Appendix N. Sea Level Rise Assessment Technical Report

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De Anza Cove Redevelopment Project

Sea Level Rise Assessment Technical Report

Prepared for: Harris & Associates and the City of San Diego

07 August 2023

Executive Summary

The Supplemental Environmental Project (SEP) required an extreme sea level rise assessment of an expanded wetland restoration alternative as part of the Programmatic Environmental Impact Report (PEIR) for the De Anza amendment to the Mission Bay Park Master Plan to demonstrate that the alternative would result in the establishment of 80 acres of additional functional wetlands, not including the Kendall-Frost Marsh/Northern Wildlife Preserve, in the year 2100. This Sea Level Rise Assessment Technical Report provides the required assessment of the expanded wetland alternative, identified in the PEIR as “Alternative 3 – Wetlands Optimized”, as well as the City’s preferred plan, known as De Anza Natural and shown in Figure 3 in the PEIR. The requirement of the SEP was met with a sea level rise modeling assessment and conceptual grading exercise that resulted in 85.6 acres of viable wetland habitat for De Anza Natural and 87.3 acres for the PEIR Alternative 3 – Wetlands Optimized with 7 feet of sea level rise modeled for both. It should be noted that the conceptual grading design herein is just one of many approaches that could be taken in the future when a project is proposed as part of a public General Development Plan process per Council Policy 600-33; this study is simply to show that 80 acres is attainable as called for in the SEP given the current set of sea level rise parameters. While this establishes the technical feasibility of this requirement through an “all at once” adaptation approach of elevating (filling) the site by approximately 5 feet, an adaptive planning and management approach is more appropriate. An adaptive planning approach would incorporate the balancing of wetland habitat stewardship and recreational use of this space in a dynamic fashion over time as sea level rise impacts are realized. An adaptive planning approach would include the development of a monitoring framework, thresholds, triggers, and appropriate management actions that would allow for the proactive adaptation of the space over time. The 7-foot sea level rise scenario analyzed in this report is an aggressive target to build resilience to and has a low likelihood of occurrence (0.5%). The specific land use types proposed for the De Anza Natural Amendment allow time and space for thoughtful adaptation and proactive management to occur.

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Introduction

Through the City of San Diego's (City) De Anza Natural Amendment to the Mission Bay Park Master Plan Draft Program Environmental Impact Report (PEIR) 2023, a review by the Regional Water Quality Control Board indicated that a sea level rise analysis was necessary to comply with the agreed upon Supplemental Environmental Project (SEP) requirements for the De Anza Cove Redevelopment Project (Project). The SEP is part of a settlement agreement between the City's Public Utilities Department (PUD) and the Regional Water Quality Control Board (RWQCB) for the 2016 Tecolote Canyon Sewage Spill. As one of the components to the SEP, PUD would fund additional analysis and study of the expanded restoration alternative for the PEIR being prepared for the De Anza Cove Amendment for the Mission Bay Park Master Plan. The SEP promotes the restoration of aquatic ecosystems in accordance with Tentative Resolution No. R9-2015-0041 to further recovery of streams, wetlands, and riparian systems in accordance with the RWQCB's Practical Vision.

Specifically, the SEP requires studying an expanded restoration alternative that would result in the establishment of 80 acres of additional functional wetlands (i.e., low-high salt marsh and mudflat habitat), not including the Kendall-Frost Marsh/Northern Wildlife Preserve, at year 2100 based on current models utilized by the City for sea level rise projections. As outlined in the Notice of Preparation, the De Anza Natural Amendment will rely upon sea level rise scenarios consistent with the City's Climate Resilient SD Plan (2021) and the City's Sea Level Rise Vulnerability Assessments (2019a, 2019b), and it will follow State of California sea level rise guidance.

This Sea Level Rise Assessment Technical Report (Report) demonstrates how 80 acres of functional wetland habitat can persist within two of the Project plans under a 7-foot sea level rise scenario. Conceptual grading was developed for two of the plans within the PEIR to accommodate proposed land uses and these habitat areas. It should be noted that the conceptual grading design herein is just one of many approaches that could be taken in the future when a project is proposed as part of a public General Development Plan process per Council Policy 600-33; this study is simply to show that 80 acres is attainable as called for in the SEP given the current set of sea level rise parameters. The Project plans evaluated are described below:

- <u>Proposed Project – De Anza Natural (Figure 2):</u> The De Anza Natural plan would expand the Project Area's natural habitat and improve water quality through the creation of additional wetlands while implementing nature-based solutions to protect the City against the risk of climate change in line with the City's Climate Resilient SD Plan (2021). The Project would maximize wetland restoration while maintaining active recreation acreage and providing for a variety of other community and visitor-serving uses, including low-cost visitor accommodations (which could include recreational vehicles and camping facilities), passive recreational opportunities, and improvements to increase public access through the park by biking/rolling and walking.
- <u>PEIR Alternative 3 – Wetlands Optimized (Figure 3):</u> The Wetlands Optimized Alternative would increase wetlands and associated transitional zones and uplands to be created and restored in northeastern Mission Bay, converting the southern portion of the De Anza "boot" and open water areas of De Anza Cove to wetlands. The Wetlands Optimized Alternative would maximize implementable wetland restoration generally reflective of existing feasibility studies for Mission Bay. It would also provide other uses, such as active recreation, regional parklands, open beach, low-cost visitor guest accommodations, boat facilities/clubhouse, uplands, and multi-use paths, but would result in reduced acreage from existing conditions for both active recreation (-16.3 acres) and low-cost visitor accommodations (-63.12 acres).

The Project is located in De Anza Cove, which is in the northeast corner of Mission Bay Park in the City. The Project Area is bounded to the east by Mission Bay Drive, the north by Grand Avenue (on the eastern portion of the Project Area) and Pacific Beach Drive (on the western portion), the west by Crown Point Drive, and the south by Mission Bay. The Rose Creek mouth bisects the Project Area into eastern and western portions (Figure 1).

Figure 1. De Anza Cove Redevelopment Project Site

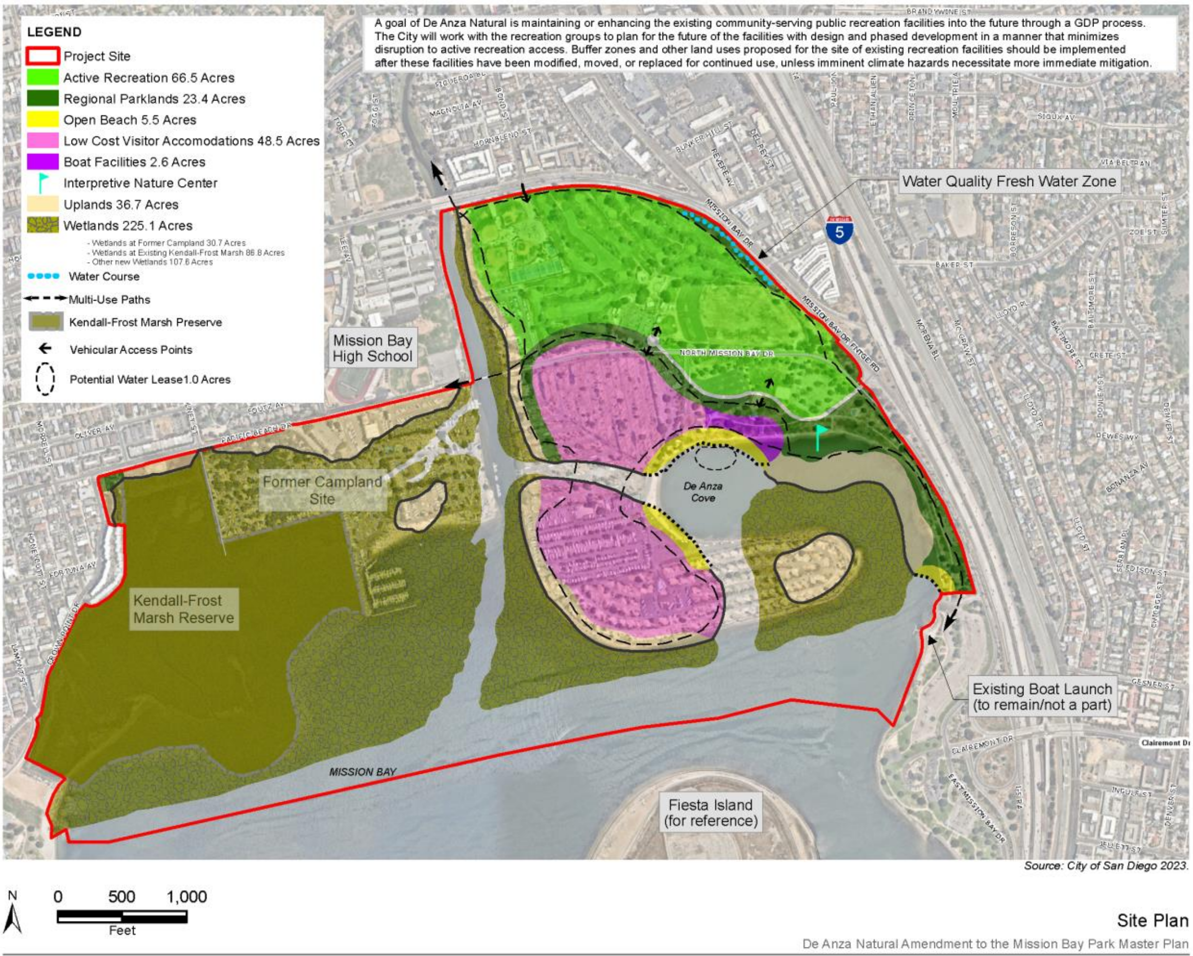


Figure 2. Proposed Project De Anza Natural

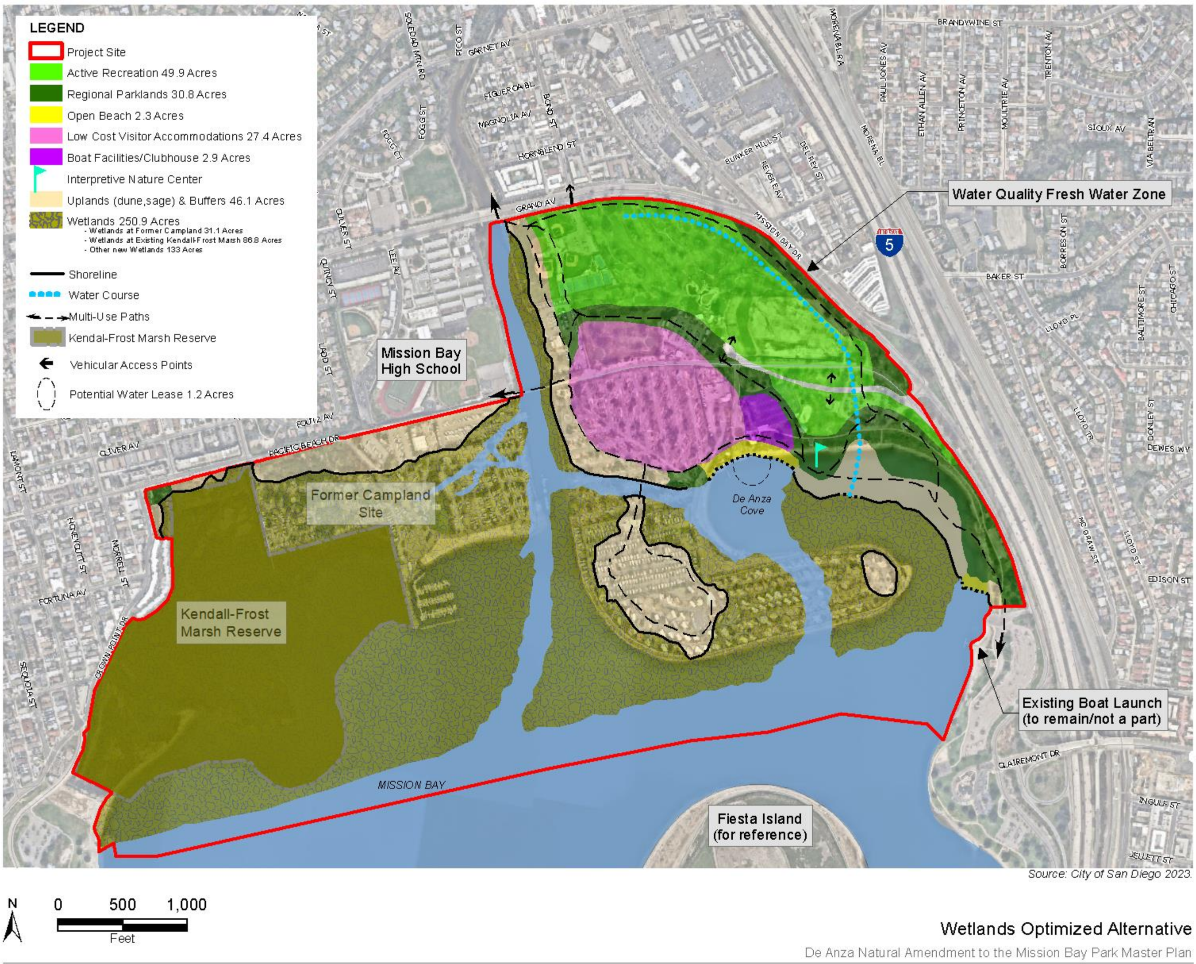


Figure 3. PEIR Alternative 3 – Wetlands Optimized

Baseline Conditions

Site Grades

In order to establish baseline conditions, GHD utilized available topographic and bathymetric data to generate existing conditions in the Project Area (Figure 1). These data were utilized to generate an elevation surface for the Project site, which was used to provide a basis for the grading design of the two plans. A LiDAR survey collected in 2014 under the USGS National Geospatial Technical Operations Center (NGTOC) was used for the landside, topographic data that was combined with high resolution bathymetric data for submerged portions of the site, collected in 2013 by Merkel and Associates. For consistency with City standards, both data sets were converted from their native vertical datums (i.e., NAVD88) to NGVD29 in feet. NAVD88 elevations were converted to NGVD29 using the adjustment factor of 2.093 feet (NGVD29 to NAVD88) retrieved from the NOAA North American Vertical Datum Conversion (VERTCON) for the Project location.

Water Levels

Tides

The tides in southern California are mixed semi-diurnal, meaning there are two unequal low and high tides each lunar day, which is approximately 25 hours. The NOAA tide station in San Diego Bay (Station 9410170) is representative of tides and water levels at the Project Site. The water levels inside Mission Bay are largely dictated by astronomical or extreme tides occurring in the ocean that flood through the mouth of the bay. Tidal datums from the San Diego Bay Station were converted to NGVD29 for the purposes of this study to be consistent with City standards. The tidal datums for a range of water levels for this station are shown in Table 1.

Table 1. Datums for San Diego Tide Gauge (Sta. 9410170)

Datum	Elevation, ft NAVD88	Elevation, ft NGVD29
Highest Observed Tide (11/25/2015)	7.81	5.72
Highest Astronomical Tide (HAT)	7.19	5.10
Mean Higher-High Water (MHHW)	5.29	3.20
Mean High Water (MHW)	4.56	2.47
Mean Tide Level (MTL)	2.53	0.44
Mean Sea Level (MSL)	2.51	0.42
NGVD29	2.09	0.00
NAVD88	0.00	-2.09
Mean Low Water (MLW)	0.51	-1.58
Mean Lower-Low Water (MLLW)	-0.43	-2.52
Lowest Astronomical Tide (LAT)	-2.49	-4.58
Lowest Observed Tide (12/17/1937)	-3.52	-5.61

Typical daily tides range from mean lower low water (MLLW) to mean higher high water (MHHW), a range of about 5.7 feet. During spring tides, which occur twice per lunar month, the tidal range increases due to the additive gravitational forces caused by alignment of the sun and moon. During neap tides, which also occur twice per lunar month, the forces of the sun and moon partially cancel out, resulting in a smaller tide range and lower high tides. The largest spring tides of the year, sometimes referred to as “King” tides, occur in the winter and summer and result in tidal ranges of 7 feet or greater.

