and Marsh, Preliminary Alternative
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 5-11

Merkel & Associates, Inc.

Marsh Design, Elevations, and Grading

Figures 5-12 and 5-13 provide the conceptual design overview, grading, and cross-sections for this recommended alternative. Figure 5-4 provides locations of cross-sections. Figure 5-13 provides cross-section views of the restored J Street Channel (Section C) and J Street Marsh shoreline (Section D). For the recommended alternative, the shoreline along the J Street Marsh would be graded to create high marsh, transitional zone, and uplands that would connect to existing marsh vegetation within the J Street Marsh. Slopes would be planted with transitional marsh vegetation and maritime succulent scrub vegetation. The marsh elevations were set in J Street Marsh based on the habitat elevations described in Section 3.3. The marsh plain would slope from approximately +4.0 ft NAVD (+4.4 ft MLLW) at the limit of the existing marsh, up to approximately +6.0 ft NAVD (+6.4 ft MLLW) at a slope of 200:1 (H:V) (Figure 5-13, Section D). The high marsh and transition area would then slope up to +8.0 ft NAVD (+8.4 ft MLLW) at a steeper 50:1 (H:V) slope. Above the transition area, the slope would transition from 20:1 (H:V) up to the existing development grade to provide marsh transgression space under sea level rise conditions in the future. No grading is proposed for the Telegraph Creek area (discussed further in Section 5.4 below).

Along the J Street Channel, the slope would be set back to create additional marsh habitat and to help attenuate flood flows by providing more conveyance. The southern slope would be graded at a 20:1 (H:V) from the channel up to approximately +8.0 ft NAVD (+8.4 ft MLLW), and would then become steeper to a maximum slope of 8:1 (H:V), up to the existing development grade (+14.0 ft NAVD, or +14.4 ft MLLW). A hydraulic analysis would be required in the next phase of design to confirm that the proposed design maintains or improves the existing level of flood management.

Sediment would be excavated using land-side equipment as this would provide the most flexibility for construction, would eliminate tidal restrictions for work, and would be cost effective. Shoreline armoring, where present, would be removed so that upland slopes could be graded. Sediment excavated from the J Street Channel and Marsh would be utilized on-site to create marsh habitat within the former SBPP intake and discharge channels, and along the CVWR access road, as described in Sections 5.1 and 5.2.

Jetty Removal

To facilitate habitat connectivity, the jetty on the southern edge of the J Street Marsh would be lowered to high marsh elevations. This would provide a marsh berm to prevent frequent tidal flow-through and minimize marsh erosion, while still allowing habitat connection between J Street Marsh and the former SBPP intake channel.

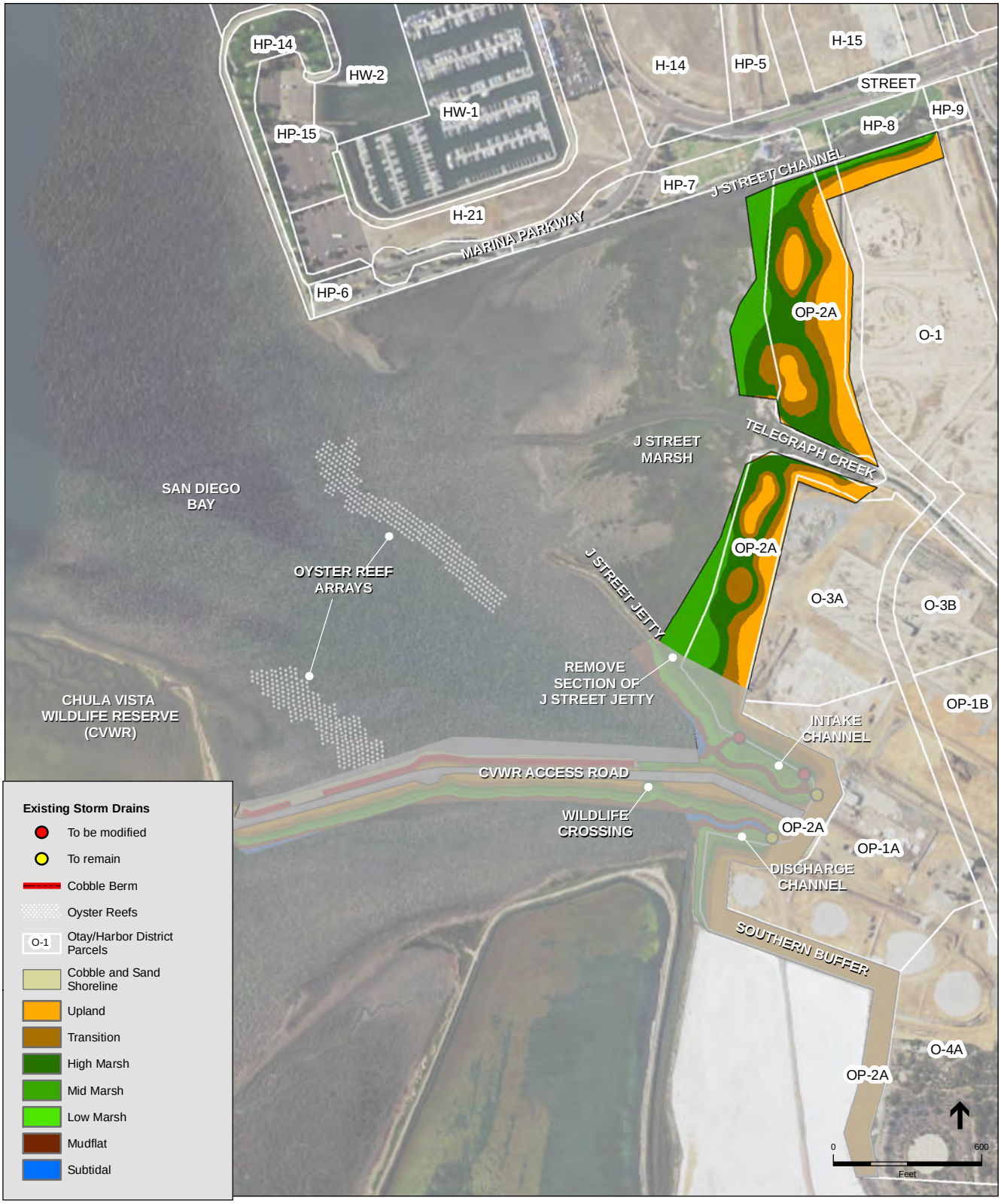
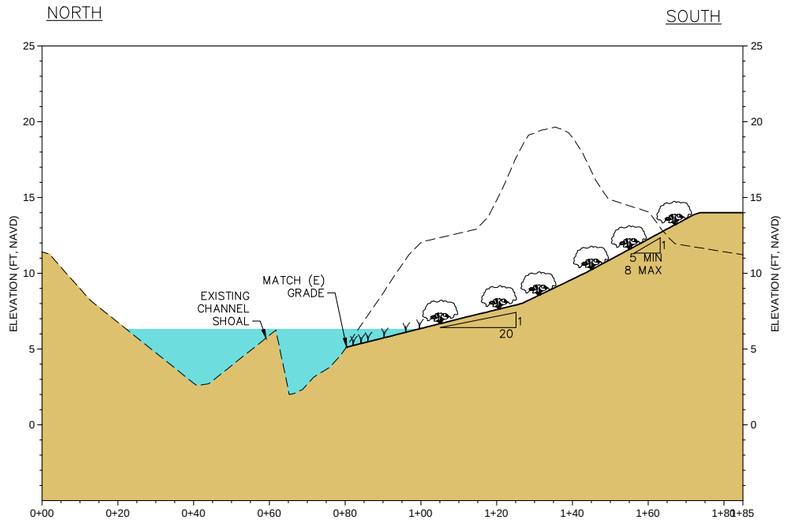
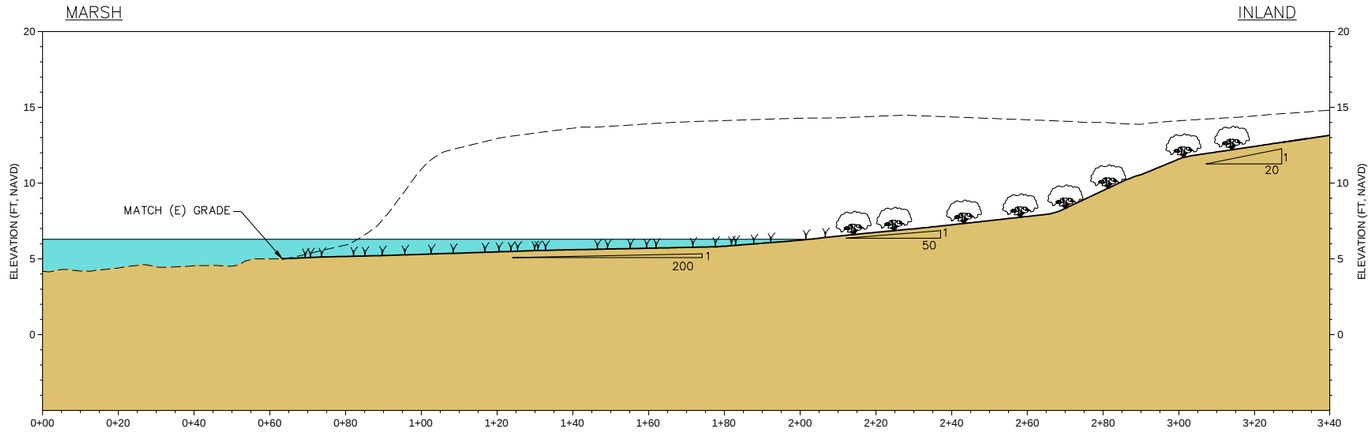


Figure 5-12
Recommended Alternative for Focus Area 6:
J Street Channel and Marsh



C J STREET CHANNEL - GRADING SECTION

Scale:
H: 1" = 40'
V: 1" = 10'



D J STREET MARSH - GRADING SECTION

Scale:
H: 1" = 40'
V: 1" = 10'

SOURCE:

Figure 5-13
Cross-sections for Focus Area 6
J Street Channel and Marsh

5.4 FOCUS AREA 7: TELEGRAPH CREEK

5.4.1 Existing Conditions

Telegraph Creek is located south of the J Street Marina, and north of the former SBPP intake channel, draining into the center of the J Street Marsh (Figure 5-14). The creek consists of a concrete-lined channel that runs from J Street Marsh to an enclosed culvert that runs beneath Bay Boulevard and Interstate 5. The channel contains minimal vegetation, supporting only a small amount of freshwater marsh and riparian vegetation on a seasonal basis when sediment accretes in the channel sufficiently to support plant growth. The mouth of the creek is cleared seasonally to maintain flood control conditions and prevent upstream flooding. Telegraph Creek is a U.S. Army Corps of Engineers flood management project.

