A-6: Wetland Value Assessment

Modeling Documentation

Jefferson County Ecosystem Restoration Feasibility Study

Wetland Value Assessment Modeling

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Prepared by:

United States Army Corps of Engineers
Regional Planning and Environmental Center

US Army Corps of Engineers ®
Galveston District

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers, Galveston District (USACE), in partnership with Jefferson County and the Sabine-Neches Waterway Navigation District, is reviewing restoration opportunities in Jefferson County, Texas. A Jefferson County Ecosystem Restoration (JCER) Integrated Feasibility Report and Environmental Assessment (IFR-EA) is being prepared to describe the results of investigations and analyses used to determine the feasibility of restoring the aquatic habitat in the study area.

The US Army Corps of Engineers (USACE) intends to seek authorization to fund and execute ecosystem restoration in Jefferson County, Texas, pursuant to Section 110 of the Rivers and Harbors Act of 1962 and Resolution 2620 from the House of Representatives Committee on Transportation and Infrastructure entitled “Sabine Pass to Galveston Bay, Texas.” USACE is the lead Federal agency for the proposed project and will oversee compliance with applicable federal laws and regulations required for the project as well as protection measures for sensitive biological resources.

The purpose of the study is to evaluate existing coastal habitat problems and identify implementable solutions to restore degraded habitats in the study area. The study will help contribute to larger ongoing efforts to improve, preserve, and sustain ecological resources along the Texas coast by stakeholder groups, non-governmental organizations, and government agencies at the local, state, and federal level. Specific study problems include:

- Land loss due to erosion, subsidence, and relative sea level change (RSLC) threatens the geomorphic structure and hydrologic function of the coastal shoreline and inland marsh systems.
- Altered hydrologic conditions are contributing to the conversion of low salinity coastal habitats (e.g. freshwater and intermediate marsh) to those that survive under more saline conditions (e.g. brackish and saline marshes) or open water.
- Longshore sediment transport is significantly reduced, limiting the sustainability of the coastal ecosystem.

1.1 Plan Formulation

During the early stages of plan formulation, it was decided to develop costs and benefits and conduct cost effective and incremental analysis on fully formed plans, rather than measure by measure. The final array of plans, based on planning strategies, resulted in eight core alternatives (including the No Action alternative), several of which had two scales or variations. Additionally, each of the plans was evaluated using beneficial use materials as source, except for Alternative 6, which was originally formulated using beneficial use as a source. A summary of the alternatives is presented in Table 1.

Table 1. Summary of Alternatives

Alternative	Features	Strategy
Alternative 1A	Nearshore berm and marsh restoration	Indirect (Passive) Alternative: natural restoration of the area and depends on natural systems to sustain the project in the future
Alternative 1B	Sand engines and marsh restoration	
Alternative 2A	Breakwaters and beach nourishment, marsh restoration and GIWW armoring	Direct (Engineered) Alternative: marsh/shoreline/armoring restoration effort designed for long-term solutions to problems
Alternative 2B	Beach nourishment and GIWW armoring	
Alternative 3	Beach nourishment, marsh restoration (mostly south of GIWW), GIWW armoring, no Texas Point Shoreline features	Complimentary Alternative: works synergistically with other agency, state, and local plans that are funded
Alternative 4A	No beach nourishment, marsh restoration (around Keith Lake only), minimal GIWW armoring	Keith Lake Alternative: marsh restoration focused around Keith Lake
Alternative 4B	Beach nourishment at Texas Point, no marsh restoration, minimal GIWW armoring	
Alternative 6A	Beach nourishment at Texas Point, marsh restoration	Marsh restoration and Texas Point shoreline (beneficial use)
Alternative 6B	Sand Engine at Texas Point, marsh restoration	
Alternative 10	Breakwaters and beach nourishment, marsh restoration, and GIWW armoring	South of GIWW Focus Alternative: marsh and shoreline restoration between the Gulf of Mexico and the south bank of the GIWW
Alternative 13	Sand Engine at Texas Point, beach nourishment and breakwaters, additional marsh restoration, GIWW armoring	Hybrid alternative to address concerns in constructing breakwaters offshore at Texas Point (offset with Sand Engine concept)

1.2 Wetland Value Assessment Model

The JCER feasibility study utilized the Wetland Value Assessment Coastal Marsh (Version [v] 2.0) and Barrier Headland (v1.0) Community Models to calculate benefits to each of the alternatives developed for the study.