Extreme Water Levels

Ocean water levels typically vary within predictable astronomical tide ranges; however, sea level anomalies caused by El Niño Southern Oscillation or storm surge events can increase the water levels above the predicted astronomical tide. These events, in combination with high astronomical tides, can result in extreme water levels (EWL) and increased potential for flooding of low-lying coastal areas. The EWLs corresponding to various annual exceedance probabilities are shown in Table 2 and Figure 4. An annual exceedance probability of 1% refers to a return period of 100 years, while an annual exceedance probability of 99% refers to a return period of 1 year.

Table 2. Extreme Water Levels for the San Diego Bay (Sta. 9410170)

Annual Exceedance Probability (Return Period)	Feet Above NAVD88	Feet Above NGVD29
1% (100 year)	7.87	5.78
10% (10 year)	7.64	5.55
50% (2 year)	7.35	5.26
99% (1 year)	6.96	4.87

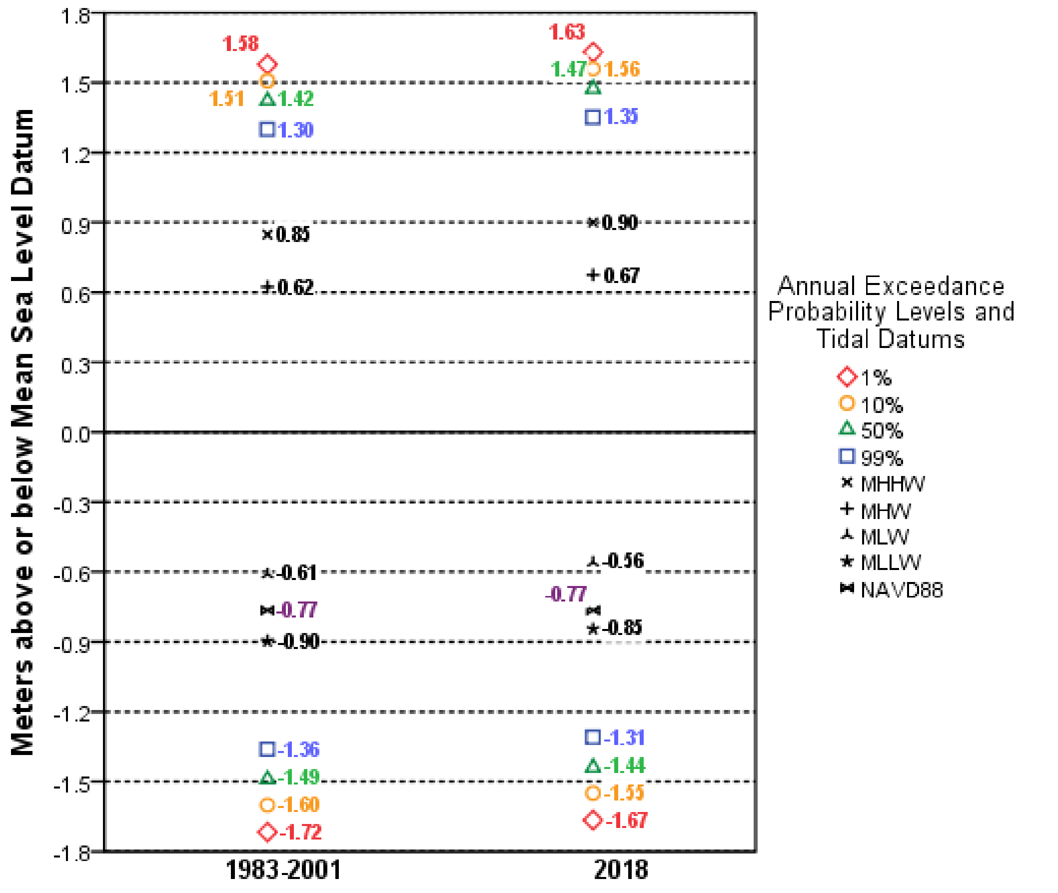


Figure 4. Exceedance Probability Levels and Tidal Datums for the San Diego Bay (Sta. 9410170)

Sea Level Rise

Historic Sea Level Trends

NOAA calculates long term mean sea level (MSL) trends for various tidal stations with adequate data coverage. The MSL trends are calculated at monthly intervals and do not include seasonal fluctuations. These trends are provided for the San Diego Bay tide station, which covers 1906 to present (Figure 5).

The relative sea level trend is a rise of 2.21 mm/yr (0.09 inches/yr), which equates to an increase of 0.75 feet in 100 years (1906 to present). Assuming a linear sea level rise trend at a rate of 2.21 mm/yr and a 30-year timeframe, the MSL would increase 66.3 mm (2.6 inches). However, sea level rise projections are not linear, and the historic rate of sea level rise depends on the timeframe examined.

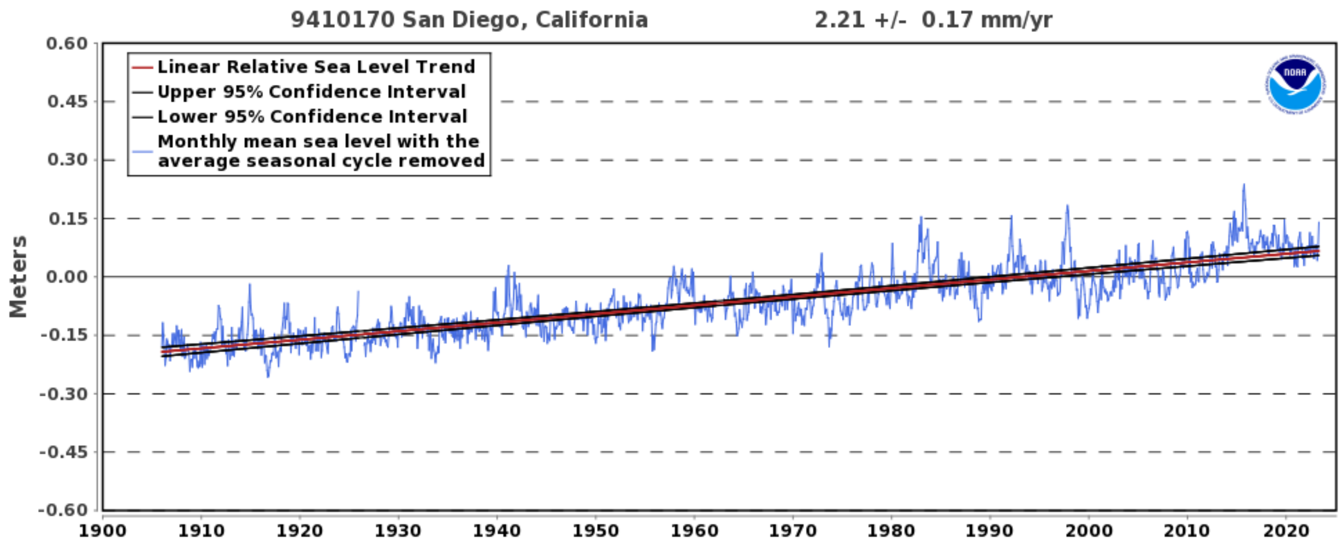


Figure 5. Relative Sea Level Trend for San Diego Bay Station 9410170 (NOAA, 2023)

Sea Level Rise Projections

Sea level rise projections along the west coast of California are provided by the Ocean Protection Council (OPC) in the 2018 State of California Sea Level Rise Guidance document for 12 active tide stations (OPC, 2018). The California Coastal Commission Sea Level Rise Policy Guidance (2018) refers to this guidance as the “best available science” regarding sea level rise projections in California. The San Diego tide station (Sta. 9410170) is the representative tide station to be used for the Project Site for sea level rise projections based on the OPC guidance. These projections are shown in Table 3 and Figure 6 for a range of probabilistic scenarios through the year 2150.

When interpreting sea level rise projections, it is important to consider the design life and risk tolerance of the Project being evaluated. The state guidance documents do not specify how these projections should be combined with other hazards such as an extreme storm event. Risk is specified by the OPC as risk aversion and is defined as “… the strong inclination to avoid taking risks in the face of uncertainty” (OPC, 2018). The guidance defines three categories of risk aversion:

Low Risk: Refers to the high end of the “likely range” and is intended for projects which would suffer little or no damage or disruption if sea level rise exceeded this projection.

Medium-High Risk: Refers to the 1-in-200 chance (0.5%) projection and applies to projects which would suffer greater consequences (damage and disruption) if sea level rise exceeded this projection.

Extreme Risk: Refers to the worst-case scenario and is intended for projects that would pose a major threat to life, public health and safety, or to the environment if damage or disruption were to be expected.

The proposed Project will provide passive and active recreational areas with fringing wetland habitat areas. These land uses align within the “Low Risk Aversion” or possibly more conservatively the “Medium-High Risk Aversion” category since coastal flooding of these spaces would result in little or no damage or disruption (Table 3). These land uses also have a high resiliency (ability to recover from short duration flooding without major repair or recovery efforts).

Table 3 Sea Level Rise Projections for San Diego (OPC, 2018)

Time Horizon	Low Risk Aversion		Medium-High Risk Aversion	Extreme Risk Aversion
	66% probability sea level rise is between… (feet)		0.5% Probability Projection (feet)	H++ Scenario Projection (feet)
2030	0.4	0.6	0.9	1.1
2050	0.7	1.2	2.0	1.8
2060	0.9	1.6	2.7	2.8
2070	1.1	2.0	3.6	3.9
2100	1.8	3.6	7.0	10.2
2150	3	6.1	13.3	22.0

A 7.0-foot sea level rise scenario was selected to be modeled for this assessment as a conservative measure and as required by the SEP. This scenario is the upper end of the range of projections for the year 2100 Medium-High Risk Aversion. This scenario is also consistent with the scenario used by the City for prior sea level rise studies. It is important to consider the likelihood of this scenario occurring by year 2100, which is very low (0.5%). It is important to note that for future planning of City projects where damage or disruption as a result of coastal flooding is minimal, a lower sea level rise scenario (that has a higher likelihood of occurrence) might be more appropriate.

While time horizons are a critical component in planning for sea level rise and designing resilience projects, they can often be misaligned with on the ground activities that will occur between the designed conditions and when impacts are experienced. While there is a very low likelihood of 7-feet of sea level rise occurring by 2100 at this Project Site (i.e., 0.5%), it is very likely that some level of sea level rise will impact the Project Site by this time horizon and beyond (Figure 6). Additionally, there is a high likelihood and confidence that the City will monitor and take actions to support the resilience of land uses and wetland habitat as impacts are observed.

Furthermore, sea level rise science and guidance on adaptation is constantly evolving. The H++ sea level rise scenario, for example, is in the process of being removed from the State guidance based on an improved understanding of the timing of possible large future ice sheet loss contributions (Sweet et al., 2022). Future updates to the sea level rise guidance documents should be anticipated as new research and data becomes available.

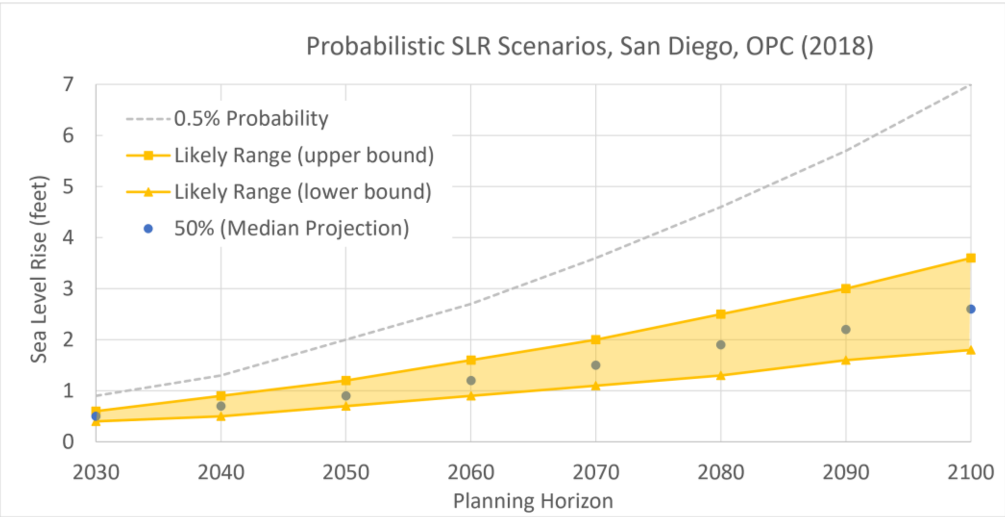


Figure 6. Sea Level Rise Projections for San Diego (OPC, 2018)

Sea Level Rise Exposure

To understand existing site exposure to sea level rise, sea level rise scenarios were compared to the site grades under two water levels scenarios in combination with the 7-feet of sea level rise projection. The 7-foot sea level rise scenario was modeled on top of mean high water (MHW) to illustrate average daily high tide conditions with sea level rise (Figure 7). The same sea level rise scenario was also modeled on top of an extreme spring high tide condition (Figure 8) to understand the site exposure under king tides that occur a few times a year.

The high sea level rise scenario used in this analysis (7 feet) shows clear impacts to habitat areas, the level of service, and usability of the site. If no project or adaptation measures were performed or implemented on this site, it is likely that as sea levels rise over time, wetland habitat will continue to be squeezed and the use of the site for recreation would be compromised.

Figure 7. Existing Conditions Modeled with Mean High Water (MHW) (2.47 ft NGVD29) Plus 7 Feet of Sea Level Rise

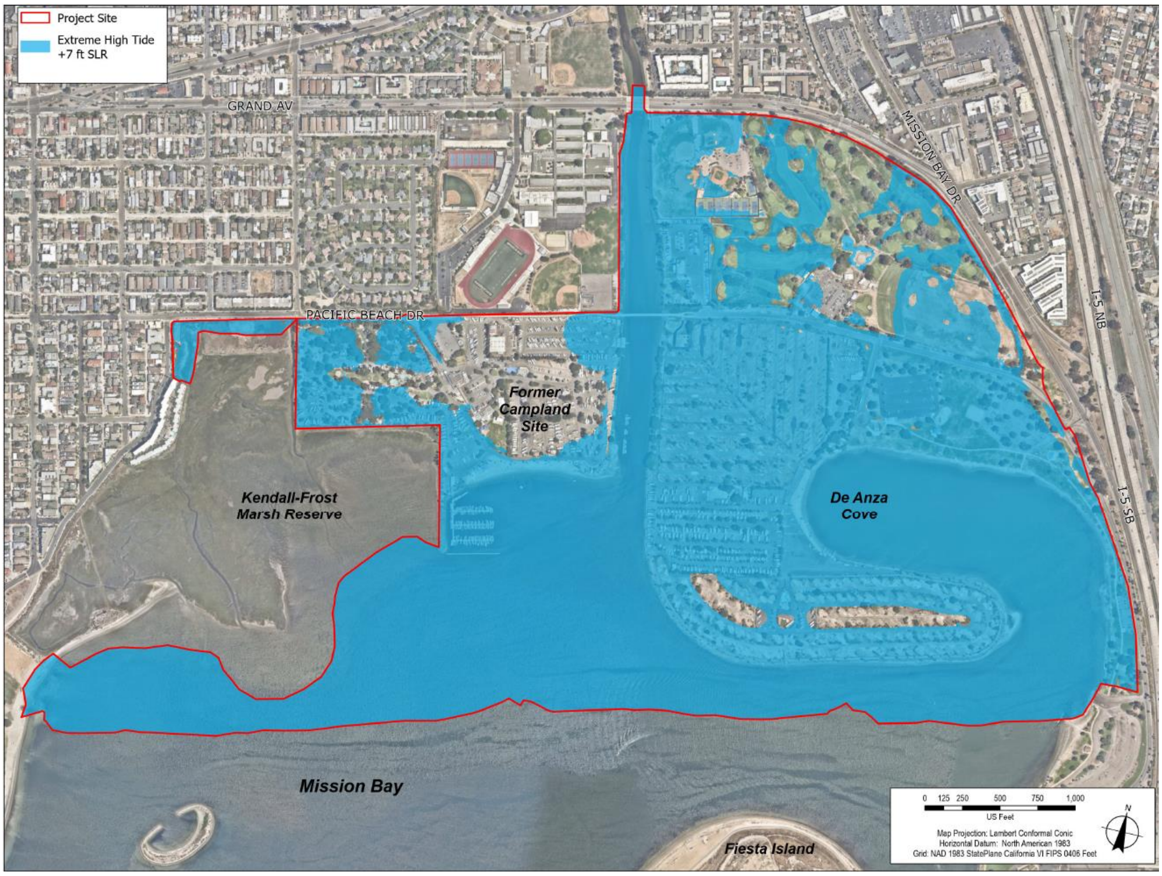


Figure 8. Existing Conditions Modeled with Extreme High Tide (5.28 ft NGVD29) Plus 7.0 Feet of Sea Level Rise

Wetland Habitat Types

A Wetland Habitat Survey (Appendix A) was prepared to establish reference geomorphic conditions for wetland habitats within Mission Bay. These reference habitat bands were needed to help predict the evolution of wetland habitats under the 7-foot sea level rise scenario for each plan. The nearest analogous site where wetland habitat exists is the Kendall Frost Marsh Reserve; thus, this was the site of the biological investigation.