5.4.2 Restoration and Enhancement Considerations

Table 5-7 summarizes habitat enhancement and restoration priorities for Focus Area 7: Telegraph Creek, and identifies opportunities and constraints unique to this focus area.

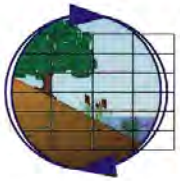
Table 5-7. Priorities, Opportunities, and Constraints for Focus Area 7: Telegraph Creek

Priorities	Opportunities	Constraints
• Naturalize Telegraph Creek to improve its habitat value. • Maintain Telegraph Creek's function as a flood control channel.	• Remove or reduce concrete channel lining and restore riparian and freshwater marsh vegetation.	• Telegraph Creek does not have upstream habitat connectivity due to presence of underground culvert. • Telegraph Creek is a U.S. Army Corps of Engineers flood management project. • Must maintain flood control function of Telegraph Creek and cannot increase risk of flooding. • Project permitting to change existing conditions would be prohibitive.

The primary restoration priority for Focus Area 7 is to improve habitat function by reducing or eliminating the concrete lined channel of Telegraph Creek and restoring freshwater marsh, brackish marsh, and/or riparian habitats. However, this area is isolated by the culvert that runs beneath Interstate 5 and there is no upstream habitat connectivity. Therefore, any created wetlands would have limited functions and values. Further, Telegraph Creek is a U.S. Army Corps of Engineers flood management project and any restoration and enhancement within the creek could not increase the risk of upstream flooding. The permitting process, and approvals from the U.S. Army Corps of Engineers, required to make any changes to the creek configuration, if possible, would be lengthy and costly. Additionally, underground utilities pass beneath the concrete lining, including facilities constructed in 2016 as a result of the Master Plan. While some conceptual alternatives were

Looking east along concrete-lined Telegraph Creek before it crosses beneath Interstate 5 via a buried culvert.

Looking west along concrete-lined Telegraph Creek as it enters J Street Marsh.



Focus Area 7: Telegraph Creek, Existing Conditions
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 5-14

Merkel & Associates, Inc.

initially explored for this focus area, they were not carried forward into a recommended design alternative due to these project constraints.

5.4.3 Preliminary Restoration Alternatives

Alternative 1: Modify Existing Concrete-lined Channel

Preliminary alternatives for Focus Area 7 include variations to reduce or eliminate the concrete channel sides and lining in the reach between Interstate 5 and the J Street Marsh. Figure 5-15 provides a typical cross-section location along the creek, and conceptually illustrates some options to create habitat within the creek channel. All restoration options considered would be completed within the buffer areas planned for the Otay District of the Chula Vista Bayfront. Options include:

Reduce Concrete Lining

One option would be to remove the concrete sides of the creek, leaving only the concrete lining at the base on the channel. The remaining earthen channel sides could then be graded, widening the channel and creating an area that could be restored with a combination of freshwater marsh, brackish marsh, and/or riparian habitats. The concrete lined base of the channel could be cleared and maintained as required for flood protection.

Remove Concrete Lining

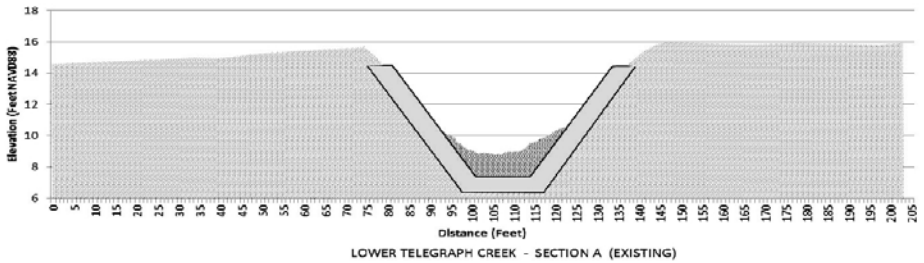
A second option would be to remove the entire concrete lining within the creek. Earthen slopes would then be graded, widening the channel and creating an area that could be restored with a combination of freshwater marsh, brackish marsh, and/or riparian habitats. This would maximize potential for habitat creation but would be difficult to maintain for flood protection as the channel would eventually fill completely with vegetation.

Remove Concrete Lining and Replace with Vertical Concrete Walls

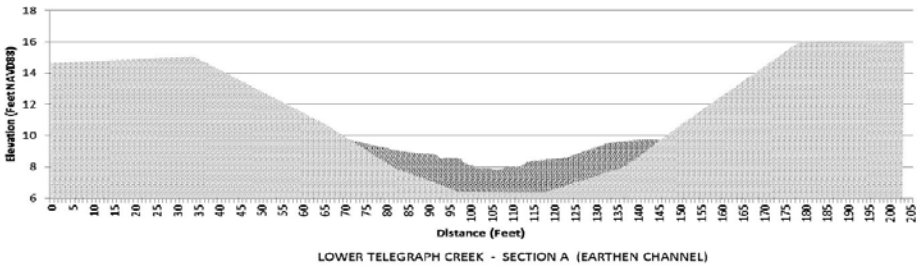
A third option would be to remove the existing concrete lining within the creek. The creek would then be widened and vertical concrete barrier walls would be installed to enclose and define the widened channel. The bottom of the channel could be restored with a combination of freshwater marsh, brackish marsh, and/or riparian habitats. This option would reduce flood risk, as the creek would be widened substantially. However, it would be difficult to clear or maintain the channel for flood protection as the channel would eventually fill completely with vegetation.

5.4.4 Recommended Conceptual Design Alternative for Focus Area 7

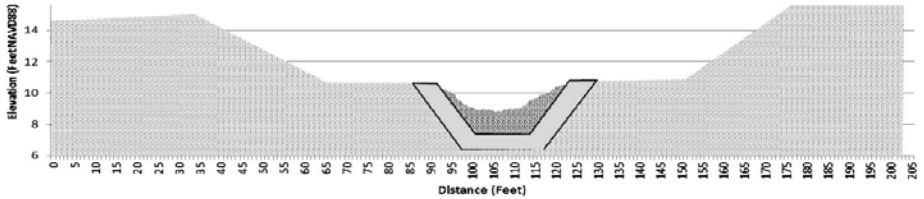
Due to the project constraints described above, the recommended alternative for Focus Area 7: Telegraph Creek would be maintained as existing conditions.



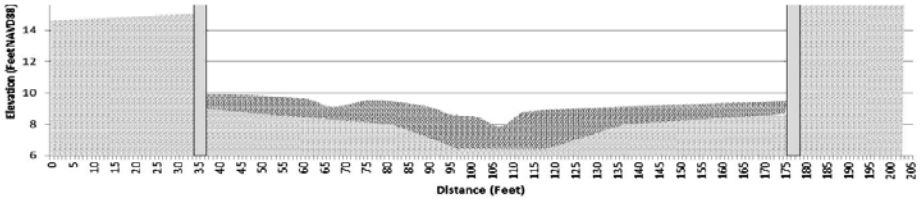
LOWER TELEGRAPH CREEK - SECTION A (EXISTING)



LOWER TELEGRAPH CREEK - SECTION A (EARTHEN CHANNEL)



LOWER TELEGRAPH CREEK - SECTION A (FLOOD BENCH/DEFINE LOW FLOW)



LOWER TELEGRAPH CREEK - SECTION A (EARTHEN CHANNEL/VERTICAL WALLS)

N
W E
S

Focus Area 7: Telegraph Creek, Preliminary Alternatives
Restoration and Enhancement of the
Chula Vista Bayfront, Chula Vista, CA

Figure 5-15

Merkel & Associates, Inc.

6.0 RECOMMENDED HOLISTIC RESTORATION ALTERNATIVE

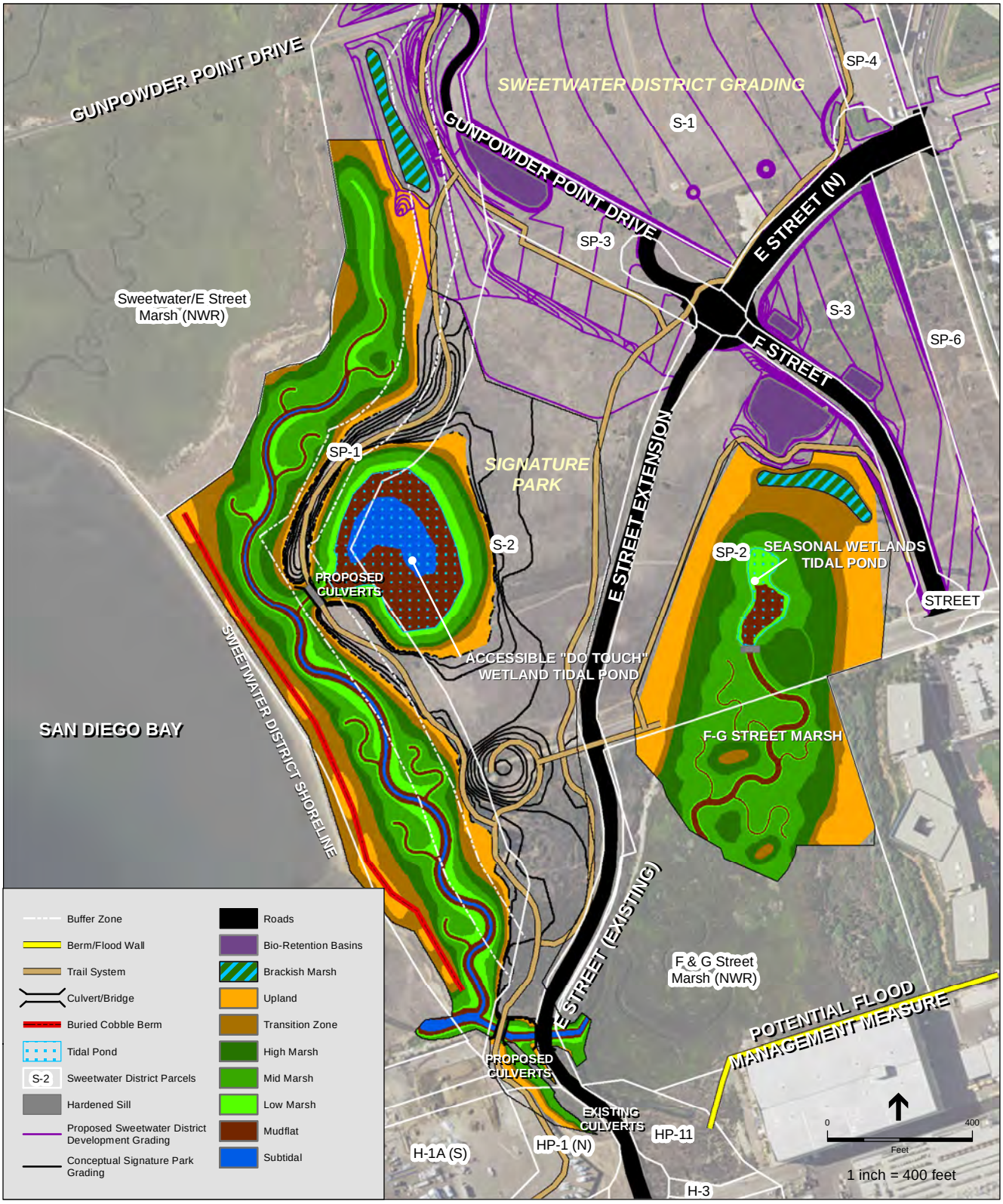
6.1 RECOMMENDED ALTERNATIVE FOR ENTIRE CHULA VISTA BAYFRONT

In previous sections of this document the priorities and considerations, preliminary restoration alternatives, and the recommended conceptual design alternatives have been presented for seven focus areas along the Chula Vista Bayfront and the planning process. Details related to each focus area are included in Sections 4 and 5 of this document.