The WVA methodology is similar to the USFWS Habitat Evaluation Procedures (HEP), in that habitat quality and quantity are measured for baseline conditions and predicted for future without-project conditions and future with-project conditions. Instead of the species-based approach of HEP, the WVA models use an assemblage of variables considered important to the suitability of a given habitat type for supporting a diversity of fish and wildlife species. As with HEP, the WVA allows a numeric comparison of each future condition and provides a combined quantitative and qualitative estimate of project-related benefits on fish and wildlife resources.

WVA models operate under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated and expressed through the use of a mathematical model developed specifically for each habitat type. Each model consists of 1) a list of variables that are considered important in characterizing fish and wildlife habitat; 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Indices) and different variable values; and 3) a mathematical formula that combines the Suitability Indices for each variable into a single value for wetland habitat quality, termed the Habitat Suitability Index (HSI).

The product of an HSI value and the acreage of available habitat for a given target year (TY) is known as the Habitat Unit (HU). The HU is the basic unit for measuring project effects/benefits on fish and wildlife habitat. Future HUs change according to changes in habitat quality and/or quantity. Results are annualized over the period of analysis to determine the Average Annual Habitat Units (AAHUs) available for each habitat type.

The change (increase or decrease) in AAHUs for each future with-project scenario, compared to the future without-project conditions, provides a measure of anticipated impacts. A net gain in AAHUs indicates that the project is beneficial to the habitat being evaluated; a net loss of AAHUs indicates that the project is damaging to that habitat type.

The habitat variable-habitat suitability relationships within these WVA models have not been verified by field experiments or validated through a rigorous scientific process. However, the variables were originally derived from HEP suitability indices taken from species models for species found in that habitat type. An independent external peer review of the WVA Models has been conducted by the USACE Eco-PCX[1]. The reviewers agreed that the concept and application of the models are sound for planning efforts. The models seem to sufficiently capture the habitats being modeled and do not have any irreparable deficiencies.

[1] Battelle Memorial Institute. 2010. Final Model Review Report for the Wetland Value. Prepared for the Department of the Army, U.S. Army Corps of Engineers, Ecosystem Planning Center of Expertise, Mississippi Valley Division. Retrieved 28 July 2017 from https://cw-environment.erdc.dren.mil/models/WVA%20Model%20Review_TCN09032_Final%20Report_083110.pdf.

1.2.1 Coordination

A meeting with representatives of USACE, National Marine Fisheries Service (NMFS), US Fish and Wildlife Service (USFWS), Environmental Protection Agency (EPA), Texas Parks and Wildlife Department (TPWD), and Texas General Land Office (GLO) was held on October 26-27, 2017 to discuss the use of the WVA models and examine the values of the variables for the existing conditions and FWOP conditions. A collaborative discussion was undertaken for each variable of each of the models including the future without-project (FWOP) and future with-project (FWP) condition. Concurrence by all representatives was required before a value was assigned to each variable in the models. The model discussions in Section 2.0 and 3.0 describe the assumptions made during the meeting to determine variable scores and the data used to help inform those decisions.

2.0 BRACKISH MARSH COMMUNITY MODEL

The WVA Marsh Models (Fresh/Intermediate Marsh, Brackish Marsh, and Saline Marsh) were initially developed as the primary means of measuring the wetland benefits of candidate projects proposed for funding under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA). In addition, the WVA Marsh Models have also been used for determining potential impacts and/or benefits under USACE civil works projects and for mitigation purposes. Since the initial development, the WVA Marsh Models have undergone several revisions including the omission of certain variables, modifications to the Suitability Index (SI) Graphs, and modifications to the Habitat Suitability Index (HSI) formulas.