To characterize existing wetland habitat bands, a biological field investigation was conducted at the Kendall Frost Marsh Reserve by GHD on July 13th, 2023. The primary objective of the survey was to document and validate the elevation of transition zones between wetland habitat types (i.e., upland to mudflat). Methodology and findings from that assessment are provided in Appendix A.

The Project Site is comprised of subtidal, mudflat, salt marsh, and upland habitat types. The surveyed habitat type transition zones were relatively consistent across each transect and the variation was reasonable considering site-specific differences such as hydrology and freshwater input, tidal connectivity, and geology (soil permeability). Among the mudflat to salt marsh transition and the salt marsh to upland transitions, the variation in elevation was approximately 1.1 feet. Based on these results, it is recommended that the elevation band of the potential salt marsh habitat be represented by the high upland transition and low mudflat transition. That is, the salt marsh habitat ranges from 7.0 feet to 2.1 feet. These habitat bands are presented below in Table 4 and Figure 9.

Table 4. Wetland Habitat Elevation Zone Bands

Habitat Type	Elevation Range (ft, NAVD88)		Elevation Range (ft, NGVD29)	
	Upper	Lower	Upper	Lower
Upland/Transition	> 7.0	7.0	>4.9	4.9
Salt Marsh (wetland habitat)	7.0	2.1	4.9	0.0
Mudflat (wetland habitat)	2.1	-0.4	0.0	-2.5
Subtidal	-0.4	< -0.4	-2.5	<-2.5

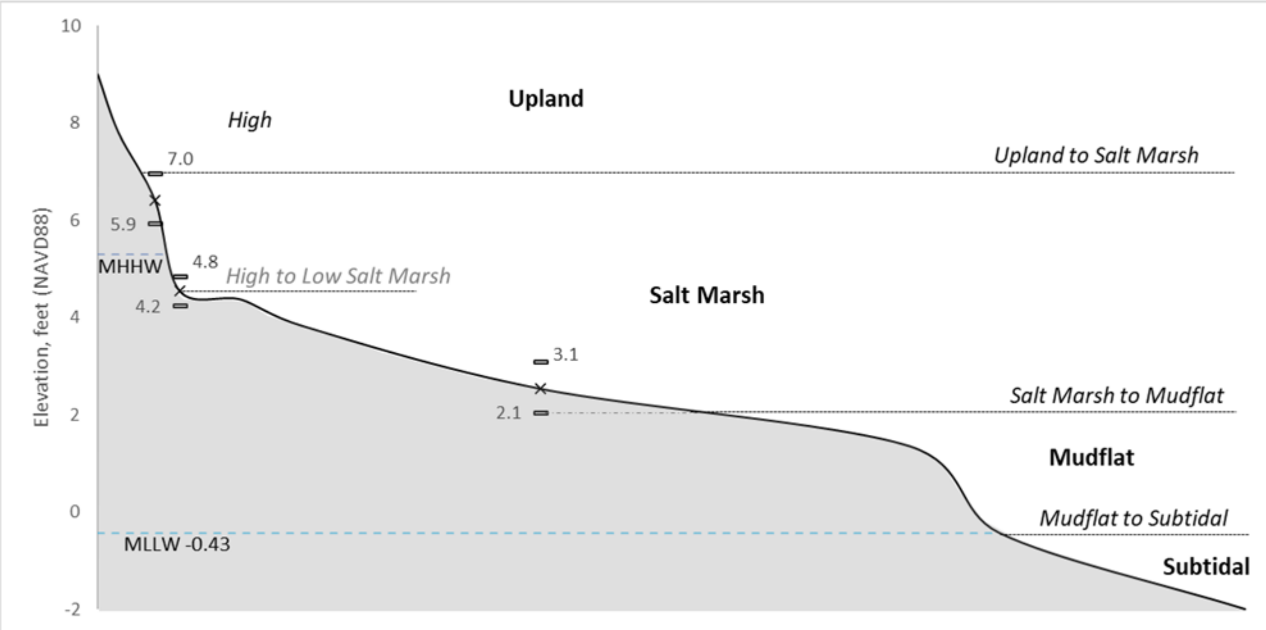


Figure 9. Surveyed Habitat Transition Elevations (range of surveyed values shown above/below point)

Sea Level Rise Modeling

Conceptual grading plans were developed for both De Anza Natural and the PEIR Alternative 3 – Wetlands Optimized plans that considered how the site would be developed (i.e., earthwork cut and fill) in order to support the proposed land uses and wetland habitat areas under an extreme future water level scenario (i.e., sea level rise and extreme tide). Based on the habitat elevation bands defined in the Wetland Habitat Survey, habitat areas were established within the grading plans that allow the wetland habitat to transgress upslope with sea level rise. Each of the two grading models were established using AutoCAD Civil 3D. Each plan was modeled assuming simplistic grading (i.e., level graded pads up to proposed developed areas). Slight modifications in the grading plans were necessary to achieve the proposed land use areas and 80 acres of viable wetland habitat under a 7-foot sea level rise scenario. The methodology and results of this modeling effort are presented in this section.

Methods

Water Level Buildup

To preserve the usability of proposed Project land uses, minimum threshold land elevations were established by conducting an analysis of potential future water levels. A “buildup” of future water levels was performed that took into account future scenarios of sea level rise under an extreme spring tide or king tide. A 1-foot freeboard elevation was applied to the water level buildups as a conservative measure in order to give vertical tolerance to the land use areas to account for more extreme tides than the one considered. That is to say, the water level buildup consisted of an extreme high tide plus the 2100 sea level rise scenario (7 feet) plus an additional 1.0 foot of freeboard. This elevation was used as the minimum elevation for graded areas that included all active land use types.

Conceptual Grading Plans

Two conceptual grading plans were analyzed to determine land use type and area under current and year 2100 conditions. Each plan used the same elevation breaks for each habitat band to establish the conceptual grading model.

Slopes and Drainage

Terrain modeling for each grading model considered current drainage patterns and accommodated existing storm drain facilities. Each model was developed to tie into the existing storm drain network in order to convey storm water away from developed areas, through the Project, and into Mission Bay. Each model considered generally how each land use would drain toward drainage facilities and did not incorporate detailed drainage design within the Project area. Within future design development phase, a more detailed grading plan will be necessary to develop the drainage design plan.

Land Use Types & Preservation

As described in Section 3.1.1, minimum threshold elevations for land use types were established by taking into account the extreme high tide plus the year 2100 sea level rise scenario plus an additional 1.0 foot of freeboard. Cross slopes were determined based upon feedback from the City and general understanding of the intended function and use of each proposed land use area. Active recreation areas were limited to a 2% cross slope to ensure relatively flat areas for playing fields and other recreation activities. A 4-5% cross slope was used for low-cost visitor serving areas to ensure those areas could provide reliable spaces for camping and overnight accommodations. In general, each land use type was valued consistently, and the grading plan strove to preserve the viability and function of all land use and habitat types through the 7-foot sea level rise scenario. However, due to limited space, SEP requirements, and community feedback, wetland habitats, active recreation, and low-cost visitor serving areas were prioritized to persist and be preserved as part of this assessment.

Wetland Habitat Evolution

Evaluation of existing site conditions was used to guide the development of conceptual site grading plans for each plan. Based upon the habitat zonation bands, present day grades for both plans were developed under the approach to 1) preserve planned wetland under the current condition, and 2) provide mudflat or wetland habitat in the 2100 sea level rise scenario (7 feet.). Figure 10 illustrates the framework for grading upland and high marsh areas under current sea levels with the understanding that these areas would transition to mudflats under a 7-foot sea level rise scenario. This methodology was used to develop elevations for both plans where present-day marsh would become mudflat; thus, remaining viable wetland habitat even with an extreme 7-foot sea level rise scenario.

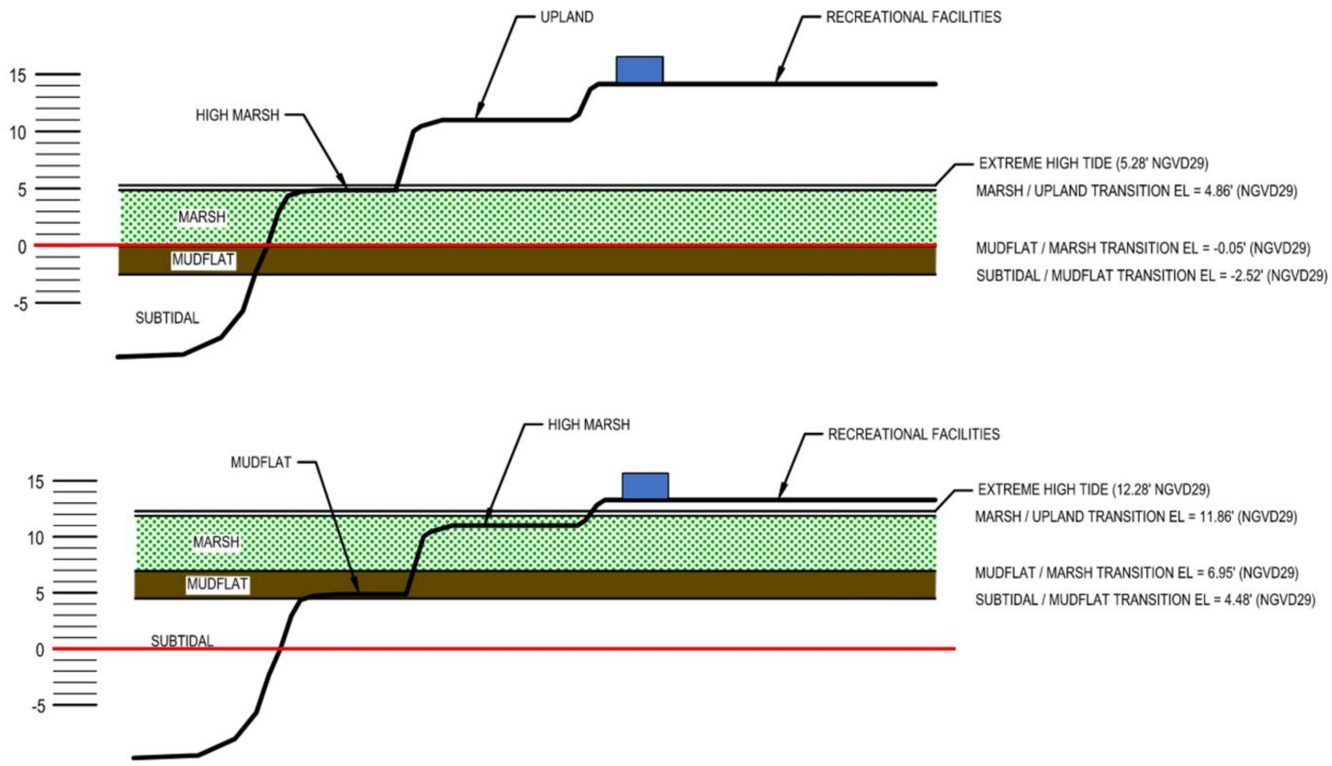


Figure 10. Cross Section of Habitat Zone Elevations Illustrating Overlap of Wetland Habitat between Present Day (top) and with 7 Feet of Sea Level Rise (bottom)

Results

To achieve the target 80 acres of additional wetland habitat, land elevations were increased for both plans to support these proposed land uses being able to accommodate sea level rise. This was achieved by adding elevation to the development footprint for the land use areas with a series of sloping habitat benches, present day salt marsh and upland habitat can transition to mudflat (Figure 10), preserving viable wetland habitat as sea levels rise. Grading elevated pads for land use areas can allow for the function and usage of those spaces to persist through sea level rise as well. Specific results for each of the alternatives are described below.

Proposed Project - De Anza Natural

The conceptual grading and sea level rise modeling for the De Anza Natural plan resulted in 85.6 acres of wetland habitat under the 7-foot sea level rise scenario (Table 5). To provide enough space and elevation for wetland habitat to persist in the De Anza Natural plan, an upland peninsula was created in the former Campland site (Figure 11). The grade of this peninsula allows for the transition to mudflat and wetland under the sea level rise scenario (Figure 12). Due to the size of the low-cost visitor accommodations in the southern portion of the Project area, space was limited to allow for transition of wetland habitat without creating additional upland areas. A broader upland area was also graded into the southeast corner of the Project site. This section was able to integrate with the desired adjacent land use types as part of this plan, while still allowing for wetland habitat transition with sea level rise. 68.1 acres of upland transition to wetland with the modeled sea level rise for the De Anza Natural plan.

Figure 11. De Anza Natural Conceptual Grading Plan under Existing Water Levels

Figure 12. De Anza Natural Conceptual Grading Plan under 7-foot Sea Level Rise Scenario

Table 5. Proposed Project - De Anza Natural Land Use and Habitat Acreages with and without Sea Level Rise

Land Use Type		Year 2023 Without Sea Level Rise (Acres)	Year 2100 With 7 Feet of Sea Level Rise (Acres)
Designated Land Use Zones*	Active Recreation	66.5	66.5
	Regional Parklands	22.4	22.1
	Open Beach	2.1	1.0
	Low-Cost Visitor Accommodations	48.3	48.2
	Boat Facilities	2.6	2.6
Wetland Habitat	Uplands	68.4	0.3
	Marsh (wetland habitat)	126.5	43.1
	Mudflat (wetland habitat)	11.4	42.5
	Wetland habitat total	137.9	85.6
*Designated land use zones may also be classified as disturbed or developed upland habitat, though the acreages are not included in the upland total			

Cross sections were selected across the Project site to depict the transitional slopes from proposed active recreational land uses to mudflat (Figure 13). Cross sections A through E are provided below (Figure 14).