Figure 6-1 provides the recommended conceptual design for the Sweetwater District of the Chula Vista Bayfront. The recommended alternative for the Sweetwater District would provide a balance between habitat restoration, natural resource protection, and recreational and educational opportunities. For this alternative, Lagoon Drive would be removed, creating an open tidal condition between the F&G Street Marsh and Seasonal Wetlands. The twin corrugated 24-inch drains that carry water from the Entrance Channel and connector marsh under Marina Parkway/E Street and into the F&G Street Marsh would remain in place and an additional culvert would be installed beneath Marina Parkway/E Street to the north of the existing drains in order to increase the tidal prism and allow for restoration of the Seasonal Wetlands without de-watering the F&G Street Marsh. Tidal flats and marsh habitat, along with a tidal pond would be restored within the Seasonal Wetlands. Trails and bikeway 16-foot wide multipurpose trail/bikeway would be routed around the Seasonal Wetlands, and would cross over the F&G Street Marsh Entrance Channel to provide an important linking piece of the San Diego Bayshore Bikeway.

A tidal channel would be excavated within the buffer area, along the length of the Sweetwater District Shoreline, extending from the F&G Street Marsh Entrance Channel in the south midway to Gunpowder Point Drive in the north. The constructed channel system would connect to San Diego Bay via a new connection created at the F&G Street Marsh Entrance Channel. A cobble berm would be created along the Sweetwater District shoreline to protect the created marsh from storm surges and erosion. A tidal pond would be excavated along the central portion of the main restored channel extending into the adjacent planned Signature Park recreation area. This “do touch wetland” would not be fenced and would provide wildlife viewing and educational opportunities through direct access to this portion of the restored wetlands. Trails, overlooks, and interpretive signage would be created in a manner to maximize enjoyment of, while also protecting, adjacent natural habitats. Sea level rise transgression areas would be incorporated within buffers adjacent to restored and enhanced wetlands.

Figure 6-2 provides the recommended conceptual design for the Otay District of the Chula Vista Bayfront. The recommended alternative for the Otay District would increase wetlands habitat, provide transgression areas for sea level rise, and would provide a means to protect the CVWR access road. For this alternative, the southern bank of the J Street Channel, the shoreline of the J Street Marsh, and the Southern Buffer area located to the south of the former SBPP discharge channel would be graded to provide marsh habitat, as well as transitional and upland habitat that would accommodate sea level rise. The excavated sediment would be placed within the terminus of the former SBPP intake and discharge channels and along the CVWR access road to create tidal flats and marsh



Chula Vista Bayfront Enhancement . 140803

Figure 6-1

Recommended Alternative for the Sweetwater District of the Chula Vista Bayfront

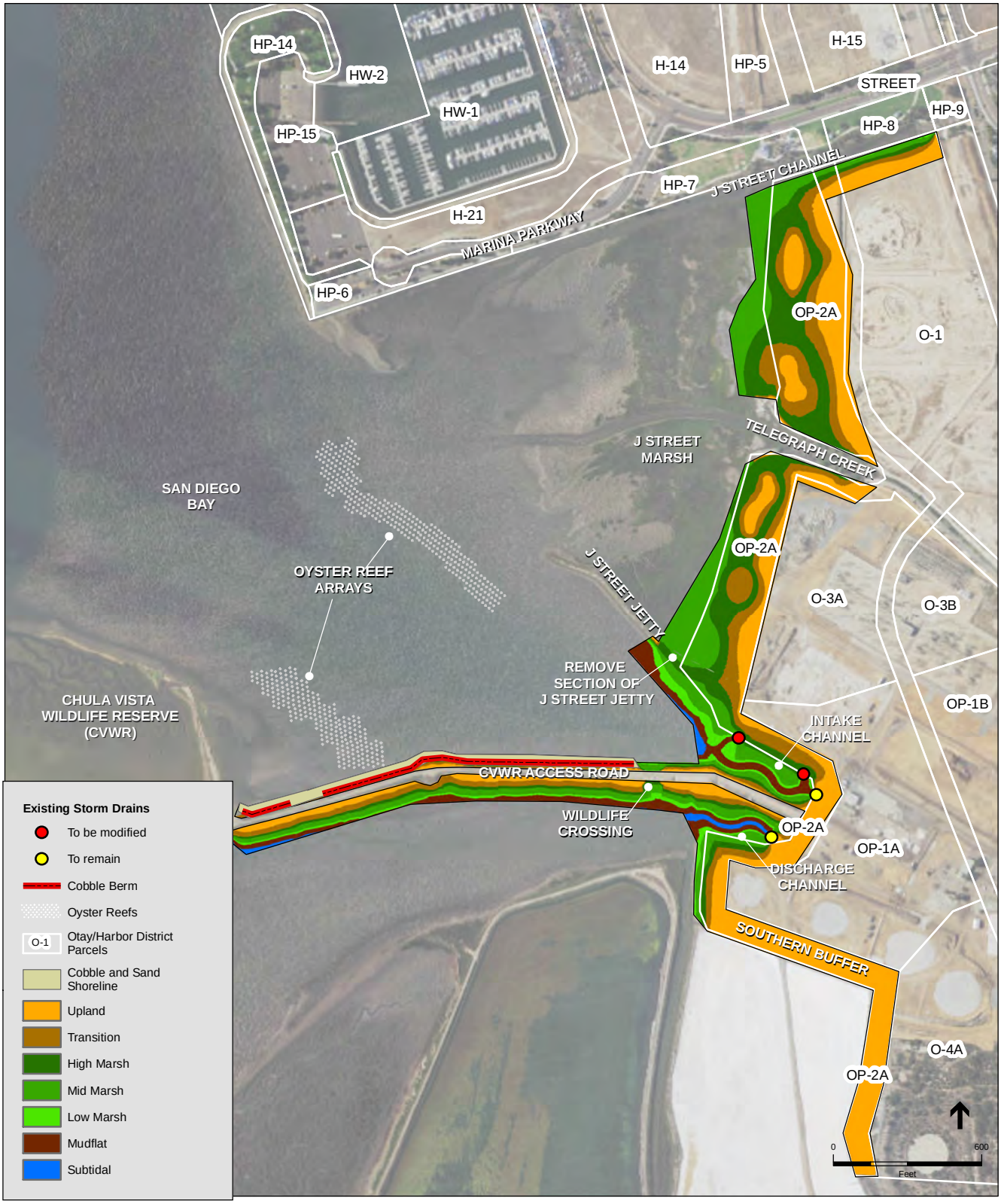


Figure 6-2
Recommended Alternative for the
Otay District of the Chula Vista Bayfront

habitat that would serve as a linkage between the J Street Marsh to the north and South Bay Salt Ponds to the south. The remainder of the intake and discharge channels would remain as moderately deep subtidal habitat for continued usage by the population of green sea turtles that inhabit south San Diego Bay.

The CVWR access road would be widened, but not elevated, and a cobble berm would be installed along the northern (intake channel) side of the road. Marsh habitat would be created along the southern (discharge channel) shoreline. A portion of the existing roadway would be removed and a series of box culverts with a cattle grate surface would be installed to provide a marsh connection between the intake and discharge channels. This crossing would also provide some protection of the CVWR from land-based predators.

No modifications are recommended for the Telegraph Creek Channel or the concrete-lined portion of the J Street Channel.

The acreage of habitats created for the recommended alternative within the Sweetwater District and Otay District are summarized in Table 6-1. Due to limitations of existing wetlands and habitat mapping, as well as to the level of design and engineering completed for focus areas within this Plan, it is not possible to estimate habitat or wetlands impacts at this time. An updated wetlands delineation and habitat mapping effort would be required prior to Plan implementation.

Table 6-1. Proposed Acres of Habitat Created for Recommended Alternative

Habitat Type	F&G Street Marsh, Seasonal Wetlands, and Entrance Channel	Sweetwater District Shoreline[2]	Former SBPP Intake and Discharge Channels and CVWR Access Road	J Street Channel and Marsh	HABITAT TOTALS
Low Marsh	0.6	2.3	1.7	-	**4.6**
Mid/High Marsh	6.9	8.5	9.5	8.3	**33.2**
Brackish Marsh	0.4	0.4	-	-	**0.8**
Transition/Uplands	4.8	7.1	10.9[1]	9.0	**31.8**
TOTAL	**12.7**	**18.3**	**22.1**	**17.3**	**70.4**

[1]includes graded slopes in Southern Buffer area
[2]does not include upland slopes north of Gunpowder Point Road adjacent to planned RV Park

6.2 POTENTIAL IMPACTS OF SEA LEVEL RISE

As indicated throughout this document, the predicted sea level rise for San Diego Bay would result in large scale habitat changes throughout the Chula Vista Bayfront Planning Area. A sea level rise model was prepared in order to facilitate an understanding of how the recommended restoration and enhancement alternatives for the Chula Vista Bayfront would respond to sea level rise. The