The marsh community models were developed to determine the suitability of marsh and open water habitats in the Louisiana coastal zone, but has since been revised and been certified for use in East Texas. The WVA Marsh Models were designed to function at a community level and therefore attempt to define an optimal combination of habitat conditions for all fish and wildlife species utilizing coastal marsh ecosystems.

For purposes of the JCER Feasibility Study, the WVA Marsh Models v2.0 was used. Version 2.0 incorporates recommendations made by independent reviewers of the v1.0 model[2]. The WVA suite of marsh models in v2.0 was approved for Regional Use in specified EPA Level IV Ecoregions within the Galveston and New Orleans Districts on October 31, 2017.

2.1 Period of Analysis/Target Years

The environmental period of analysis for the study is 50 years. HSI values are determined for each target year (TY). Target years, determined by the model user, represent when significant changes in habitat quality or quantity were expected during the 50-year period of analysis, under future with-project and future without-project conditions. For this study, target years were run in 10 year intervals. In determining future with-project conditions, all project-related direct (construction) impacts were assumed to occur in TY1.

2.2 Area of Application

Tidal marsh landscapes have two major components, the vegetated intertidal zone and the aquatic habitats of pools and channels[3]. The WVA Marsh Model was applied to areas within the restoration units. Each restoration unit was delineated using a number of variables including: of sufficient size to include pools and/or channels, similar rates of wetland loss, and similar factors influencing wetland loss. The acreage used to calculate the habitat quality score was based on the acreage of land within the restoration unit, excluding open water areas. Therefore, the acreage is not held constant for the FWOP or FWP conditions. In the FWOP condition, the acreage steadily decreases over the 50 year period of analysis because of erosion, subsidence, and RSLC, amongst other factors influencing wetland degradation. For the FWP conditions, the acreage increased for several target years following

[2] Battelle Memorial Institute. 2010.

[3] Kneib, R.T., 1997. The role of tidal marshes in the ecology of estuarine nekton. *Oceanography and Marine Biology: an Annual Review*, 35, 163-220.

construction due to filling in open water areas, but then decreased as erosional and climate change processes overtook parts of the restoration unit, particularly along the fringes of the units.

2.3 Marsh Model Selection

The coastal marsh community models are applied to all marsh and associated open water habitats within the coastal zone. The WVA Marsh Models manual specifies that model application should correspond to the marsh type(s) found within the project area according to the habitat classification data obtained from the United States Geologic Survey (USGS).

Existing condition marsh vegetation and water acreages are based on a USGS classification using 2010 imagery[4]. The mapping effort indicates that freshwater marsh occurs mostly north of the GIWW and minimal saline marsh occurs along the fringes on the SNWW and in Texas Point NWR. The rest of the focused study area is classified as brackish marsh. Despite fresh and saline marshes being found in the focused study area, only the brackish marsh model was used to calculate benefits. For the freshwater marsh areas, this decision was based on the assumption that by the time construction was complete, the intermediate rate of sea level change would have converted most of the marsh areas to brackish marsh. There was concern that if the freshwater marsh model was used to calculate benefits, the model would show an impact due to conversion to brackish marsh (not by restoration actions but by anticipated future conditions) leaving 0 acres of fresh marsh. The freshwater marsh would already be lost and converted to brackish marsh, but restoration actions would be improving the overall function of the brackish marsh, which would be a net benefit.

For the saline marsh areas, a similar situation would exist. If the saline marsh model was used, after restoration is implemented, the model would show a loss of habitat resulting in an impact. When really the purpose of converting saline marsh to brackish is to restore the area to more historic conditions, which did not include the extent of saline marsh found today or expected in the future.

These assumptions were conveyed to the ECO-PCX prior to completing model runs. The ECO-PCX concurred with use of the brackish marsh for all alternatives and marsh areas.