Figure 13. De Anza Natural Cross Section Locations

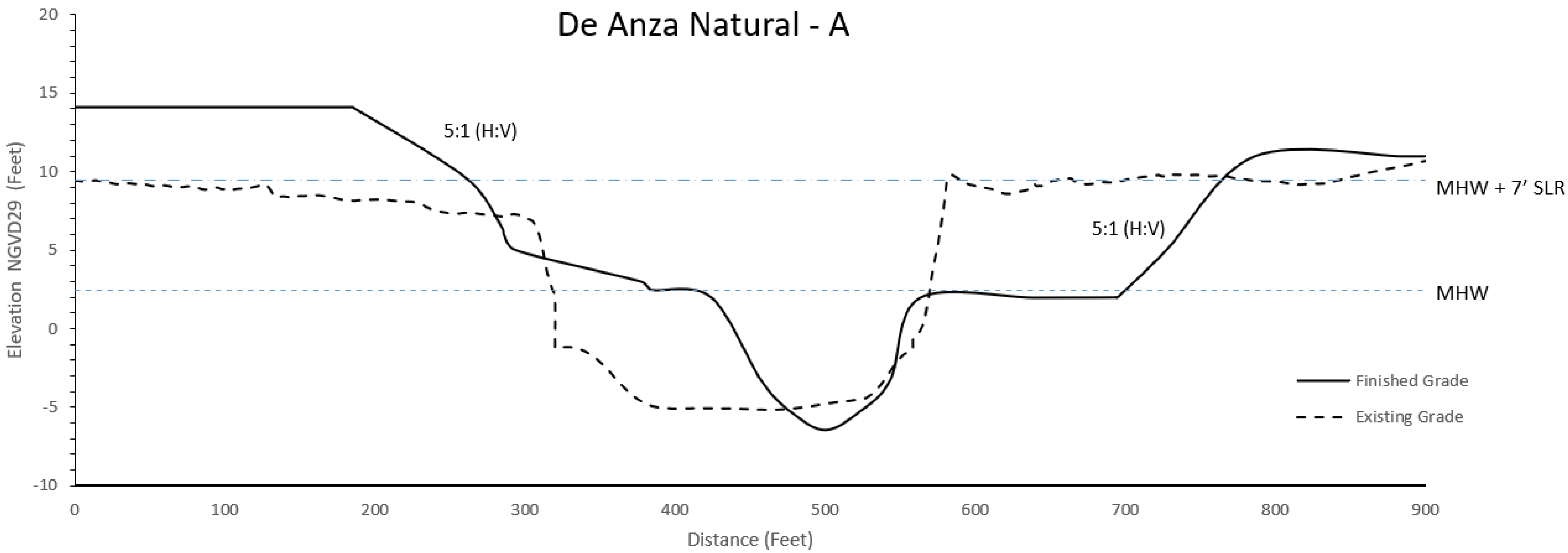


Figure 14. De Anza Natural Cross Section A

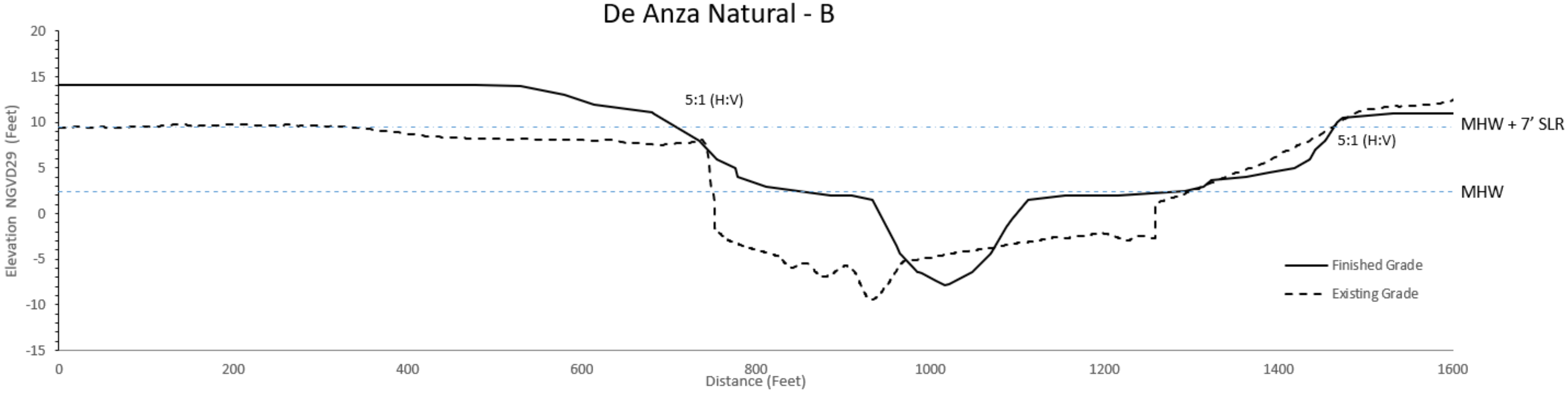


Figure 14. De Anza Natural Cross Section B

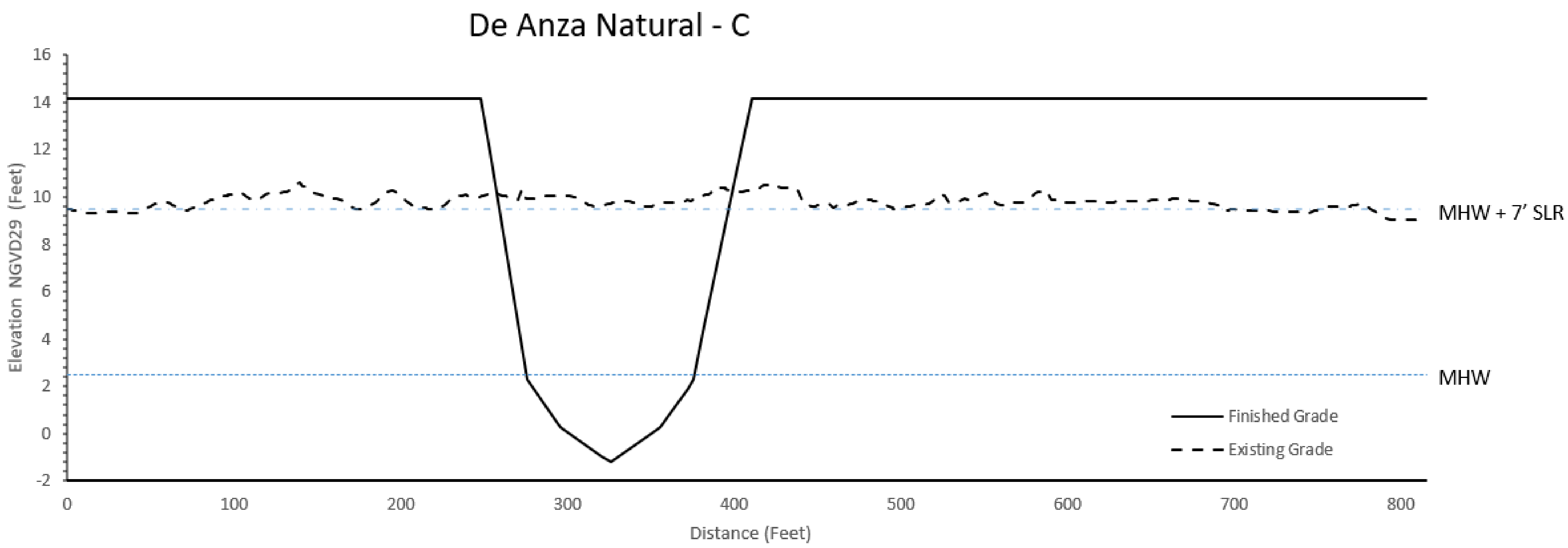


Figure 14. De Anza Natural Cross Section C

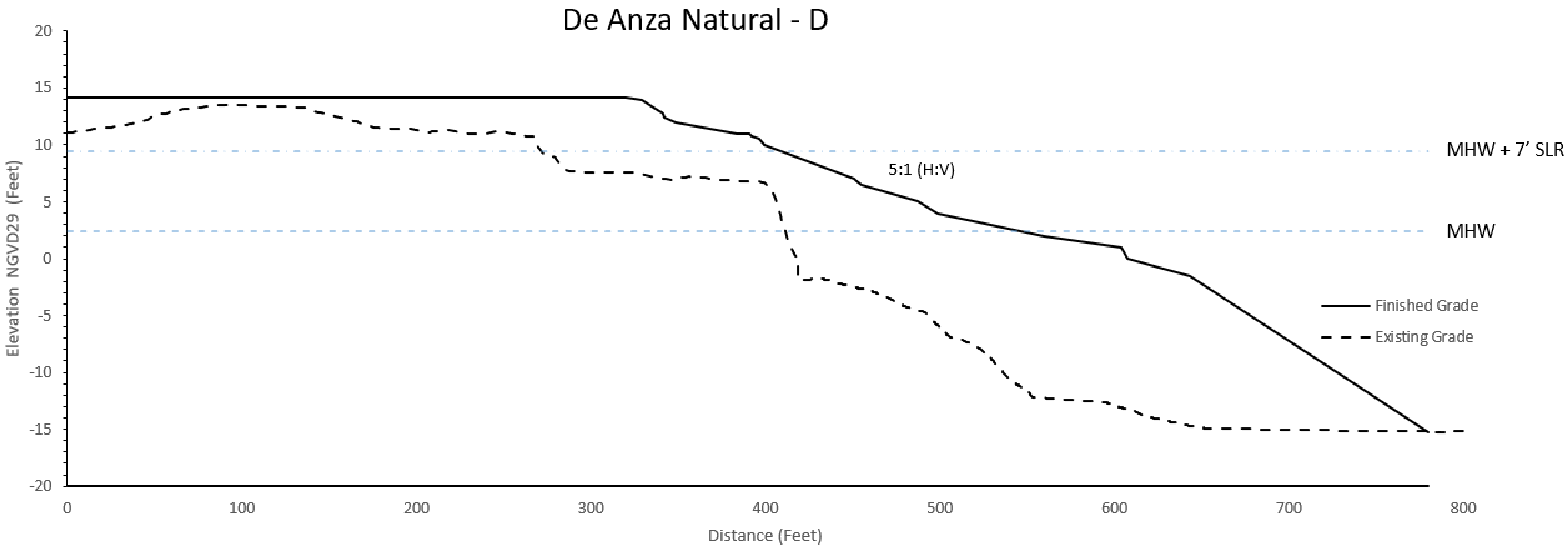


Figure 14. De Anza Natural Cross Section D

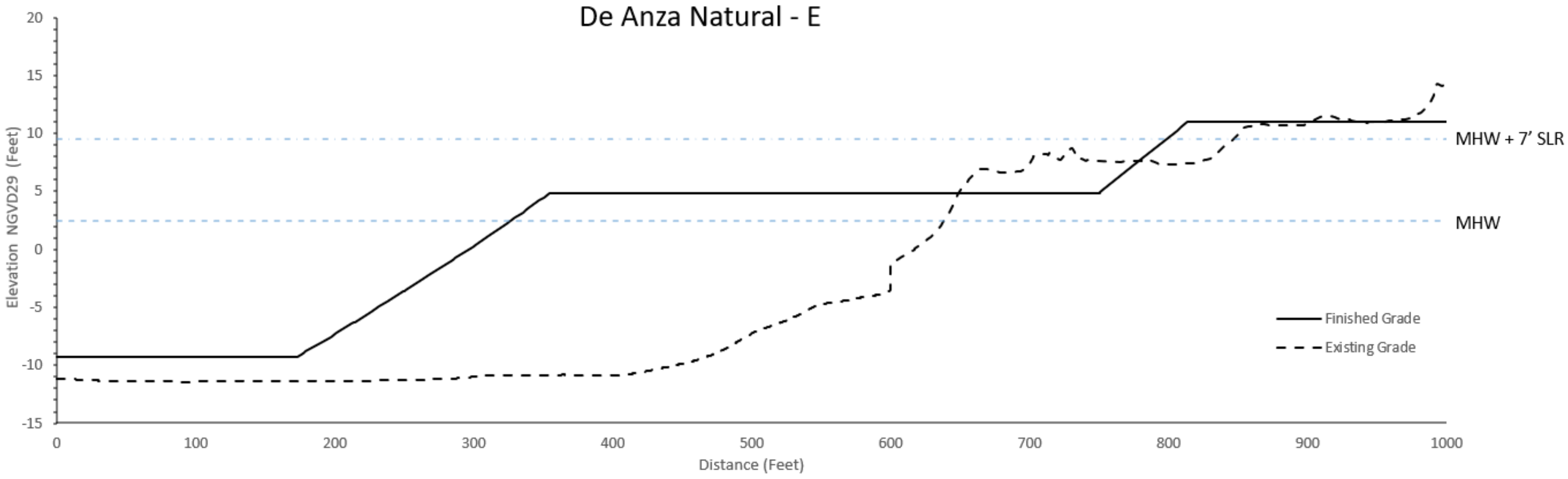


Figure 14. De Anza Natural Cross Section E

PEIR Alternative #3: Wetlands Optimized

The conceptual grading and sea level rise modeling for the Wetlands Optimized plan resulted in 87.3 acres of wetland habitat with 7 Feet of sea level rise (Table 6). Due to the generally reduced footprint of this alternative, minimal grading modifications were necessary to achieve the desired result (Figure 15). An expanded upland transition zone was developed in the southeastern island feature of this plan. Grading for upland transition zones and present-day salt marsh would allow for the conversation to mudflat under the sea level rise scenario considered (Figure 16). 53.0 acres of upland transition to wetland with the modeled sea level rise for the Wetlands Optimized plan.

Figure 15. Alternative #3: Wetlands Optimized Conceptual Grading Plan under Existing Water Levels

Figure 16. Alternative #3: Wetlands Optimized Conceptual Grading Plan under 7-foot Sea Level Rise Scenario

Table 6. Alternative #3: Wetlands Optimized Land Use and Habitat Acreages with and without Sea Level Rise

Land Use Type		Year 2023 Without Sea Level Rise (Acres)	Year 2100 With 7 Feet of Sea Level Rise (Acres)
Designated Land Use Zones*	Active Recreation	49.3	49.3
	Regional Parklands	29.9	29.3
	Open Beach	0.9	0.5
	Low-Cost Visitor Accommodations	27.2	27.2
	Boat Facilities	2.9	2.9
Wetland Habitat	Uplands	53.3	0.3
	Marsh (wetland habitat)	170.2	52.6
	Mudflat (wetland habitat)	11.5	34.7
	Wetland habitat total	181.7	87.3
*Designated land use zones may also be classified as disturbed or developed upland habitat, though the acreages are not included in the upland total			

Cross sections were cut across select areas of the Project site to depict how the slopes transition from proposed active recreational land uses to mudflat for this alternative (Figure 17). Cross sections A through E are provided below (Figure 18).