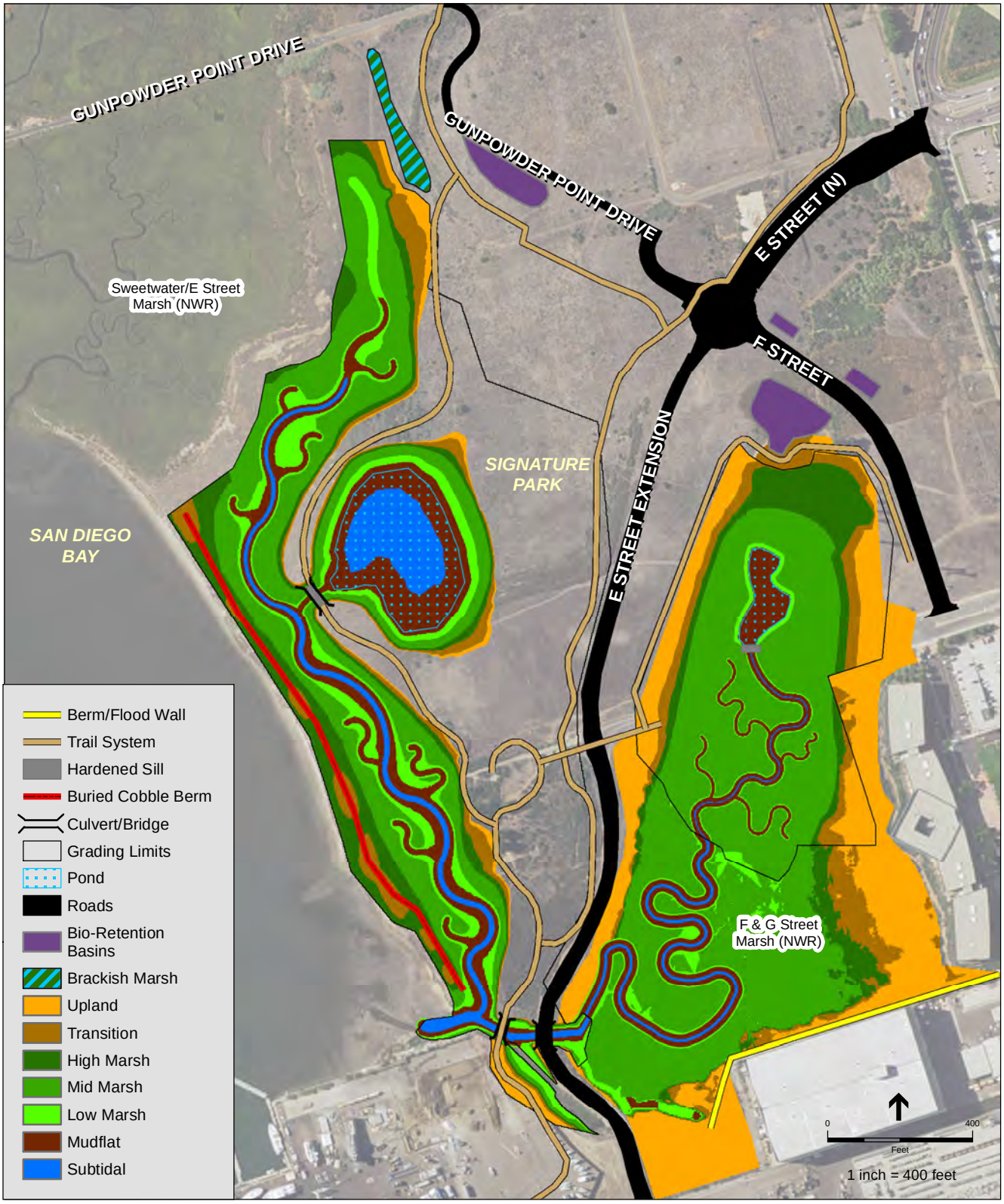
Sweetwater District was selected for analysis due to the large quantity of planned tidal habitat restoration within this area, and because the re-development planning for the Chula Vista Bayfront has progressed the farthest within this district.

Figure 6-3 through Figure 6-6 illustrate potential habitat conversion of the restored and enhanced habits of the Sweetwater District under four sea level rise scenarios: 1 foot, 2 feet, 3.2 feet, and 5.5 feet of predicted rise (NRC 2012). These figures indicate the location of a berm/floodwall likely to be required to protect the properties to the south of F&G Street Marsh from flooding under these sea level rise scenarios. Under a 1 foot sea level rise scenario (predicted to occur as early as 2030), a majority of transition and high marsh habitat planned under the recommended alternative would transition to mid and low marsh habitat. The berm along the shoreline would support high marsh habitat. Tidal ponds would remain. The habitat within the F&G Street Marsh NWR would occur as mid and low marsh habitat with a wide band of high marsh and transitional habitat along the slopes of the marsh.

Under a 2 foot sea level rise scenario (predicted to occur as early as 2050), high and mid marsh habitat would largely transition to low marsh throughout the Sweetwater District. However, bands of mid and high marsh habitat would remain at the north end of F&G Street Marsh and Seasonal Wetlands, as well as along the buffer slopes adjacent to Signature Park along the Sweetwater District shoreline. The berm along the shoreline would also support high marsh habitat.

Under a 3.2 foot sea level rise scenario (predicted to occur as early as 2070), the majority of remaining marsh habitat would transition to low marsh that would fringe large areas of unvegetated tidal flats (mudflats). Transitional and upland habitat along the slopes of the F&G Street Marsh and Seasonal Wetlands, as well as along the slopes adjacent to Signature Park would transition to mid and high marsh habitat. These marsh transgression areas have been incorporated in the recommended alternative to accommodate this sea level rise scenario.

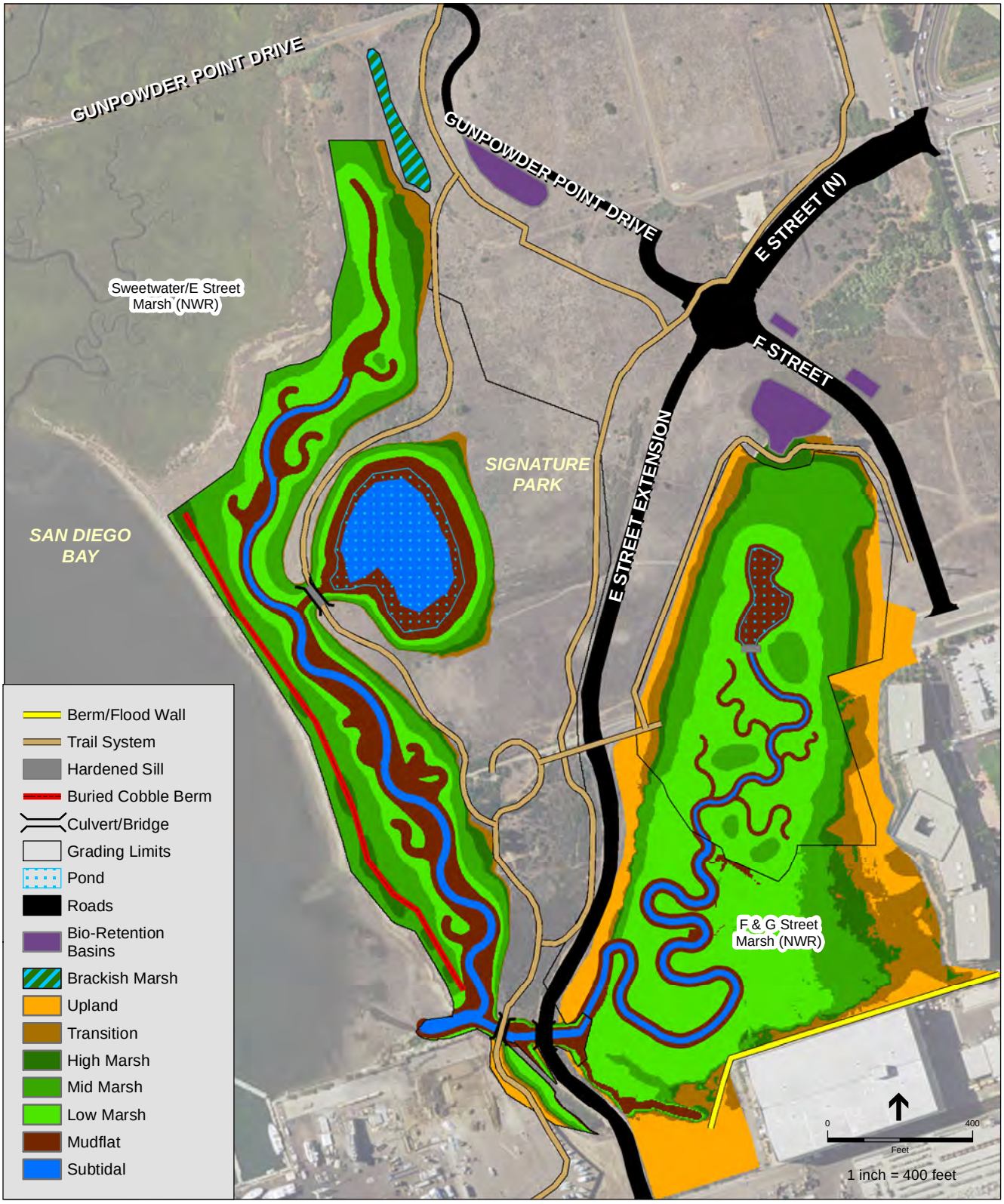
Under a 5.5 foot sea level rise scenario (predicted to occur as early as 2100), the majority of originally restored habitats would transition to unvegetated mudflat and shallow subtidal waters. Remaining marsh habitat would occur as a narrow fringe along the banks of the F&G Street Marsh and Seasonal Wetlands, and slopes adjacent to Signature Park. The cobble berm along the Sweetwater District shoreline would likely not maintain sediment or support vegetation. This area would, however, provide a hard intertidal structure along the shoreline that could transition to oyster reefs.



Chula Vista Bayfront Enhancement . 140803

Figure 6-3

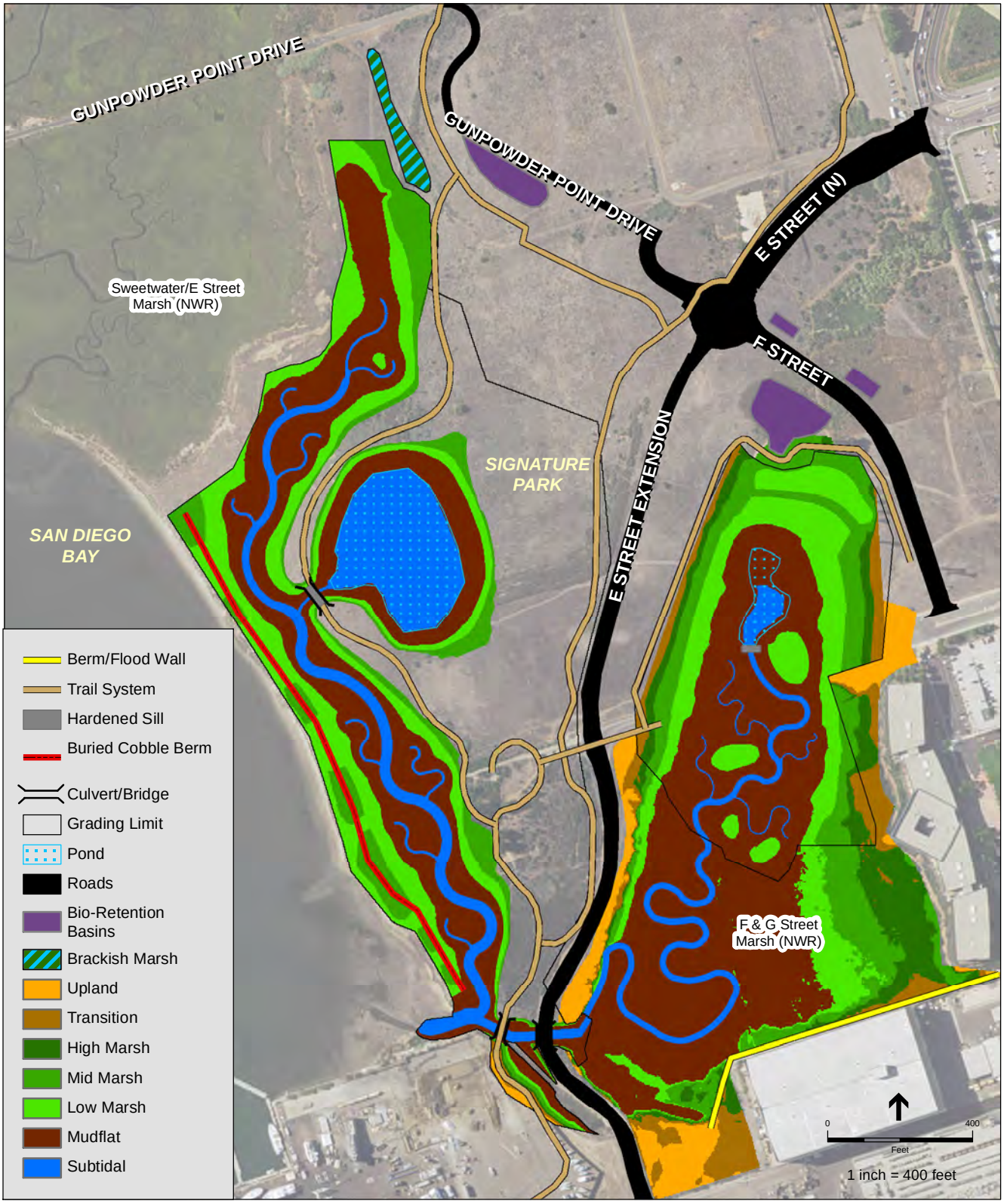
Sweetwater District under 1 ft of Sea-Level Rise (2030)