2.4 Model Variables

The WVA Marsh Models for fresh/intermediate, brackish, and saline marsh consist of six variables: V_1) percent of wetland area covered by emergent vegetation; V_2) percent of open water covered by aquatic vegetation; V_3) marsh edge and interspersion; V_4) percent of open water ≤ 1.5 feet deep in relation to marsh surface; V_5) salinity; and V_6) aquatic organism access. Changes in each variable are predicted for future without-project and future with-project scenarios over a 50-year period of analysis. By incorporating variables of SAV and shallow open water into each of the marsh models, impacts to those habitat components are combined with impacts to emergent marsh. Because emergent marsh is of higher overall fish and wildlife value than SAV, and because SAV is of higher value than shallow open water, those latter components receive proportionally less weight when combined into one AAHU value.

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[4] Enwright, N.M., Hartley, S.B., Couvillion, B.R., Brasher, M.G., Visser, J.M., Mitchell, M.K., Ballard, B.M., Parr, M.W., and Wilson, B.C., 2015, Delineation of marsh types from Corpus Christi Bay, Texas, to Perdido Bay, Alabama, in 2010: U.S. Geological Survey Scientific Investigations Map 3336, 1 sheet, scale 1:750,000. Available at: http://dx.doi.org/10.3133/sim3336 (Downloaded 05 May 2017).

2.4.1 Variable 1 (V_1): Percent of Wetland Area Covered by Emergent Vegetation

Persistent emergent vegetation provides foraging, resting, and breeding habitat for a variety of coastal fish and wildlife species. Detritus from coastal marshes also provides a source of mineral and organic nourishment for organisms at the base of the food chain. In this model, an area that is 100 percent shallow water is assumed to have minimal habitat suitability (SI = 0.1). For all marsh types, optimal vegetative coverage is assumed to be 60 to 80 percent (SI = 1.0). This assumption was changed from v1.0 in response to comments submitted during peer-review. This assumption is in line with the general biological understanding that optimum cover falls in the 60 to 80 percent range.

Existing Condition: Baseline total marsh and water acres of each restoration unit were calculated using the 2010 aerial imagery that covers the focused study area. Geographic Information System (GIS) tools were used to calculate the percent of the total restoration unit that had visible emergent vegetation (i.e. not open water). Due to some uncertainty with aerial imagery in identifying emergent versus floating vegetation, these values were verified by experts with local knowledge that the ratio of emergent vegetation to open water was realistic.

FWOP: The National Oceanic and Atmospheric Administration (NOAA) Marsh Migration[5] 0.5-foot and 2.0-foot sea level rise data were used to determine the future percent of emergent vegetation in year 2027 and 2077, respectively, within each restoration unit in the absence of restoration. This rise data is slightly more aggressive than the USACE intermediate curve, which predicates a 0.43-foot and 1.89-foot sea level rise in 2027 and 2077, respectively.

FWP: The marsh restoration measure would involve placing dredged material within approximately 65% of the marsh, leaving 35% shallow open water. The emergent marsh platform would be raised to +1.2 MSL at year 0 and to +2.2 MSL at year 30. The elevation and ratio of emergent marsh to open water can be largely controlled through strategically placed dredged material and reworking the material until the targets are reached. Additionally, adaptive management triggers have been set that would initiate adaptive management in the event that the target ratios are not at a minimum maintained, but preferably increase in emergent cover. Therefore, the anticipated value of V_1 has minimal uncertainty for the FWP.

2.4.2 Variable 2 (V_2): Percent of Open Water Area Covered by Aquatic Vegetation

For the purpose of this model, aquatic vegetation is defined as any of the diverse array of floating-leaved and submerged aquatic plants that are typically found in the study area, including seagrasses which grow entirely underwater. Aquatic vegetation coverage is included as an important marsh variable because it provides important food and cover to a wide variety of fish and wildlife[6]. Aquatic vegetation provides a refuge from predation, and because of this protection, densities of many invertebrates (infaunal and epifaunal) and small fish are greater in floating or submerged vegetated areas than in nearby unvegetated areas. Aquatic vegetation provides additional benefits by stabilizing

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[5] National Oceanic and Atmospheric Administration (NOAA). 2018. Digital Coast Sea Level Rise Data Download. NOAA Office for Coastal Management. Available at: https://coast.noaa.gov/slrdata/.