Figure 17. Alternative #3: Wetlands Optimized Cross Section Locations

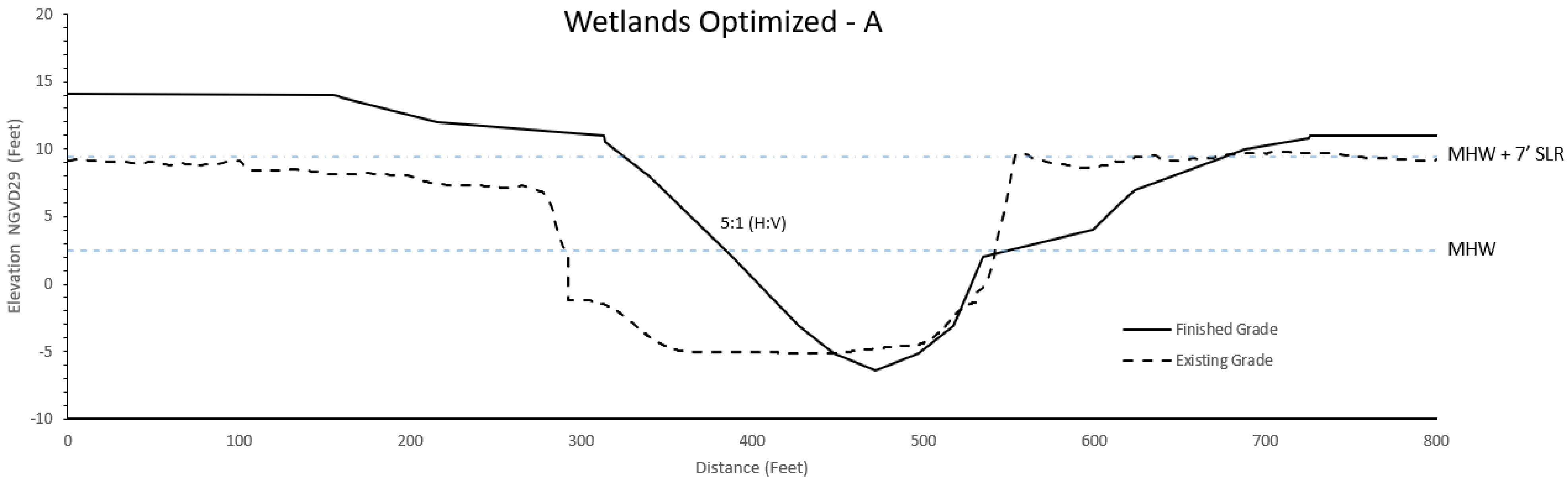


Figure 18. Wetlands Optimized Cross Section A

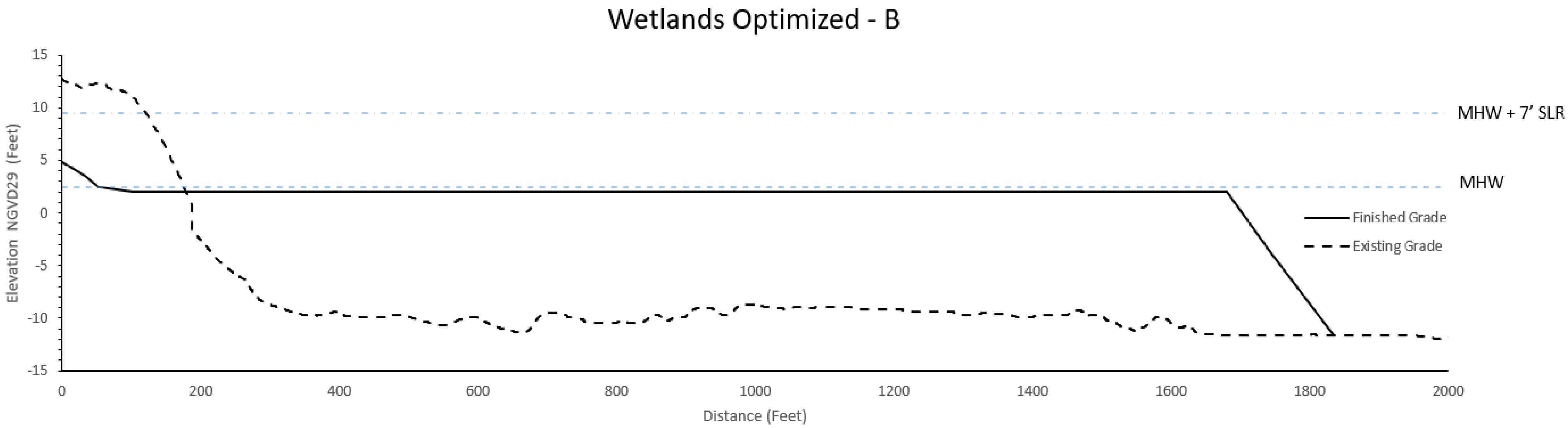


Figure 18. Wetlands Optimized Cross Section B

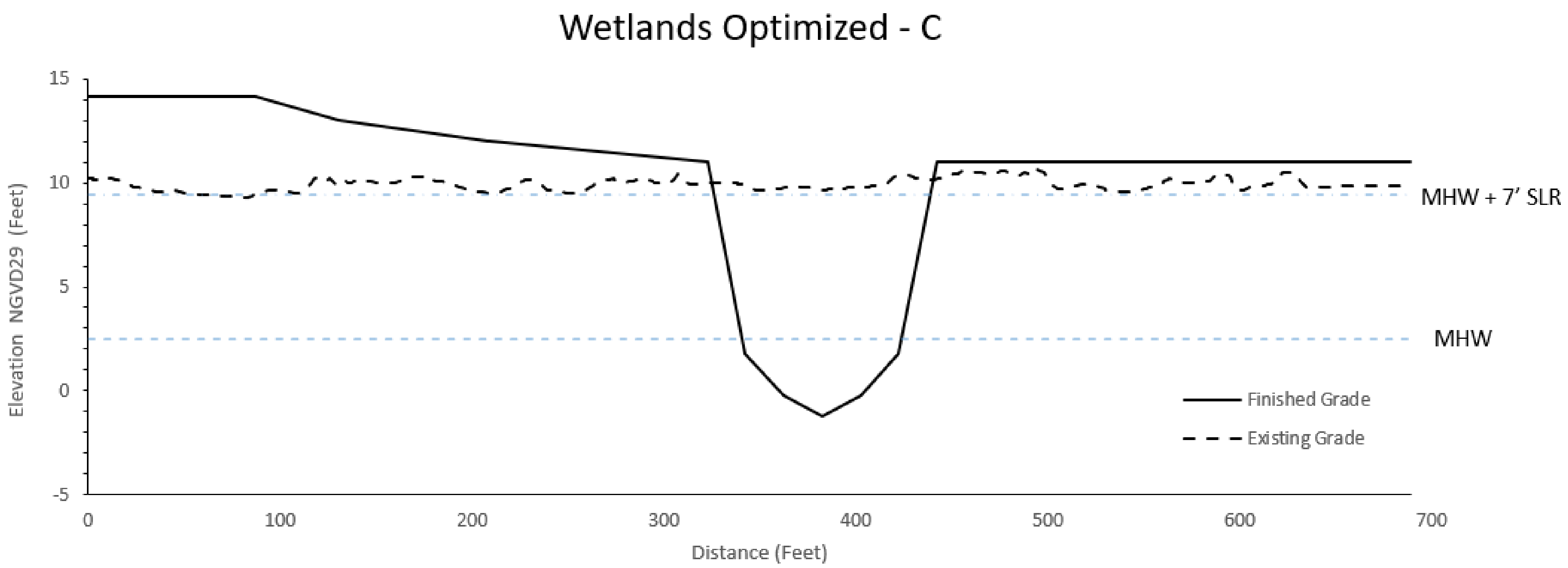


Figure 18. Wetlands Optimized Cross Section C

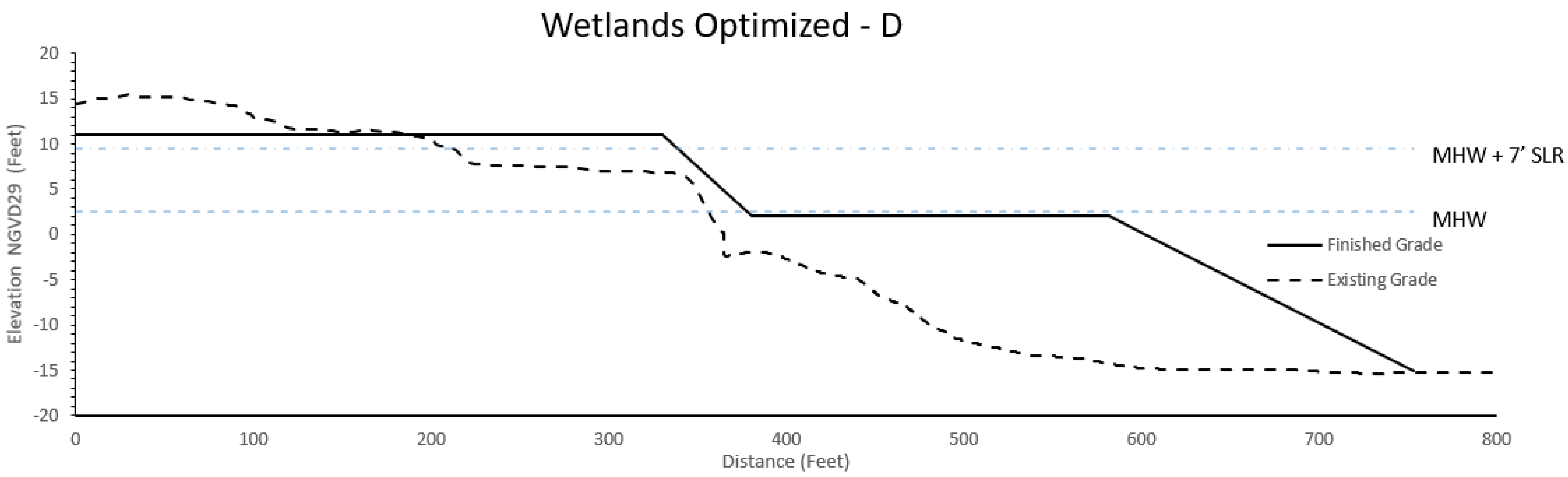


Figure 18. Wetlands Optimized Cross Section D

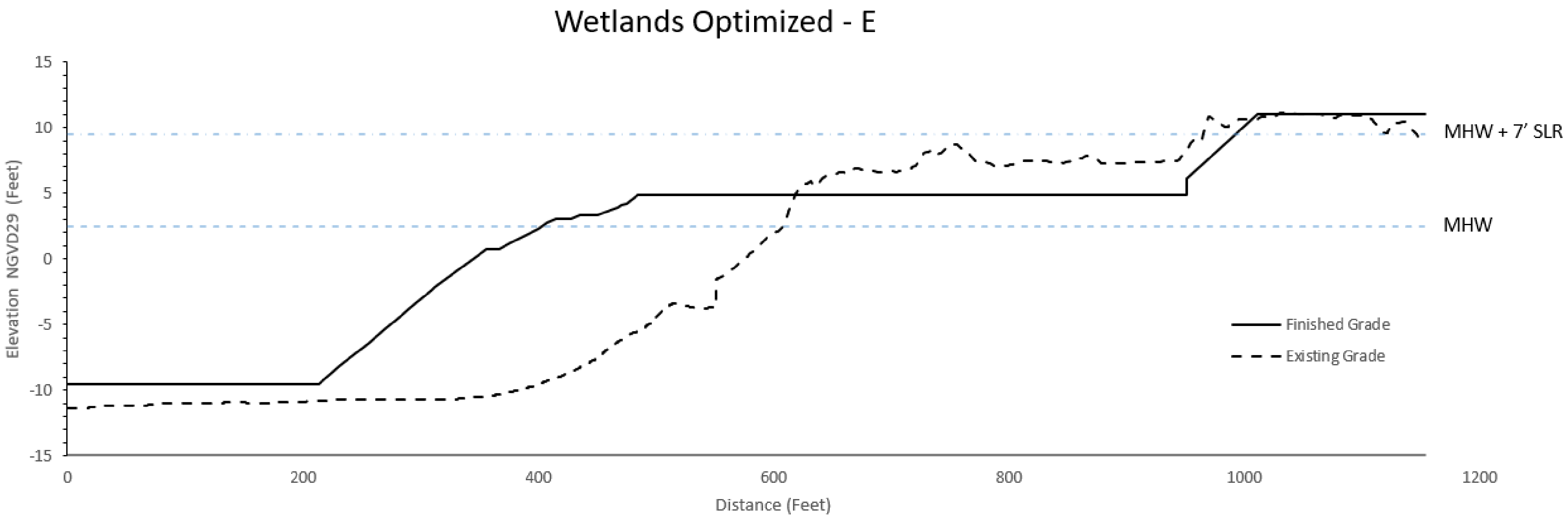


Figure 18. Wetlands Optimized Cross Section E

Management and Adaptation Considerations

Adaptive management involves monitoring the results of a management decision and updating actions as needed, and as based on new information and results from the monitoring (CCC, 2018). In light of sea level rise projections, it is prudent to use an adaptive management approach for management of wetland areas, habitat areas and restoration projects with clearly defined triggers for adaptive actions. Such an approach allows for various outcomes to be planned for and allows for highest and best use of coastal spaces and logical transition points. As this Project moves into the final engineering design phase, an adaptive management plan would be developed that supports the monitoring and stewardship of both habitat and land use areas.

As illustrated in this Report, by adding elevation to the development footprint for the land use areas with a series of sloping habitat benches, present day salt marsh and upland habitat can transition to mudflat, preserving viable wetland habitat as sea levels rise. Grading elevated pads for land use areas can allow for the function and usage of those spaces to persist through sea level rise as well. While the analysis presented in this Report validates the potential for 80 acres of wetlands for the two plans, it is very likely that as sea levels rise and impacts to wetlands and land use areas are experienced, management actions will be performed between now and when 7 feet of sea level rise happens. What is presented through this assessment is that it is possible to provide the necessary pad elevation through grading/filling the Project site for land uses and wetland habitat to persist under an extreme 7-foot sea level rise scenario. However, it is important to note that while this exercise presented this is possible, current science is showing that there is a small probability (0.5%) of sea level rise meeting or exceeding 7.0 feet by 2100.

Thus, adaptive management plans should be developed and implemented in this area given the intended land use types. Adaptive planning should include what uses would be possible under different levels of service, what projects and actions may need to be planned and implemented, and under what conditions the City should initiate those actions (i.e., triggers and thresholds). While this assessment looks at a low probability (0.5%) sea level rise scenario under a long-term time horizon (2100), this site presents an opportunity for any redevelopment project to incorporate resilient design features due to the flexibility of the existing and proposed land use designations. Active recreation, regional parkland, and other recreational land uses represent an important community resource. These areas contain some amount of flexibility and adaptive capacity to sea level rise. New and innovative wetland restoration techniques can provide regular benefits continuing to support habitat goals of any future concept.

Active monitoring of habitat health and infrastructure impacts can inform various management actions and restoration efforts. As monitoring efforts identify squeezing of wetland habitat, strategies such as thin layer sediment placement can assist with wetland habitat persisting and keeping pace with lower rates of sea level rise. Wetland habitat throughout California has been severely impacted and reduced through development and coastal squeeze limiting available space for habitat areas. As such, it is a sensitive habitat area that typically has little to no space to migrate landward as sea levels rise. Providing transition zones and planning projects with wetland migration in mind can assist to increase the adaptive capacity of this important ecosystem.

Comprehensive planning will run parallel and compliment redevelopment activities for the Project site, including the identification of thresholds and triggers that guide the City towards planning and implementing future adaptation and resilience projects. Future project planning and environmental permitting efforts related to the Project plans should include more robust hydrological and sea level rise analysis that consider sedimentation rates, flow parameters into existing wetland areas and through newly created channels, water quality considerations, and geomorphic aspects (such as dendritic channels) of the design alternatives.

Conclusion

The Supplemental Environmental Project (SEP) agreement required the City of San Diego (City) to perform a sea level rise assessment of the De Anza Natural Amendment to the Mission Bay Park Master Plan and an enhanced wetland restoration alternative (PEIR Alternative 3 – Wetlands Optimized.) The purpose was to demonstrate how 80 acres of additional functional wetlands (low-high salt marsh and mudflat habitat) could persist at year 2100 based on current models utilized by the City that project a 7-foot sea level rise scenario by the end of the century. Conceptual grading plans were developed for each of the plans by generating a minimum elevation that included all active land use types. This was set through a water level build-up consisting of an extreme high tide plus the 2100 sea level rise scenario (7.0 feet) plus an additional 1.0 foot of freeboard. Using elevation habitat bands specific to Mission Bay, wetland migration and transition was assessed. Modifications to the elevations, slopes, and grading plan were made to support land use types and wetland habitats to persist.

Acreages for land use types and wetland habitats were calculated for both current conditions (2023) and with 7 feet of sea level rise to demonstrate that the SEP requirement was met. The sea level rise modeling assessment and simplistic grading exercise resulted in 85.6 acres of viable wetland habitat for the De Anza Natural plan and 87.3 acres for the PEIR Alternative #3 - Wetlands Optimized with 7 feet of sea level rise.

While this establishes the technical feasibility of this requirement, an adaptive planning and management approach is recommended to balance stewardship of wetland and recreational uses for this site over time as sea level rise impacts are realized. The development of monitoring, thresholds, triggers, and management actions that proactively approach designing land uses with future conditions in mind would support the greatest likelihood of ensuring land use types and wetland habitat areas are preserved. The 7-foot sea level rise scenario included in this assessment is an aggressive target to build resilience to, has a low likelihood of occurrence (0.5%), and the specific asset types included in this Project allow for time and space for thoughtful adaptation and proactive management to occur over time.

While this assessment looks at a high-end sea level rise scenario under a long-time horizon, considering the intended land use, this site presents an opportunity for any redevelopment project to be designed with resilience in mind which may mean elevation and physical space/buffers from the coastline. Active recreation, regional parkland, low-cost visitor accommodations, and other recreational land uses represent important community resources. However, in terms of adaptability to sea level rise, these areas contain some amount of flexibility and adaptive capacity. New and innovative wetland restoration techniques can provide regular benefits continuing to support habitat goals of any future concept.

Future project planning and environmental permitting efforts related to the proposed future Project should include more robust hydrodynamic and sea level rise analysis that consider sedimentation rates, tidal currents throughout existing wetland areas and through newly created channels, water quality considerations, ecological trade-offs associated with short-term habitat impacts verse long-term creation and geomorphic aspects (such as dendritic channels) of the design alternatives.