Chula Vista Bayfront Enhancement . 140803

Figure 6-4

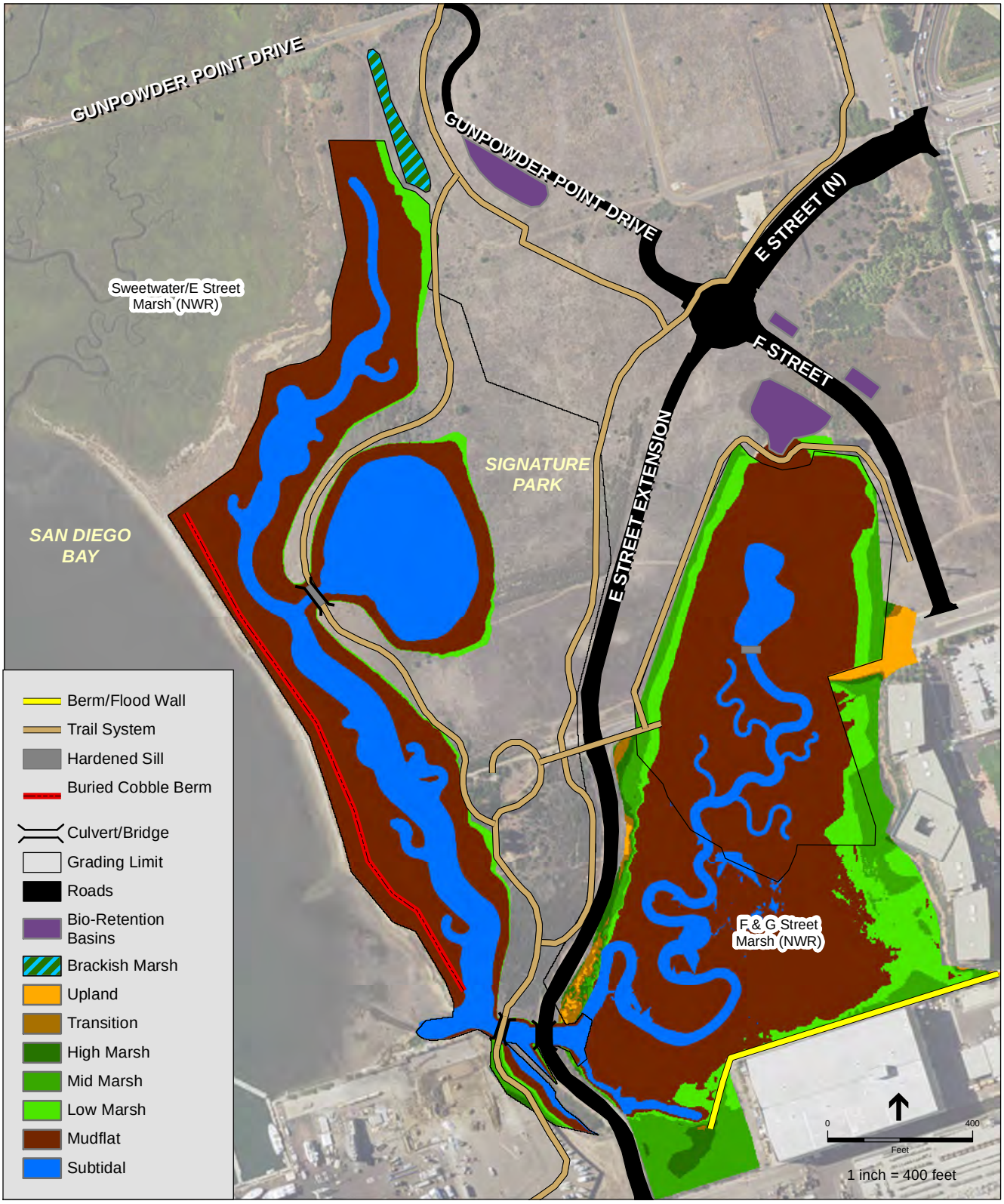
Sweetwater District under 2 ft of Sea-Level Rise (2050)



Chula Vista Bayfront Enhancement . 140803

Figure 6-5

Sweetwater District under 3.2 ft of Sea-Level Rise (2070)



Chula Vista Bayfront Enhancement . 140803

Figure 6-6

Sweetwater District under 5.5 ft of Sea-Level Rise (2100)

6.3 QUANTITIES AND COSTS

Preliminary quantities and opinion of probable construction costs are presented in Table 6-2. For planning purposes, an order of magnitude estimate has been provided. This cost estimate is intended to provide an approximation of total project costs appropriate for the conceptual level of design. These cost estimates are considered to be approximately -30% to +50% accurate, and include a 35% contingency to account for project uncertainties (such as final design, permitting restrictions and bidding climate). These estimates are subject to refinement and revisions as the design is developed in future stages of the project.

The quantity and cost estimates assume that excavated soil can be re-used within the Chula Vista Bayfront. Sediment characterization (sampling and testing) may need to be performed during subsequent phases of design and permitting to confirm this assumption. The estimates also assume that the excess excavated material could be placed as fill or stockpiled within the Sweetwater District (for the Sweetwater shoreline, F&G Street Marsh Entrance Channel, F&G Street Marsh and Seasonal Wetlands areas), Otay District (for the J Street Channel and Marsh and Southern Buffer areas), and possibly the Harbor District.

This cost estimate does not include the following items, which are considered parts of other related projects:

- Sweetwater District development (i.e., RV Park) grading and improvements
- Sweetwater District grading and improvements beyond habitat enhancement
- Sweetwater Shoreline brackish marsh grading
- Signature Park project grading and improvements (the “do-touch wetland” is included in costs)
- Sweetwater District Trails and public access bridges
- Sweetwater District Fencing
- Otay District development grading and improvements
- Chula Vista Wildlife Reserve access road improvements/modifications
- Otay District Trails and public access
- Otay District Fencing

Please note that the actual cost of construction may be impacted by the availability of construction equipment and crews and fluctuation of supply prices at the time the work is bid[1].

[1] The estimates herein and the project team make no warranty, expressed or implied, as to the accuracy of such opinions as compared to bids or actual costs.

Table 6-2. Quantities and Opinion of Probable Costs for Chula Vista Bayfront Enhancement

Costs in Dollars in the Year 2017
Conceptual Level (Order of Magnitude)
Contingency 35-50% and anticipated level of accuracy -30% to +50%

Sweetwater Shoreline and F&G Street Marsh Entrance Channel

Mobilization (see notes)	1	LS	$	280,000	$ 280,000
Grading					
Clearing and grubbing	18.3	AC	$	19,000	$ 347,700
Marshplain grading (cut)	149,400	CY	$	12	$ 1,792,800
Marshplain grading (fill)	800	CY	$	9	$ 7,200
Cobble berm (cut)	40,000	CY	$	12	$ 480,000
Cobble berm (fill/replace)	20,000	CY	$	9	$ 180,000
Stockpile excess cut	168,600	CY	$	6	$ 1,011,600
Cobble berm (North Beach)	1	LS	$	1,423,600	$ 1,423,600
Hardened sill	1	LS	$	89,400	$ 89,400
Revegetation					
Low marsh	2.3	AC	$	3,000	$ 6,900
Mid and high marsh	8.5	AC	$	4,000	$ 34,000
Transition and upland	7.1	AC	$	4,500	$ 31,950
Brackish Marsh	0.4	AC	$	2,000	$ 800
Raising E Street[1]	1.0	LS	$	1,884,520	$ 1,884,520
Totals					
Construction subtotal					$ 7,570,470
Contingency	35%				$ 2,649,665
Other costs (permitting, design, monitor	10%				$ 757,047
Total					$ 10,977,200

F&G St Marsh, Entrance Culvert, and Seasonal Wetlands

Mobilization (see notes)	1.0	LS	$	100,000	$ 100,000
Grading					
Clearing and grubbing	12.7	AC	$	19,000	$ 241,300
Marshplain grading (cut)	38,900	CY	$	12	$ 466,800
Marshplain grading (fill)	500	CY	$	9	$ 4,500
Stockpile excess cut	38,400	CY	$	6	$ 230,400
Hardened sill	1	LS	$	44,700	$ 44,700
Arch Culvert	1	LS	$	854,400	$ 854,400
Revegetation					
Low marsh	0.6	AC	$	3,000	$ 1,800
Mid and high marsh	6.9	AC	$	4,000	$ 27,600
Brackish Marsh	0.4		$	2,000	$ 800
Transition and upland	4.8	AC	$	4,500	$ 21,600
Totals					
Construction subtotal					$ 1,993,900
Contingency	35%				$ 697,865
Other costs (permitting, design, monitor	10%				$ 199,390
Total					$ 2,891,200

J St Channel and Marsh

Mobilization (see notes)	1	LS	$	130,000	$ 130,000
Grading					
Clearing and grubbing	17.3	AC	$	19,000	$ 328,700
Marshplain grading (cut)	121,300	CY	$	12	$ 1,455,600
Marshplain grading (fill)	1,500	CY	$	9	$ 13,500
Stockpile excess cut	92,600	CY	$	6	$ 555,600
Revegetation					
Mid and high marsh	8.3	AC	$	4,000	$ 33,200
Transition and upland	9.0	AC	$	4,500	$ 40,500
Oyster reefs (allowance)	1.0	LS	$	100,000	$ 100,000
Totals					
Construction subtotal					$ 2,657,100
Contingency	35%				$ 929,985
Other costs (permitting, design, monitor	10%				$ 265,710
Total					$ 3,852,800

Table 6-2. Quantities and Opinion of Probable Costs for Chula Vista Bayfront Enhancement

Former Intake/Discharge Channels and CVWR Access Road					
Mobilization (see notes)	1	LS	$ 260,000	$	260,000
Grading					
Clearing and grubbing	18.1	AC	$ 19,000	$	343,900
Marshplain grading (cut)	36,900	CY	$ 12	$	442,800
Marshplain grading (fill)	64,100	CY	$ 12	$	769,200
Wildlife passage culverts	1	LS	$ 114,700	$	114,700
Cobble berm (Wildlife Rd)	1	LS	$ 2,943,300	$	2,943,300
Culvert modification (allowance)	1	LS	$ 100,000	$	100,000
Floating curtain/Turbidity barriers	5,000	LF	$ 40	$	200,000
Revegetation					
Low marsh	1.7	AC	$ 3,000	$	5,100
Mid and high marsh	9.5	AC	$ 4,000	$	38,000
Transition and upland	6.9	AC	$ 4,500	$	31,050
Oyster reefs (allowance)	1	LS	$ 100,000	$	100,000
Totals					
Construction subtotal				$	5,348,050
Contingency	35%			$	1,871,818
Other costs (permitting, design, monitor	10%			$	534,805
Total				$	7,754,700
Southern Buffer					
Mobilization (see notes)	1	LS	$ 35,000	$	35,000
Grading					
Clearing and grubbing	4.0	AC	$ 19,000	$	76,000
Southern buffer transition slope (cut)	32,400	CY	$ 12	$	388,800
Stockpile excess cut	32,400	CY	$ 6	$	194,400
Revegetation					
Transition and upland	4.0	AC	$ 4,500	$	18,000
Totals					
Construction subtotal				$	712,200
Contingency	35%			$	249,270
Other costs (permitting, design, monitor	10%			$	71,220
Total				$	1,032,690
GRAND TOTAL				$	26,508,600

Total stockpile volume		
Stockpile excess cut	239,400	CY

Notes

1. Costs for raising E Street provided by the Port of San Diego and Rick Engineering

Items not included

Sweetwater District
- Sweetwater District grading & improvements
- Sweetwater shoreline brackish marsh
- Signature Park Project grading & improvements- The "Do-touch" wetland is included in the costs for Sweetwater.
- Trails
- Public access bridges
- Fencing
- Remediation of contaminants- Further investigation should be conducted to quantify extent of contamination.

Otay District
- CVWR access road improvements/modifications to road bed
- Trails/public access
- Fencing

6.4 RESTORATION AND REGULATORY PLANNING

As indicated at the beginning of this document, a number of factors affect the timing and phasing of implementation of restoration and enhancement within the focus areas along the Sweetwater and Otay Districts of the Chula Vista Bayfront. While some of the elements of recommended restoration alternatives for focus areas may be developed and constructed independent of, or in parallel with, other elements, many of the elements must be completed serially, and have phasing restrictions in order to be efficiently conducted without resulting in undesirable consequences associated with implementation.

Figure 6-7 shows the focus areas described in this document in context of the recommended alternative for restoration and enhancement of the entire Chula Vista Bayfront Planning Area. Table 6-3 summarizes phasing considerations and requirements for implementation of restoration within each of the focus areas. For the reasons described previously, Focus Area 7: Telegraph Creek is not included in this analysis. The following text describes phasing considerations.

6.4.1 Overall Phasing Consideration

The alternatives for restoration and enhancement of the Chula Vista Bayfront provided in this document have been developed in a programmatic context where the activities within one focus area of the Chula Vista Bayfront are intended to act synergistically or to interface with other focus areas to enhance natural habitat connectivity through the Bayfront. As such, it is important that this holistic view of habitat restoration/enhancement not get lost in the final engineering, regulatory approval, and implementation process. This would undermine the fundamental intent of this Plan to be considered as a whole, but for which individual elements, if parted out, may not hold the same functional logic. As an example, if the large bottomless arch culvert contemplated for the Entrance Channel of the F&G Street Marsh in the Sweetwater District were advanced as a standalone action, it may result in impacts to wetlands (coastal salt marsh habitat and open water) that are in excess of gains. Further, it may fall outside of the allowable uses in wetlands under section 30233 of the Coastal Act. However, when viewed in the context of the whole recommended restoration alternative for the Sweetwater District as proposed in this Plan, the culvert provides critical hydrologic and habitat connectivity and is essential to the restoration of wetlands within the Seasonal Ponds. In order to avoid a tyranny of small decisions, it is recommended that a number of actions related to phasing and implementation of Plan elements be taken to ensure that the broader connectivity vision not get lost. These include the following:

1) **Confirm or update environmental documents for consistency with Plan alternatives.** It will be necessary to explore the whole of the Plan as well as its parts in the context of the existing approvals for the Chula Vista Bayfront to determine consistency. The existing Master Plan EIR does not address an enlarged culvert or bridge structure under Marina Parkway/E Street or the removal of the existing Lagoon Drive in association with the connectivity of the Seasonal Ponds to the F&G Street Marsh. It further excludes work on the NWR, that is subject to the National Environmental Policy Act (NEPA).

Restoration Alternative for Entire Chula Vista Bayfront for Project Phasing

Restoration and Enhancement of the Chula Vista Bayfront, Chula Vista, CA

Figure 6-7

Table 6-3. Phasing Requirements for Restoration and Enhancement Alternatives for the Chula Vista Bayfront

Phasing Requirements	Focus Area 1: F&G Street Marsh & Seasonal Wetlands	Focus Area 2: F&G Street Marsh Entrance Channel	Focus Area 3: Sweetwater District Shoreline	Focus Area 3N: Sweetwater District Northern Slopes	Focus Area 4: SBPP Intake and Discharge Channels	Focus Area 5: CVWR Access Area	Focus Area 6: J Street Channel and Marsh
Environmental Documents	• CEQA review • NEPA action	• CEQA review • NEPA action	• Confirm consistency with existing entitlements	• confirm consistency with existing entitlements	• confirm consistency with existing entitlements	• confirm consistency with existing entitlements	• confirm consistency with existing entitlements
Permitting and Agreements	• PMP review and CDP review for consistency • USFWS/ NWR agreement • Wetland Permits/ Consultations	• PMP review, and CDP review for consistency • USFWS/NWR agreement • Wetland Permits/ Consultations	• PMP review,. and CDP review for consistency • Wetland Permits/ Consultations	• PMP review and CDP review for consistency	• PMP review, and. and CDP review for consistency • UFSWS/NWR partnership • Wetland Permits/ Consultations	• PMP review and CDP review for consistency • Wetland Permits/ Consultations	• PMP review, and. and CDP review for consistency • Wetland Permits/ Consultations
Planning & Development of Adjacent Parcels	• Analyze potential flooding of parcels to south • E Street extension to relieve traffic on Lagoon Drive • Trail planning • Infrastructure planning	• Analyze potential flooding of parcels to south • Raise E Street • Trail planning • Infrastructure planning	• Park and buffer planning and construction • Trail planning	• RV Park planning and construction • Park and buffer planning • Trail planning	• Park and buffer planning in Otay District (trails, bikeways)	• Not required	• Park and buffer planning in Otay District (trails, bikeways)
Planning & Development of other Focus Areas	• Implement Focus Areas 1 and 2 together.	• Implement Focus Areas 1 and 2 together	• Implement partial Focus Area 2 for tidal access	• Not required	• Implement with Focus Area 6 to gain fill material	• Implement with Focus Area 6 to gain fill material	• Implement with Focus Areas 4 & 5 for re-use of sediment
Sediment / Material Needs	• Sediment surplus • Review for contaminants	• Sediment surplus • Possible contaminants	• Sediment surplus; possible use in Signature Park	• Sediment deficit; balanced with RV Park construction	• Sediment deficit	• Sediment deficit	• Sediment surplus

2) **Additional environmental review and amendment of the Port Master Plan** will likely be necessary for elements of the Restoration and Enhancement Alternatives for the Chula Vista Bayfront. It should be acknowledged that individual phases of work under this Plan may result in gains or losses of habitats; however, the whole of the Plan would result in habitat gains, and the serial progression of phases of the Plan ensures that gains are always ahead of any losses of habitat areas or function. For this reason, it would be beneficial for the District the City, and resource and regulatory agencies to consider adoption of the Plan in its entirety.

3) **Explore opportunities for comprehensive long-term renewable permits for the implementation of the Plan.** The completion of comprehensive permits provides a framework for agencies and the public to review the whole of the action and it reduces risk of individual elements of this Plan being weighed out of context. Further, comprehensive permits would allow several other benefits. First, this regulatory approach would allow the pooling of gains and losses of habitat function in a manner that allows impacts associated with the restoration to be offset by gains within the same permit. Since the gains would commence earlier in the Plan than elements with greater impact, this provides for a substantial net up-front restoration with which to offset later impacts. Another benefit of comprehensive permits is that this approach would allow for completion of Plan-based Clean Water Act section 401 Water Quality Certification, Endangered Species Act section 7 consultations for avian species and turtles, consultation under the Magnuson-Stevens Fisheries Conservation and Management Act for Essential Fish Habitat, and consultation under section 106 of the Historic Preservation Act. This would assist in establishing standards for construction that may be fully considered in the development of final design and construction schedules. All elements under the Plan would require a Coastal Development Permit (CDP) for implementation.

4) **Encourage the U.S. Fish & Wildlife Service to advance NEPA and other NWR actions necessary to implement work**, where activities rely on federal participation. Under the Plan, some elements would either contribute directly to improved function of the NWR, or the NWR may benefit from cooperative action, specifically for the work associated with F&G Street Marsh. Cooperation may also benefit the interface of habitat buffer features in the Otay District. Restoration of the Seasonal Ponds and enhanced connectivity between F&G Street Marsh and the San Diego Bay shoreline cannot be fully accomplished without cooperation of the USFWS to enhance this segment of the NWR. For this reason, collaborative pursuits to advance the Plan should be sought.

5) **Provide the broad Plan context to each phase of the Plan implementation** by sharing the design documents for completed and planned elements with each engineering team working on the restoration program. This will assist in ensuring a retention of intent through the implementation effort and will minimize moving away from the initial goals of the Plan.

With the broader actions in mind, the sections below examine the relationships and conditional nature of various elements of the Plan. These are discussed by focus area as depicted in Figure 6-7.