Assumptions & Limitations

The analysis presented in this report is limited to the scope of work, data availability, and objectives identified by the City of San Diego. As such, the results of the sea level rise analysis, simplistic grading, and viable habitat assessment contain several assumptions and limitations.

An important distinction to note within this analysis was the geographic limit of study area. The Kendall-Frost Marsh Reserve was explicitly not included within the analysis as the SEP requires studying an expanded restoration alternative that would result in the establishment of 80 acres of additional functional wetlands, not including the Kendall-Frost Marsh/Northern Wildlife Preserve. Throughout this report, mapping and tabular results do not consider Kendall-Frost Marsh Reserve. Any interpretation of analysis from this report should include this consideration.

Given the long-time horizon of the 7-ft sea level rise scenario which was analysed within this study, 2100, certain processes that would influence wetland change and migration over the coming decades were identified but not included in this study. As such the analysis included in this report subcategorized viable wetland habitat into marsh and mudflat zones. Habitat zonation and delineation is described in further detail in Section 3.2. GHD recommends that future planning and studies should include systematic fluvial analysis, such as hydrologic and hydraulic parameters, sedimentation rates for material draining from watershed systems, such as Rose Creek, along with other fluvial characteristics (e.g., channel function and slope stability, scour rates, flow characteristics, etc. Additionally, as new channels are created within De Anza Cove which primarily are designed to serve recreational activities, additional investigation of flow and water quality parameters would be necessary to reduce risks to public health and safety.

Due to the nature of the simplistic grading performed within this, full details on constructability, integration with existing infrastructure, and the functionality of the various intended land use types were not assessed. General assumptions were made where transitions across land use types were designed to meet certain elevations, cross slope, and other basic factors. However, additional details are needed as designs are further developed to ensure that future construction plans have the necessary information to successfully implement the Project.

References

California Coastal Commission (CCC). 2018. California Coastal Commission Sea Level Rise Policy Guidance

City of San Diego. 2021. Climate Resilient SD Plan

City of San Diego. 2023. De Anza Natural Amendment to the Mission Bay Park Master Plan. Draft Program Environmental Impact Report (PEIR) SCH #2018061024

City of San Diego. 2019a. Sea Level Rise Vulnerability Assessment

City of San Diego. 2019b. State Lands Sea Level Rise Vulnerability Assessment

NOAA Tides & Currents. 2023. Station 9410170 San Diego. Accessed from: https://tidesandcurrents.noaa.gov/datums.html?id=9410170

Ocean Protection Council (OPC). 2018. State of California Sea-Level Rise Guidance 2018 Update. Accessed from: https://opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf

Sweet, W.V., B.D. Hamlington, R.E. Kopp, C.P. Weaver, P.L. Barnard, D. Bekaert, W. Brooks, M. Craghan, G. Dusek, T. Frederikse, G. Garner, A.S. Genz, J.P. Krasting, E. Larour, D. Marcy, J.J. Marra, J. Obeysekera, M. Osler, M. Pendleton, D. Roman, L. Schmied, W. Veatch, K.D. White, and C. Zuzak, 2022: Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines. NOAA Technical Report NOS 01. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Spring, MD, 111 pp. https://oceanservice.noaa.gov/hazards/sealevelrise/noaa-nostechrpt01-global-regional-SLR-scenarios-US.pdf

Appendix A

Wetland Habitat Survey for the De Anza Cove Redevelopment Project (GHD 2023)

Wetland Habitat Survey Technical Memorandum

August 7, 2023

To	Kelsey Hawkins, Harris & Associates		
Copy to	Jordan Moore, City of San Diego	**Email**	braden.froble@ghd.com
From	Braden Froble; Ryder Burliss; Miles Hartnett	**Project No.**	12612179
Project Name	De Anza Cove Redevelopment SEP Sea Level Rise Assessment		
Subject	De Anza Cove Wetland Habitat Survey		

1. Introduction

This Program Environmental Impact Report (PEIR) for the proposed De Anza Natural Amendment to the Mission Bay Park Master Plan (Project) seeks to demonstrate the establishment of 80 acres of additional functional wetlands (low-high salt marsh and mudflat habitat) with sea level rise (SLR) through 2100. Two project concept configurations are being examined and an SLR analysis is necessary to satisfy the Supplemental Environmental Project (SEP) requirements. In order to assess SLR and model future wetland habitat conditions, the Project required an assessment of baseline conditions that define the representative wetland habitat elevation for Mission Bay. Wetland habitat data pertaining to upland, salt marsh, and mudflat habitat is limited in the Project area, thus a survey was needed to fill this data gap.

The Project area is located within the northeastern portion of Mission Bay and is adjacent to the Kendall Frost Marsh Reserve (Kendall Frost Reserve), which is part of the greater Northern Wildlife Preserve. The Northern Wildlife Preserve effectively serves as a reference site for the wetland concepts examined in the Sea Level Rise Assessment Technical Report. GHD conducted a Wetland Habitat survey of the Kendall Frost Reserve and Northern Wildlife Preserve (Study Area) on July 13th, 2023 to determine the appropriate elevation ranges associated with upland, salt marsh, and mudflat habitat. The primary objective of the survey is to document and validate the transition zones between wetland habitat types (*i.e.*, upland to salt marsh). The survey was intended to establish baseline conditions for habitat modeling of the two conceptual redevelopment project designs.

Elevations presented in this memo are provided relative to the North American Vertical Datum of 1988 (NAVD88) unless stated otherwise.

1.1 Site Description

The surveys within the Study Area are located in the wetland habitat spanning between the Kendall-Frost Reserve and the Northern Wildlife Preserve, both of which are adjacently located within Mission Bay, San Diego, California. The Kendall Frost Reserve is owned and managed by the University of California, while the Northern Wildlife Preserve is owned and managed by the City of San Diego (City). This unique wetland habitat provides opportunities for studying wetland ecology, water quality, and the effects of urbanization on coastal habitats.

Coastal salt marsh and tidal wetlands provide valuable ecological services and important habitat for various plant and animal species. The Study Area, including both the Kendall Frost Reserve and the Northern Wildlife Preserve, covers an area of approximately 94 acres and is situated along the northern shoreline of

Mission Bay. This area is characterized by tidal channels, uplands, salt marsh, mudflats, and areas of emergent vegetation. The Marsh is tidally influenced, experiencing regular inundation by saltwater, which contributes to the unique ecological dynamics.

The vegetation in the Study Area consists of several salt-tolerant plant species adapted to saline conditions, water, and periodic flooding. Common plant species found in the Marsh include saltgrass (*Distichlis spicata*), Pacific cordgrass (*Spartina foliosa*), and pickleweed (*Salicornia sp*.). These plants provide habitat, food sources, and protection for numerous bird species, invertebrates, and other wildlife.

The Marsh serves as an important stopover site for migratory birds, providing nesting, feeding, and resting areas. It is particularly notable for attracting and supporting various endangered shorebird species such as the light-footed clapper rail, Belding's Savannah sparrow, sandpiper, snowy plover, and herons.

2. Wetland Habitat Types in the Study Area

The De Anza Cove Study Area is comprised of subtidal, mudflat, salt marsh, and upland habitat types. These habitat types are broadly described in the southern California context in this section.

2.1 Subtidal

Subtidal habitats in California refer to the underwater areas that are consistently submerged below tidal levels along the state's coastline and extend into the oceanic waters. Subtidal habitats encompass a wide range of marine environments, including rocky reefs, kelp forests, seagrass beds, and soft-bottom habitats. The vegetation in this habitat is primarily composed of fully submerged aquatic vegetation including kelp (*e.g., Macrocystis spp., Nereocystis spp.),* seagrass (*e.g., Zostera spp., Phyllospadix spp*.), eelgrass (*e.g., Zostera marina*), and algae of various species, including red algae (*e.g., Gelidium spp.),* green algae (e.g., *Ulva spp*.), and brown algae (*e.g., Sargassum spp*.) (NPS, 2016). Apart from kelp and seagrass, other submerged aquatic plants may also be found in subtidal habitats, such as various types of filamentous algae, mosses, and submerged herbs. These smaller, less conspicuous plants contribute to the overall biodiversity and ecological functioning of the subtidal habitat (NPS, 2022).

Subtidal vegetation plays a vital role in providing habitat, food resources, and nursery areas for a wide range of marine organisms, contributing to the overall health and productivity of coastal ecosystems in California. These habitats in California are home to a rich diversity of marine life and play crucial ecological roles, such as providing shelter, food resources, and nursery grounds, for numerous species. They contribute to the overall health and biodiversity of coastal ecosystems (NPS, 2022).

Eelgrass is a species of particular significance due to its high ecological productivity (NMFS, 2014). Eelgrass is often found in the upper sub-tidal zone and is considered an indicator species for the upper bound of the subtidal zone in the Baywide Integrated Natural Resources Management Plan (U.S. Navy, 2013). However, eelgrass is also known to persist in the lower range of mudflat habitat.

2.2 Mudflat

California mudflats are coastal habitats characterized by areas of exposed sediment consisting of fine-grained, silty, or muddy material. They are found along the shores of estuaries, bays, lagoons, and other intertidal zones in California. Mudflats are typically found in sheltered areas with low wave energy, where sediment deposition occurs due to the settling of suspended particles. They are influenced by the ebb and flow of tides, experiencing regular inundation by saltwater during high tides and exposure during low tides. This challenging environment can support certain species of salt-tolerant grasses, such as cordgrasses (*e.g., Spartina spp.)* and salt meadow grass (*Spartina patens*), as well as halophytic herbs (U.S. Navy, 2013). Mudflats may host herbaceous plants that are adapted to saline environments. Examples include sea lavender (*Limonium spp*.), sea purslane (*Sesuvium portulacastrum*), and sea aster (*Aster tripolium*). Various species of algae and seaweeds can colonize mudflats as well, including green algae (*e.g., Ulva spp*.), red algae (*e.g., Gracilaria spp.),* and brown algae (*e.g., Fucus spp*.) (NPS, 2016). These provide important food sources for many organisms and contribute to the overall productivity of the mudflat ecosystem.

Mudflats generally contain a substantial amount of organic matter and microorganisms, although usually in lesser quantities compared to eelgrass beds or salt marshes. These communities serve as important feeding grounds for shorebirds, waterfowl, and other wading birds that rely on the rich food resources found in the sediment, such as worms, clams, crustaceans, and small invertebrates (U.S. Navy, 2013). Mudflats play a significant role in the coastal ecosystem as transitional zones between the land and water. They provide valuable ecosystem services, including nutrient cycling, sediment trapping, and water filtration. Mudflats also act as buffers, helping to dissipate wave energy and reduce coastal erosion.

2.3 Salt Marsh

Salt marshes in southern California exhibit several characteristic features including tidal influence, vegetation, salt tolerance, salinity gradient, intertidal zones, rich biodiversity, and ecosystem services. Salt marshes are transitional zones between terrestrial and marine environments, subject to regular tidal inundation and influenced by the ebb and flow of tides. Salt marshes are dominated by halophytic plants that are adapted to thrive in saline conditions (U.S. Navy, 2013). The lower salt marsh is dominated by Pacific cordgrass (*Spartina foliosa*), while the higher elevation of salt marsh is dominated by pickleweed (*Salicornia spp.*) and various halophytic herbs (Calflora, 2023). These plants have developed mechanisms to tolerate or excrete excess salt, allowing them to thrive.

The dense vegetation in salt marsh communities provides crucial habitat and nesting grounds for various bird species, including shorebirds, waterfowl, and wading birds (U.S. Navy, 2013). It also serves as a shelter, feeding ground, and nursery for a variety of fish, invertebrates, and other wildlife. Salt marshes play important roles in the coastal ecosystem, providing numerous ecological services such as shoreline protection, water filtration, carbon sequestration, and nutrient cycling.

2.4 Upland

Upland communities refer to ecosystems that are located in higher-elevation areas above the salt marsh community. The lower end of this community is characterized by pickleweed, (*Salicornia Spp.)*, Shore Grass (*Distichlis littoralis*), and alkali heath (*Frankenia salina*), while the higher end of the community is characterized by the mat-forming vegetation of a variety of species adapted to the harsh and sandy conditions, such as beach evening primrose (*Camissoniopsis cheiranthifolia*), beach-bur (*Ambrosia chamissonis),* silver beachweed (*Honckenya peploides*), and other drought-tolerant plants (U.S. Navy, 2013). They help stabilize the sand dunes by trapping windblown sand, preventing erosion, and promoting the accumulation of sediment. Dune mats also provide habitat and shelter for various small invertebrates, reptiles, and birds, which utilize the microclimates and protection offered by the vegetation (CNPS, 2023).

A properly functioning upland ecosystem offers nesting, feeding, and a refuge during high-water events for numerous bird species. It also provides a source of food and shelter for fish and invertebrates. However, not all marshes within Mission Bay possess the necessary characteristics to attract birds. As a result, the bird populations reliant on marsh habitats are concentrated in the areas that retain these distinctive features.

3. Wetland Survey Methods

Survey methods consisted of both desktop literature review and field investigation conducted on July 13th, 2023 by GHD staff. Field investigations consisted of categorizing habitat types onsite according to dominant vegetation. Mapping was conducted by collecting spot elevations along several representative transects, which were selected using existing habitat data and aerial imagery obtained from desktop and literature review. Elevation and field points were captured using the EOS Arrow Gold Global Navigation Satellite System (GNSS) receiver and ArcGIS Field Collector. The EOS Arrow Gold GNSS receiver is able to stream real-time kinematic (RTK) corrections and the vertical accuracy is typically on the order of inches; however, vertical accuracy may depend on site-specific factors such as satellite availability and overhead obstructions (*i.e.*, dense vegetation). RTK corrections were obtained from the California Real Time Network (CRTN), utilizing the Scripps 5 - Mt. Soledad base station. Post processing of data was undertaken in GIS following the data collection.

3.1 Database and Literature Review

This study included a comprehensive literature and database review to guide the survey methods. The desktop and database review were conducted prior to field investigations and included reviewing and analyzing information from the California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB), the National Wetland Inventory (NWI), Natural Resource Conservation Service (NRCS) Soil Surveys accessed through UC Davis SoilWeb, CALVEG (USFS/USDA), the CDFW Vegetation Survey Points dataset, and the Jepson Manual (Baldwin et al., 2012). Satellite imagery and aerial photography accessed through Google Earth Pro was also analyzed prior to field investigations.

3.2 Field Survey Methods

Survey transects were selected inside of the Study Area that provide representative habitat types and corresponding transition zones ranging from upland to subtidal. Sample points were collected along a total of 7 transects (Figure 1); however, several other field points were also collected outside of the transects to improve the range and confidence of the data. Approximately 2 to 7 field points were collected per transect. Photo documentation was collected along with each transect. The survey was conducted from 7:30am to approximately 1:00pm (PST) on July 13th, 2023. The tides during the time of the survey ranged from +3.5 feet to +2.5 feet.