6.4.2 Sweetwater District

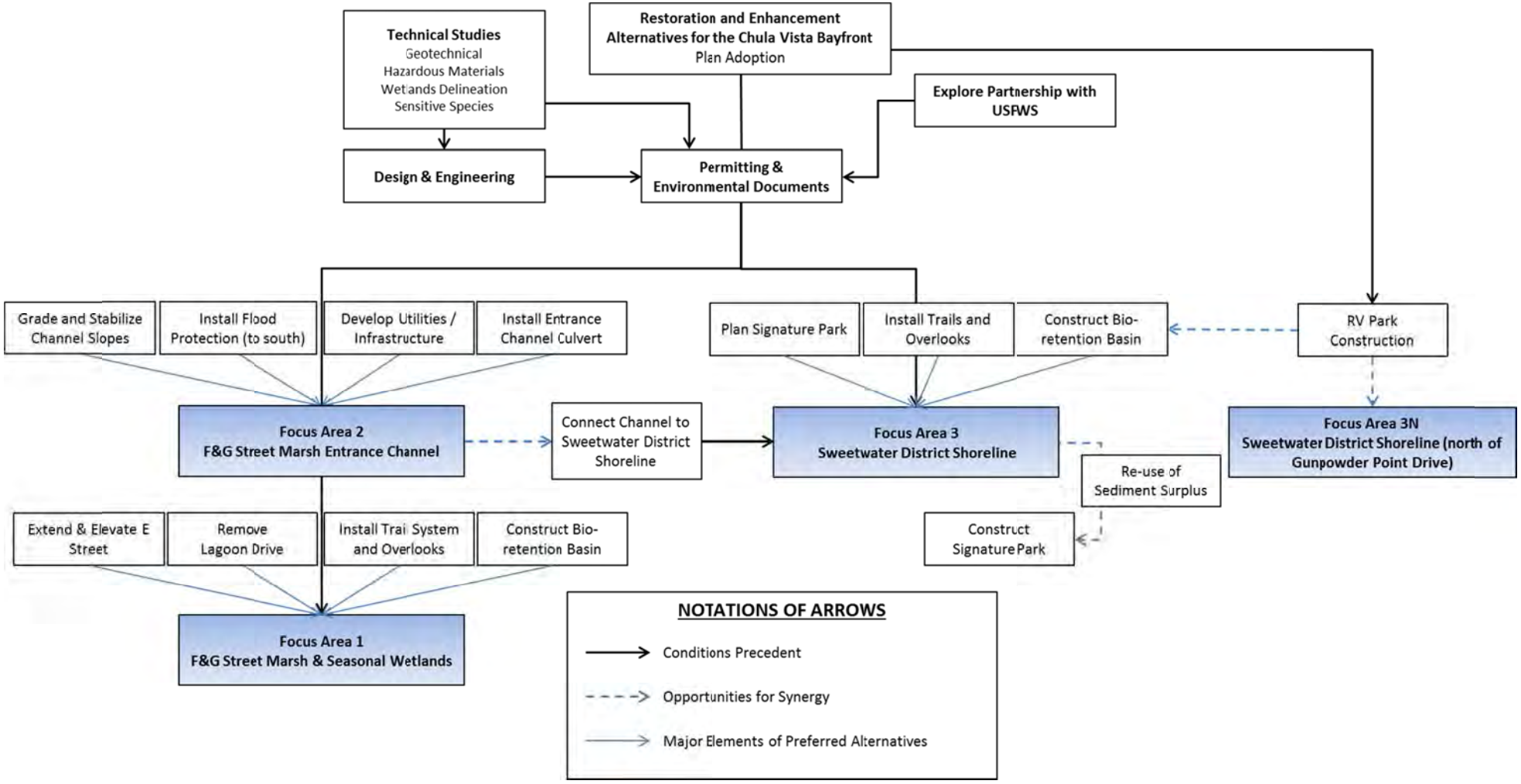
Figure 6-8 provides an implementation pathway for the Sweetwater District. This figure incorporates the overall phasing considerations discussed above. Specifically, it considers adoption of this Plan in its entirety, recommends comprehensive permitting and modifications to environmental documents for the Plan as a whole, and identifies the need for early partnership with the USFWS. The figure then illustrates an appropriate implementation pathway for each focus area. Conditions precedent (e.g. mandatory for implementation of the preferred alternative for each focus area) are shown as black arrows. Opportunities for synergy (e.g. not mandatory for implementation of the preferred alternative, but that streamline implementation and provide benefit to the overall Plan) are shown as dashed blue arrows. Major elements for the preferred alternative (e.g. elements that must be constructed as part of a preferred alternative for each focus area) are shown as solid blue arrows.

Within the Sweetwater District, the northernmost portion of the buffer area (Focus Area 3N, north and partially south of Gunpowder Point Drive) is planned to be graded and restored in conjunction with the development of the RV Park, (Figure 6-7). However, restoration of adjacent focus areas would not be required for implementation, and this action could proceed separately from other restoration activities. Restoration within Focus Area 3N would need to ensure consistency with current Project controlling documents and approvals.

Along the remainder of the Sweetwater District shoreline south of the RV Park buffer area (Focus Area 3), further planning of the adjacent parkland (Signature Park) to determine trail alignments, park interface grades, planned overlooks, and access and use objectives for the "do touch wetland" tidal pond, would be a requirement for implementation of this segment of the project. Finally, a connection to the F&G Street Marsh Entrance Channel would be required to provide tidal access for Focus Area 3. However, Entrance Channel modification would not dictate the need to commence work on the F&G Street Marsh segment of the project (Focus Area 2). As such, the connection of the Sweetwater District Shoreline (Focus Area 3) to the F&G Street Marsh Entrance Channel (Focus Area 2) is indicated in Figure 6-8 by a dashed blue line; it is not necessary to commence work within Focus Area 2 in order to provide the tidal connection, however, it would be most cost-effective if design and engineering and construction of these Plan elements were done concurrently.

The Focus Area 3 implementation would result in substantial sediment surplus, and re-use of excavated sediment should be part of project planning to enhance project efficiencies and minimize construction period environmental impacts. Potential on-site re-use of this sediment surplus is indicated in Figure 6-8 with a dashed blue line. Restoration along the Sweetwater District Shoreline of Focus Area 3 would require a U.S. Army Corps of Engineers permit issued under Rivers & Harbors Act, section 10 and Clean Water Act section 404. Permitting for this element of work could be readily addressed either programmatically with the whole of the plan, or individually, however comprehensive permitting is preferred as this area generates much of the off-setting wetland gains that would compensate for impacts in later elements of the project.

Figure 6-8 Implementation Pathway for Restoration and Enhancement of the Sweetwater District



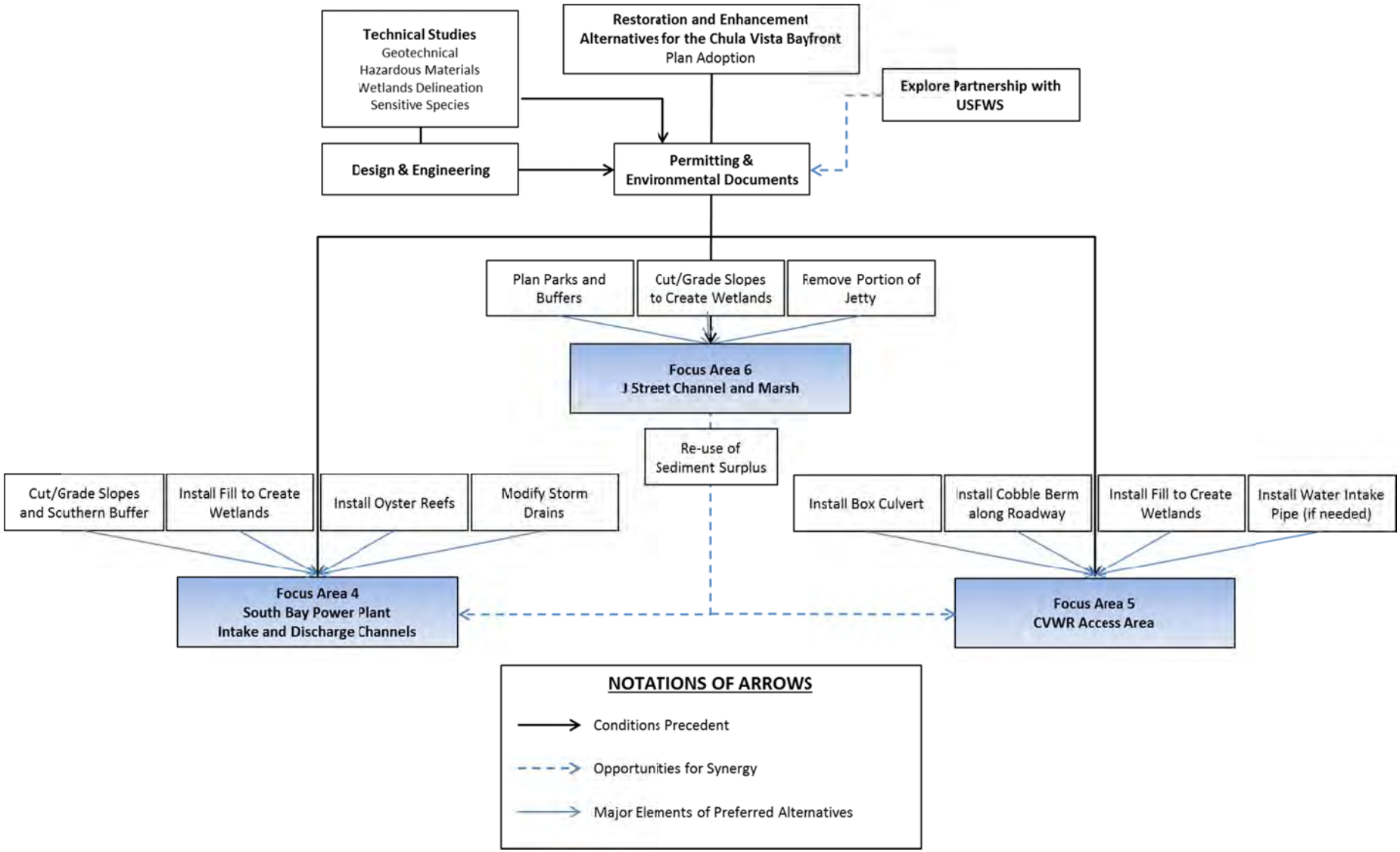
Restoration of the F&G Street Marsh and Seasonal Wetlands (Focus Area 1) should be implemented in conjunction with or following restoration of the F&G Street Marsh Entrance Channel (Focus Area 2) and restoration of these two areas should be considered a single action or serial action. As such these two focus areas are connected by a solid black line in Figure 6-8, indicating conditions precedent. Sea level rise planning (potential flood protection measures) for adjacent developed parcels to the south should be incorporated into the restoration effort at Focus Area 2 in order to avoid exacerbated flood risks. Further, planning of the pedestrian and bicycle circulation is a major element required for implementation in order to incorporate the trails around the Seasonal Wetlands and over the Entrance Channel. Planning and construction of the future E Street extension, and future infrastructure routing considerations are also a requirement for implementation as the project assumes removal of Lagoon Drive and construction of a large arch culvert in Marina Parkway as major elements. The planned extension of E Street, as well as the planned new culvert within the F&G Street Marsh Entrance Channel would be constructed to accommodate anticipated sea level rise. However, neither element contemplates raising the existing portion of E Street to meet this elevated grade. Therefore, implementation of restoration elements within Focus Areas 1 and 2 would require additional planning, engineering, and funding to provide for a consistent roadway grade for all sections E Street.