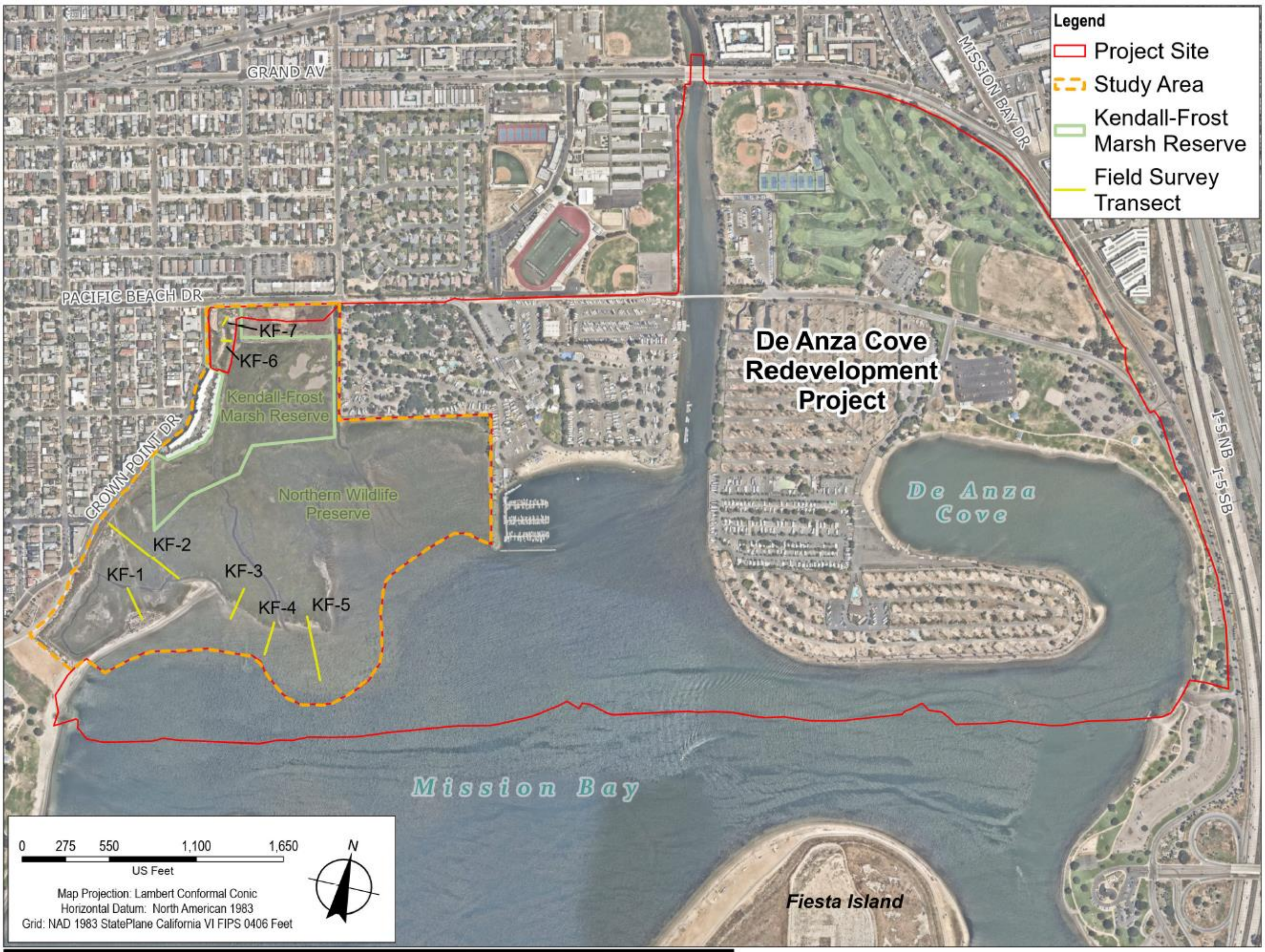


Figure 1. Study Area Relative to the De Anza Cove Project Area

4. Existing Data Review

4.1 National Wetlands Inventory

The mudflat and salt marsh habitat types are classified as Estuarine and Marine Wetland habitat according to the National Wetland Inventory (USFW, 2023). The Estuarine System comprises tidal habitats in deepwater and neighboring wetlands that are typically enclosed to some extent by land but may have varying degrees of access to the open ocean, ranging from fully open to partially obstructed or intermittent. These habitats experience occasional dilution of ocean water by freshwater runoff from the surrounding land. Additionally, in certain areas with low-energy coastlines, there is a significant amount of seawater dilution, and salinity levels may periodically exceed those found in the open ocean due to evaporation.

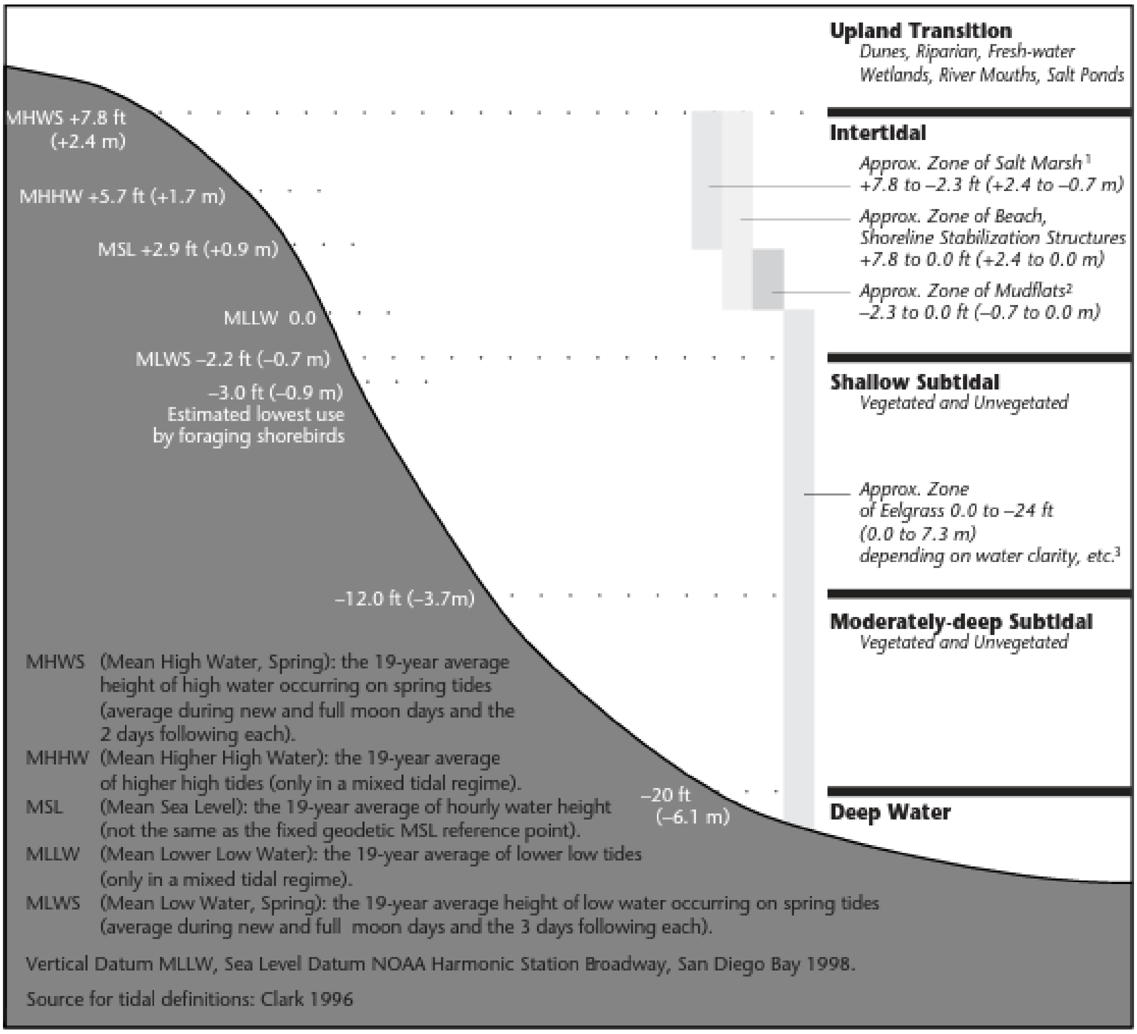
4.2 San Diego Integrated Natural Resources Plan

The San Diego Bay Integrated Natural Resources Plan (Plan) was prepared in 2013 to characterize biological resources in the San Diego Bay. The Plan describes habitat within the San Diego Bay generally according to tidal elevations and indicator species, when applicable. This Plan also provides a data assimilation regarding San Diego Bay habitat; however, there is a lack of site-specific and up-to-date information pertaining to wetland habitat in San Diego and Mission Bay. Thus, the Plan is utilized herein as a baseline comparison for the habitat comprising the De Anza Natural Amendment and Study Area.

According to the San Diego Bay Integrated Natural Resources Plan (2013), typical elevations of each habitat is as shown in Table 1 and Figure 2 (U.S. Navy, 2013). The upland habitat consists primarily of dunes above wetland habitats sitting around +7.4 feet. The intertidal habitats, including salt marsh and mudflats, vary in elevations. Salt marshes were measured to be from +1.9 feet to +7.4 feet, where they then transition to upland. Below the salt marsh, the approximate zone of mudflats is from +1.9 feet to -0.4 feet.

Table 1. Elevations Bands for San Diego Bay (U.S. Navy, 2013)

Habitat Type	Elevation Range (ft) NAVD88	
	Upper	Lower
Upland	> 7.4	7.4
Salt Marsh	7.4	1.9
Mudflat	1.9	-0.4
Subtidal	-0.4	< -0.4



[1] Lower limit of salt marsh is defined by lower limit of cordgrass (*Spartina foliosa*). These tidal elevations are estimated based on salt marshes neighboring those of San Diego Bay. This is as low as 0.7 m (+2.3 ft) MLLW in Mission Bay (Levin *et al.* unpubl. data). In Tijuana Estuary and Anaheim Bay, lower limits range from +1.1 to +1.6 m (+3.5 to +5.25 ft) MLLW (Zedler *et al.* 1982; Massay and Zembal 1979).

[2] Mudflat zone derived from lower limit of cordgrass to upper limit of eelgrass (0.0).

[3] In San Diego Bay, depth of eelgrass varies with Bay regions as follows: south Bay 0.0 to 1.8 m (0.0 to –6 ft) MLLW; central Bay 0.0 to –2.4 m (0.0 to –8 ft) MLLW; north Bay 0.0 to –3.7 m (0.0 to –12 ft) MLLW. Near the mouth in north Bay, there is a different form (wider blades) that extends down to –5.5 to 7.3 m (–18 to –24 ft) (Hoffman, pers. comm.)

Figure 2. General Habitat Types for the San Diego Bay (U.S. Navy, 2013)

5. Results

This section presents the results of the field survey and discussion around the transition zones between habitat types. The field data points collected along each transect in the Study Area are shown below in Figure 3. A total of 42 points were collected across all seven transects.

Figure 3. Collected Field Data Points

5.1 Habitat Transition Elevations

5.1.1 Mudflat to Salt Marsh

A total of 10 mudflat to salt marsh transition sample points were collected along four transects (KF-1, 3, 4, 5). The transition elevation ranged from +3.1 feet to +2.0 feet, with a mean elevation of +2.5 feet. The primary salt marsh indicator species observed at this transition zone was Pacific cordgrass, (*Spartina foliosa)*, which is typically found in the lower salt marsh (CNPS, 2023). An example mudflat to salt marsh transition zone is shown below in Figure 4 and results are shown in Figure 5.

The highest elevation mudflat to salt marsh transition was observed along KF-5 and in the vicinity of KF-1, while the lowest elevations were observed along KF-3 and KF-4. The total vertical range in elevation for the mudflat to salt marsh transition was approximately 1.1 feet. This variation is to be expected as local site hydrology, sedimentation patterns, and geology (*i.e.,* soil permeability) are likely contributing factors. The variation may also result from oceanographic forces along the shoreline, such as tidal currents and wind waves. Localized erosion and scarping at the mudflat transition zone suggest that erosion may limit the persistence of lower salt marsh in the Study Area, however, areas of ramping or a gradual transition slope from salt marsh to mudflat may suggest marsh plain progradation or expansion in discrete areas.

Figure 4. Mudflat to Salt Marsh Transition at Transect KF-4 (see red arrow)

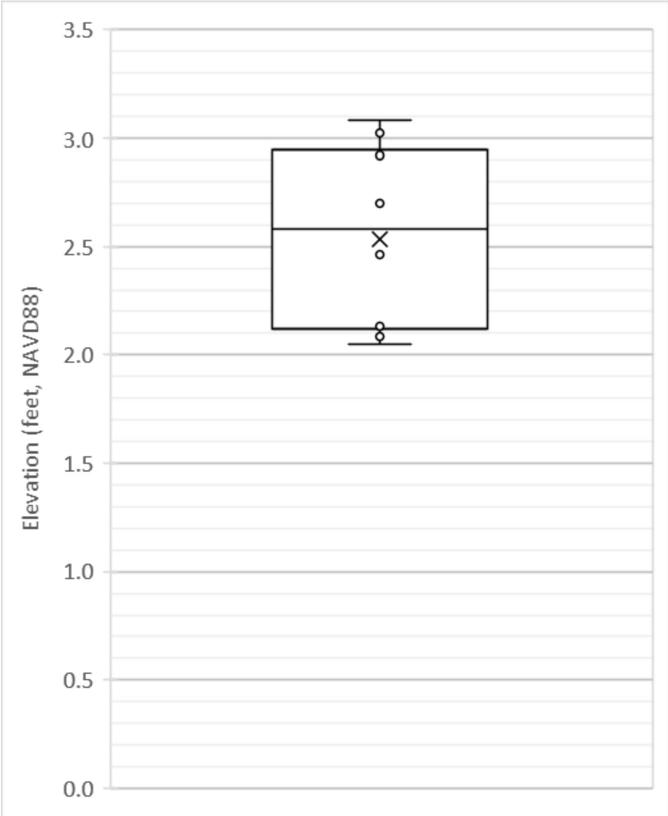


Figure 5. Mudflat to Salt Marsh Transition Elevations (Transects KF-3 through KF-5)

5.1.2 Salt Marsh to Upland

A total of eight data points were collected across four transects (KF-1, 2, 6, and 7) for the salt marsh to upland transition. The transition elevation ranged from +6.9 to +5.9 feet, with a mean elevation of +6.4 feet. The primary indicator species observed was pickleweed (*Salicornia spp.*), though Pacific cordgrass (*Spartina foliosa)* was widespread in the lower salt marsh areas. An example salt marsh to upland transition is shown below in Figure 6 and results are shown in Figure 7.

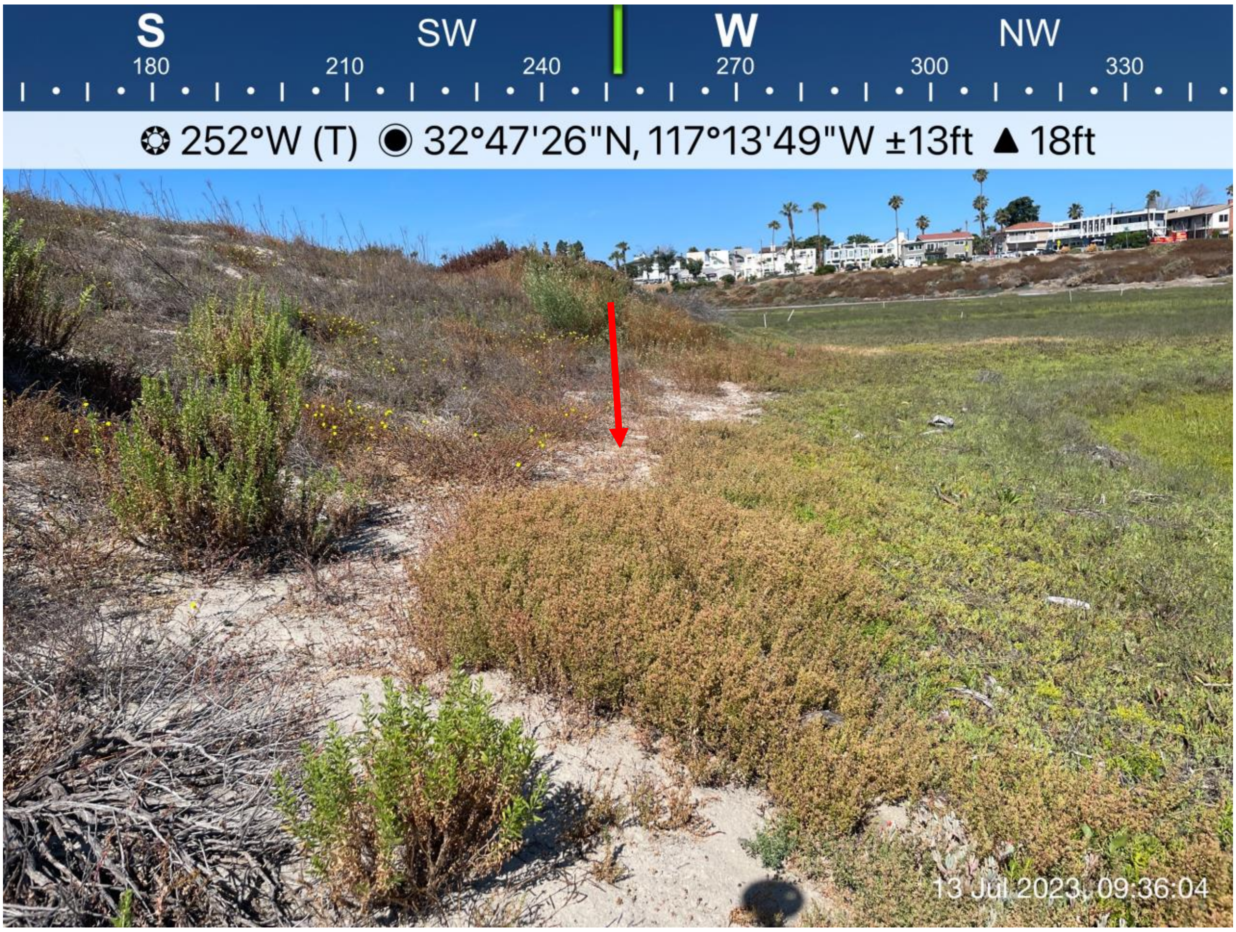


Figure 6. Pickleweed Mats at the Transition from Upland to Salt Marsh (see red arrow) at Transect KF-1