Other considerations for the Sweetwater District focus areas are that actions within Focus Areas 1 and 2 would affect existing utilities and routing of future utilities, and development of infrastructure is considered a major element of the preferred alternative for these focus areas (Figure 6-8).. The restoration would result in a sediment surplus, and re-use of excavated sediment should be part of project planning; however, some sediments from the Seasonal Wetlands may require contaminants testing and remediation. Technical studies completed as part of design and engineering (as shown in Figure 6-8) would provide the information required to determine the extent of these hazardous materials. Implementation of restoration within Focus Areas 1 and 2 would require a partnership with the USFWS, as the F&G Street Marsh is part of the San Diego Bay NWR. The project would require additional entitlements. In addition, this element of the Plan would require U.S. Army Corps of Engineers permits, along with multi-agency consultations.

6.4.3 Otay District

Figure 6-9 provides an implementation pathway for the Otay District. This figure incorporates the overall phasing considerations discussed above. Specifically, it considers adoption of this Plan in its entirety, recommends comprehensive permitting and modifications to environmental documents for the Plan as a whole, and identifies the potential for early partnership with the USFWS. The figure then illustrates an appropriate implementation pathway for each focus area. Conditions precedent (e.g. mandatory for implementation of the preferred alternative for each focus area) are shown as black arrows. Opportunities for synergy (e.g. not mandatory for implementation of the preferred alternative, but that streamline implementation and provide benefit to the overall Plan) are shown as dashed blue arrows. Major elements for the preferred alternative (e.g. elements that must be constructed as part of a preferred alternative for each focus area) are shown as solid blue arrows.

Figure 6-9 Implementation Pathway for Restoration and Enhancement of the Otay District



The restoration of the J Street Marsh and Channel (Focus Area 6) is planned to occur in buffer areas, and would require additional planning for adjacent buffers, parklands, and development parcels. Restoration of adjacent focus areas would not be required for implementation of Focus Area 6 (Figure 6-9). However, restoration of Focus Area 6 would result in a large surplus of sediment and re-use of excavated material should be part of project planning. Project timing may be based on opportunistic reuse of excavated material at adjacent development sites or within adjacent focus areas. As such, the re-use of surplus sediment generated from Focus Area 6 is indicated in Figure 6-9 by a dashed blue line connected to Focus Areas 4 and 5. Restoration of Focus Area 6 would need to be consistent with existing environmental documentation. Work in Focus Area 6, would require U.S. Army Corps of Engineers permits in order to effectively tie the restoration into the existing tidal wetlands.

Restoration of the former SBPP Intake and Discharge Channels (Focus Area 4) and the adjacent CVWR Access Area (Focus Area 5) may be completed independently; however, it would be most cost-effective to consider restoration of these two areas as a single action (indicated in Figure 6-9 as a dashed blue line). Restoration of slopes within Focus Area 4, including the Southern Buffer area, would require additional planning within adjacent parkland and areas of planned development. Restoration of Focus Areas 4 and 5 would require substantial sediment to be placed to create tidal habitats, and to widen the habitat and shore margins on the CVWR Access Area. As such, joint implementation with restoration of Focus Area 6 (which would yield a surplus of material) is considered the best option for managing fill movements. In-water restoration within Focus Areas 4 and 5 would require additional entitlements. Grading along the Southern Buffer may require a partnership with the USFWS as the adjacent South Bay Salt Ponds are part of the San Diego Bay NWR. This is indicated in Figure 6-9 by a dashed blue line at the permitting phase of work.

REFERENCES

[CCC] California Coastal Commission, 2015. California Coastal Commission Sea Level Rise Policy Guidance: Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Plans. Adopted August 12, 2015.

Cayan D., A.L. Luers, M. Hanemann, G. Franco, and B. Croes. 2006. Scenarios of climate change in California: an overview. Prepared for the California Energy Commission and the California Environmental Protection Agency. February 2006. 47 pages. Downloaded from: http://www.energy.ca.gov/2005publications/CEC-500-2005-186/CEC-500-2005-186-SF.PDF

Dudek. 2010. Final Impact Report (EIR) for the Chula Vista Bayfront Master Plan, UPD #83356-EIR-658, SCH#2005081077. Prepared for the San Diego Unified Port District. April 2010. Downloaded from: https://www.portofsandiego.org/chula-vista-bayfront-master-plan/documents/environmental-impact-reports/final-environmental-impact-report-eir-1.html

Dudek. 2015. Biological Resources Survey Report for the E Street Realignment in Chula Vista, Chula Vista Bayfront Master Plan, California. Prepared for the San Diego Unified Port District. March 2015.

Eguchi, T., J .A. Seminoff, R.A. LeRoux, P.H. Dutton, D.L. Dutton. 2010. Abundance and survival rates of green turtles in an urban environment: coexistence of humans and an endangered species. Mari ne Biology 157:1869-1877.

ESA. 2015. DRAFT – Habitat Elevations Based on Percent Inundation at Ballona. May 26, 2015.

Flint, L. E. and A. L. Flint. 2012. Simulation of Climate Change in San Francisco Bay Basins, California: Case Studies in the Russian River Valley and Santa Cruz Mountains. U.S. Geological Survey Scientific Investigations Report 2012-5132, 55 p.

Gersberg, R.M. 2014. San Diego Bay Terrain Model Final Report. Prepared for the San Diego Unified Port District. January 2014. 32 pages. Downloaded from: https://www.portofsandiego.org/bpc-policies/doc_view/5666-san-diego-bay-terrain-modelfinalreport-feb-2014.html

Grossinger, RM, ED Stein, KN Cayce, RA Askevold, S Dark, and AA Whipple 2011. Historical Wetlands of the Southern California Coast: An Atlas of US Coast Survey T-sheets, 1851-1889. San Francisco Estuary Institute Contribution #586 and Southern California Coastal Water Research Project Technical Report #589.

ICF International, Inc. 2016. South Bay Bio Reconnaissance Survey. Prepared for the San Diego Unified Port District. September 2016. 40 pages.

Madrak, S.V. 2016. Influence of temperature on habitat use by East Pacific green turtles (Chelonia mydas) in an urbanized environment. Dissertation. San Diego State University. San Diego, California, UC Davis, Davis, California.

Merkel & Associates, Inc. 2014. 2014 San Diego Bay Eelgrass Inventory and Bathymetry Update. Prepared for U.S. Navy and San Diego Unified Port District. May 2015. In publication.

Merkel & Associates, Inc., Environmental Science Associates, and CSU Fullerton. 2015. San Diego Native Oyster Restoration Plan. Prepared for the California State Coastal Conservancy and San Diego Unified Port District. May 2015. Available from: http://scc.ca.gov/webmaster/ftp/pdf/san_diego_bay_native_oyster_restoration_plan_final_reduced

[NOAA] National Oceanic and Atmospheric Administration, Department of Commerce (DOC), National Ocean Service (NOS), Coastal Services Center (CSC). 2011. 2009 - 2011 CA Coastal Conservancy Coastal LiDAR Project. Available from: https://coast.noaa.gov/digitalcoast/

[NRC] National Research Council. 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington. June 2012.

PWA. 1995. Design Guidelines for Tidal Channels in Coastal Wetlands, Prepared for the U.S. Army Corps of Engineers, Waterways Experiment Station, January 1995.

Rick Engineering. 2016. Chula Vista Bayfront Sweetwater District Grading Plan. Prepared for San Diego Unified Port District.

[SDUPD] San Diego Unified Port District. Chula Vista Bayfront Master Plan Settlement Agreement. 2010. Available from: https://www.portofsandiego.org/chula-vista-bayfront-master-plan/documents/3418-cv-bayfront-master-plan-settlement-agreement-with-bayfront-coalition/file.html

[SDUPD]. San Diego Unified Port District. Chula Vista Bayfront Master Plan Development Policies. 2012a. Available from: https://www.portofsandiego.org/chula-vista-bayfront-master-plan/documents/bayfront-cultural-and-design-committee/committee-documents/5002-cvbmp-development-policies-certified-aug-9-2012/file.html

[SDUPD]. San Diego Unified Port District. Chula Vista Bayfront Master Plan Public Access Program. 2012b. Available from: https://www.portofsandiego.org/chula-vista-bayfront-master-plan/documents/bayfront-cultural-and-design-committee/committee-documents/5001-cvbmp-public-access-program-certified-aug-9-2012/file.html

[SDUPD] San Diego Unified Port District and City of Chula Vista. 2016. Chula Vista Bayfront Master Plan Natural Resources Management Plan. May 2016. 545 pages. Available from: https://www.portofsandiego.org/chula-vista-bayfront-master-plan/documents/wildlife-advisory-group/natural-resources-management-plan-nrmp/7419-natural-resources-management-plan/file.html

Takekawa, J.Y., Thorne, K.M., Buffington, K.J., Freeman, C.M., and Block G. 2013. Downscaling climate change models to local site conditions: San Diego National Wildlife Refuge Complex. Unpubl. Data Summary Report. U.S. Geological Survey, Western Ecological Research Center, Vallejo, CA. 95pp.

Thorne, K.M, K.J. Buffington, C.M. Freeman, K.W. Powelson, G.M. Block, and J.Y. Takekawa. 2014. Projecting tidal marsh response to sea-level rise using local site conditions: San Diego Bay National Wildlife Refuge: Sweetwater Unit. Prepared for U.S. Geological Survey, Western Ecological Research Center, Vallejo, CA. 41pages.

[USFWS] United States Fish and Wildlife Service. 2006. San Diego Bay National Wildlife Refuge Sweetwater Marsh and South San Diego Bay Units Comprehensive Conservation Plan and Environmental Impact Statement. August 2006.

[U.S. Navy] U.S. Department of the Navy, Naval Facilities Engineering Command Southwest and Port of San Diego. 2013. San Diego Bay Integrated Natural Resources Management Plan, Final September 2013. San Diego, California. Prepared by Tierra Data Inc., Escondido, California.

Zeeman, C., S.K. Taylor, J. Gibson, A. Little, and C. Gorbics. 2008. San Diego Bay National Wildlife Refuge Sweetwater Marsh Unit Paradise Marsh Refuge Cleanup Project, F&G Street Marsh Contaminants Investigation. Final Report. October 2008. 106 pages.