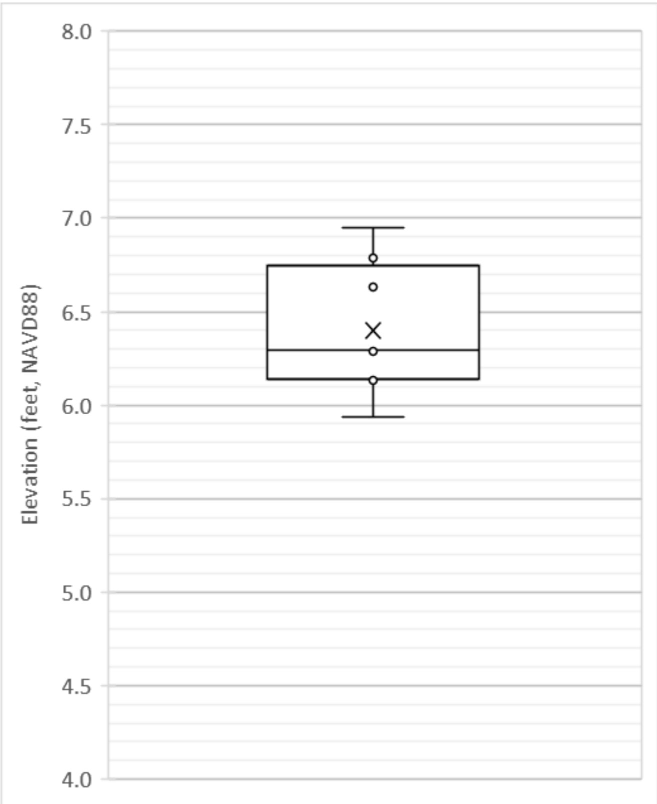


Figure 7. Salt Marsh to Upland Transition Elevations (Transects KF-1, 2, 6 and 7)

The elevation variance among this transition zone was approximately 1.0 feet, with the highest elevations observed along KF-1. The surveyed habitat type transition zones were relatively consistent across each transect and the variation was reasonable considering site-specific differences, such as hydrology and geology, relating to the connectivity between the bay and the soils.

6. Summary of Findings

In comparison to the San Diego Bay habitat bands (U.S. Navy, 2013), the surveyed Study Area elevation bands vary by 0.2 feet to 0.5 feet when considering the high and low range of surveyed salt marsh habitat. Some variation among the two sites is to be expected, as the San Diego Bay and Misson Bay are subject to slightly different hydrodynamic and environmental conditions. The upland to salt marsh transition for the San Diego Bay is 0.5 feet higher than the surveyed habitat transition for the Study Area. The San Diego Bay (2013) transition value was based on extreme astronomical tidal water levels (spring tides), which is a generalization as high-water levels at the shoreline depend on several environmental conditions. A comparison of the San Diego Bay and surveyed habitat bands are shown below in Table 2.

Table 2. Comparison of Habitat Bands for the San Diego Bay and Kendall Frost Marsh Reserve

Habitat Type	Elevation Range, feet (NAVD88)			
	Study Area Habitat Bands		San Diego Bay Habitat Bands*	
	Upper	Lower	Upper	Lower
Upland	> 6.9	6.9	> 7.4	7.4
Salt Marsh	6.9	2.0	7.4	1.9
Mudflat	2.0	-0.4	1.9	-0.4
Subtidal*	-0.4	< -0.4	-0.4	< -0.4

*Habitat band elevations after U.S. Navy (2013)

Among the mudflat to salt marsh transition and the salt marsh to upland transitions, the range in elevation among surveyed data was approximately 1.1 and 1.0 feet, respectively. Based on these results, it is recommended that the Sea Level Rise Assessment Technical Report utilize the upper and lower extent of surveyed elevations for salt marsh habitat. That is, salt marsh habitat should be represented by the high upland transition and low mudflat transition, with salt marsh habitat ranging from 6.9 feet to 2.0 feet. These values align closest with the available San Diego Bay habitat data and will capture the full range of salt marsh habitat. These recommended habitat bands are presented below in Table 3 and Figure 8.

Table 3. Study Area Habitat Band Elevation Range

Habitat Type	Elevation Range (ft) NAVD88		Elevation Range (ft) NGVD29	
	Upper	Lower	Upper	Lower
Upland	> 6.9	6.9	> 4.9	4.9
Salt Marsh	6.9	2.0	4.9	0.0
Mudflat	2.0	-0.4	0.0	-2.5
Subtidal*	-0.4	< -0.4	-2.5	< -2.5

*Habitat band elevations after U.S. Navy (2013)

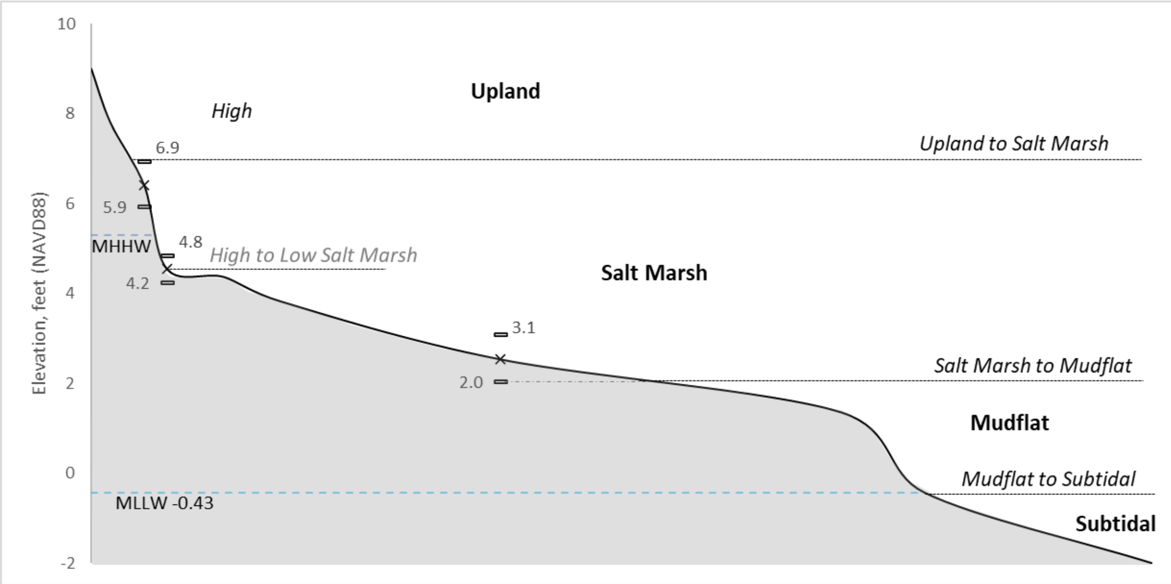


Figure 8. Surveyed Habitat Transition Elevations (range of values shown above/below point)

7. References

Baldwin, B.G., D.H. Goldman, D.J. Keil, R. Patterson, T.J. Rosatti, and D.H. Wilken (eds.). 2012. The Jepson Manual: Vascular Plants of California, 2nd Edition. University of California Press, Berkeley, CA.

California Department of Fish and Wildlife. 2021. California Natural Diversity Database (CNDDB) BIOS Commercial/Spotted Owl Viewer (online edition, v5.94.01). Sacramento, CA. Accessed on July 7, 2023 from: https://www.wildlife.ca.gov/Data/CNDDB/Maps- and-Data#43018408-cnddb-in-bios.

California Native Plant Society (CNPS). 2023. A Manual of California Vegetation (online edition). California Native Plant Society. Sacramento, CA. Accessed July 7, 2023 from: **http://vegetation.cnps.org/**.

Calflora Database: Information on California plants for education, research and conservation. Berkeley, CA, Accessed July 7, 2023 from: www.calflora.org/

National Park Service (NPS). 2016. Oceans, Coasts, & Seashores: Kelp Forests. Accessed on July 7, 2023 from: **https://www.nps.gov/subjects/oceans/kelp-forests.htm**

National Park Service (NPS). 2022. Natural Features & Ecosystems: Intertidal & Subtidal Zones. Accessed on July 7, 2023 from: **https://www.nps.gov/pore/learn/nature/intertidal.htm**

National Marine Fisheries Service (NMFS). 2014. California Eelgrass Mitigation Policy and Implementing Guidelines. NOAA Fisheries West Coast Region.

USDA. CalVeg Existing Vegetation: South Coast and Montane. Accessed on July 7, 2023 from: **https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement**

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.

U. S. Fish and Wildlife Service (USFWS). National Wetlands Inventory (NWI) Wetlands Mapper. Accessed on July 7, 2023 from: **https://www.fws.gov/wetlands/data/Mapper.html**

Attachment 1. Photo Index

Photo 1. Overview of the Study Area in Northern Wildlife Preserve (Transect KF-1) showing the elevation and vegetation change between upland and saltmarsh habitats from the upland perspective.

Photo 2. Overview of the Study Area in Northern Wildlife Preserve showing the elevation and vegetation change between upland and saltmarsh habitats from the saltmarsh perspective (Transect KF-1 & 2).

Photo 3. Transitional Zone from saltmarsh (left) to upland (right) (Transect KF-1).

Photo 4. Upland vegetation overview.

Photo 5. Upland dominant vegetation close-up of beach evening primrose (Camissoniopsis cheiranthifolia).

Photo 6. Upland vegetation to saltmarsh.

Photo 7. Upland Vegetation (Transect KF-1).

Photo 8. Transition of saltmarsh (left) to upland (right).

Photo 9. Dominant upper saltmarsh vegetation, Alkali heath (Frankenia salina). Pickleweed and glasswort, (Salicornia spp).

Photo 10. Lower saltmarsh & channel.

Photo 11. Dominant vegetation of lower saltmarsh pickleweed and glasswort, (Salicornia spp).

Photo 12. Dominant vegetation of lower salt marsh, Pacific chordgrass (Spartina foliosa).

Photo 13. Saltmarsh meets mudflat. Dominant vegetation is Pacific chordgrass (Spartina foliosa).

Photo 14. Mudflat (Vicinity of transect KF-5).

Attachment 2. Field Data

Field Data Sheet

ID	Point Type	Description	Elevation (ft)	Transect ID	Easting	Northing
32	Salt Marsh	Low Salt Marsh Habitat Confirmation point	4.1	KF-1	6260207.301	1868883.968
33	Salt Marsh	Salt Marsh Habitat confirmation point	4.5	KF-1	6260245.128	1868895.942
30	Salt Marsh	Salt Marsh Habitat confirmation point	5.2	KF-1	6260233.438	1868821.45
27	Upland	Upland habitat confirmation point (dune mat)	19.3	KF-1	6260327.358	1868785.099
28	Transition	Upland to Salt Marsh	6.8	KF-1	6260256.196	1868799.054
29	Transition	Upland to Salt Marsh	5.9	KF-1	6260247.615	1868804.323
31	Transition	Upland to Salt Marsh	6.6	KF-1	6260301.5	1868835.01
53	Salt Marsh / Transition	High Salt Marsh to Low Salt Marsh	4.2	KF-2	6260614.836	1870591.736
56	Salt Marsh	Low Salt Marsh Habitat Confirmation point	4.0	KF-2	6260219.485	1869243.242
71	Salt Marsh	Low Salt Marsh Habitat Confirmation point	2.9	KF-2	6260710.021	1869151.594
57	Mudflat	Mudflat habitat confirmation point	1.7	KF-2	6260424.006	1869110.984
54	Upland	Upland habitat confirmation point	19.5	KF-2	6259980.439	1869328.651
55	Transition	Upland to Salt Marsh	6.3	KF-2	6260030.372	1869329.89
58	Salt Marsh	Low Salt Marsh Habitat Confirmation point	3.5	KF-3	6260473.622	1869093.139
59	Salt Marsh	Salt Marsh Habitat confirmation point	4.0	KF-3	6260879.646	1869057.302
62	Mudflat	Mudflat habitat confirmation point	1.0	KF-4	6260953.279	1868872.584
64	Salt Marsh	Salt Marsh Habitat confirmation point	3.7	KF-4	6261147.82	1868947.361
63	Transition	Salt Marsh to Mudflat	2.1	KF-4	6261096.26	1868907.7
65	Transition	Salt Marsh to Mudflat	2.1	KF-5	6261181.163	1868907.888
67	Transition	Salt Marsh to Mudflat	3.0	KF-5	6261284.87	1868969.976
68	Transition	Salt Marsh to Mudflat	2.5	KF-5	6261324.278	1868957.97
50	Salt Marsh / Transition	High Salt Marsh to Low Salt Marsh	4.5	KF-6	6260461.818	1870620.895
46	Salt Marsh	Low Salt Marsh Habitat Confirmation point	4.6	KF-6	6260428.206	1870697.695
49	Salt Marsh	Salt Marsh Habitat confirmation point	4.6	KF-6	6260453.64	1870623.739
47	Upland	Upland habitat confirmation point	7.8	KF-6	6260417.505	1870612.477

ID	Point Type	Description	Elevation (ft)	Transect ID	Easting	Northing
48	Transition	Upland to Salt Marsh	6.1	KF-6	6260441.427	1870623.648
45	Salt Marsh / Transition	High Salt Marsh to Low Salt Marsh	4.8	KF-7	6260419.823	1870716.097
44	Salt Marsh	Salt Marsh Habitat confirmation point	5.3	KF-7	6260400.801	1870725.366
51	Salt Marsh	Low Salt Marsh Habitat Confirmation point	4.7	Other	6260457.254	1870578.032
35	Salt Marsh	Low Salt Marsh Habitat Confirmation point	3.0	Other	6260297.653	1868953.061
69	Salt Marsh	Salt Marsh Habitat confirmation point	3.6	Other	6261339.982	1869026.008
34	Salt Marsh	Salt Marsh Habitat confirmation point	4.0	Other	6260208.316	1868935.124
39	Transition	Salt Marsh to Mudflat	3.1	Other	6260439.814	1868910.432
60	Transition	Salt Marsh to Mudflat	2.0	Other	6260864.873	1868974.657
70	Transition	Salt Marsh to Mudflat	2.9	Other	6261426.72	1868986.925
61	Transition	Salt Marsh to Mudflat	2.1	Other	6260982.04	1868952.119
38	Transition	Salt Marsh to Mudflat	2.7	Other	6260390.194	1868886.647
36	Transition	Salt Marsh to Mudflat	2.7	Other	6260312.576	1868934.681
22	Upland	Upland habitat confirmation point	17.8	Other	6264536.34	1848268.636
40	Transition	Upland to Salt Marsh	6.9	Other	6260382.101	1868842.288
52	Transition	Upland to Salt Marsh	6.2	Other	6260571.605	1870646.849
72	Transition	Upland to Salt Marsh	6.3	Other	6260053.58	1869261.714