[6] Smith, P. and D. Meden. 2017. US Army Corps of Engineers Planning Model Improvement Program: Wetland Value Assessment Methodology Coastal Marsh Community Models. US Army Corps of Engineers, New Orleans District.

sediments and filtering water. The species composition and primary productivity of aquatic vegetative communities corresponds to the salinity regime.

Fresh and intermediate marshes, in particular, often support diverse communities of submerged and floating-leaved vegetation. Although brackish marshes support aquatic plants that serves as important sources of food and cover for several species of fish and wildlife, they generally do not support the amount and kinds of aquatic plants that occur in fresh/intermediate marshes (e.g. widgeon-grass). Some low-salinity saline marshes may contain beds of widgeon-grass and open water areas behind some barrier islands may contain dense stands of seagrass; however, saline marshes typically do not contain an abundance of aquatic vegetation as often found in fresh/intermediate and brackish marshes. Open water areas in saline marshes typically contain sparse aquatic vegetation and are primarily important as nursery areas for marine organisms.

Each of the three marsh models have varying SIs for open water with no aquatic vegetation; however, for each model no aquatic vegetation is assumed to have low suitability (SI = 0.11 for fresh/intermediate; SI=0.02 for brackish; and SI=0.08 for saline). Habitat suitability is assumed to decrease with aquatic plant coverage approaching 100 percent due to the potential for mats of aquatic to hind fish and wildlife utilization, adversely affect water quality by reducing photosynthesis by photoplankton and other plant forms due to shading; and contribute to oxygen depletion spurred by warm-season decay of large quantities of aquatic vegetation. Therefore, optimal conditions for fresh/intermediate marsh occurs between 56.25 and 87.5 percent cover; between 82.5 and 95.83 for brackish marsh and 65.91 and 90.91 for saline marsh. Areas with a greater percent cover that the optimal range see a declining trend in SI value as the area approaches 100 percent aquatic vegetation coverage. For areas with 100 percent coverage, fresh/intermediate marsh areas are assigned an SI of 0.45, while brackish marsh would receive an SI of 0.83 and saline marsh would receive an SI of 0.60.

Existing Condition: Estimating percent aquatic vegetation coverage can be difficult and problematic because coverage varies across different environmental conditions, including seasonality variances in abundance and distribution that may be cyclical across years. Because of the variability, baseline values for this variable were based largely upon previous observations in the area by modeling workgroup members, the team's knowledge of aquatic vegetation types and prevalence in the general area and examination of 2010 aerial imagery and earlier historic images.

FWOP: Based on the NOAA Marsh Migration data, it was assumed that areas that convert to open water would typically be too deep for aquatic vegetation to grow except for along the fringes where open water would be expected to be shallow enough for aquatic vegetation growth. Percent aquatic vegetation was based on the amount of fringe/shallow water habitat expected under a 0.5-foot and 2.0-foot of sea level rise.

FWP: It was assumed that the open water areas created and/or left during marsh restoration would eventually fill in with aquatic vegetation. It was assumed that at TY0 and 1, there would be approximately 20 percent aquatic vegetation coverage. Aquatic vegetation would be expected to increase over time with the assumed maximum coverage of 50 percent occurring in TY41 and increasing in coverage by about 5 percent each decade.

2.4.3 Variable 3 (V_3): Marsh Edge and Interspersion

This variable takes into account the relative amount of marsh to open water, and the degree to which open water is dispersed throughout the marsh. Interspersion is an important characteristic for freshwater and estuarine fish and shellfish nursery and foraging habitat in all marsh types[7]. The marsh/open-water edge provides cover for postlarval and juvenile organisms. Smaller, isolated ponds are less turbid and contain more aquatic vegetation, thereby providing more suitable waterfowl habitat. Conversely, a large degree of interspersion is assumed indicative of marsh degradation, as solid marsh converts to ever-larger areas of open water. Areas with a high degree of interspersion in the form of tidal channels and small ponds (Class 1) were considered optimal condition (SI = 1.0). Large ponds (Class 3) and open water areas with little surrounding marsh (Class 4) offer lower interspersion values and indicate advanced stages of marsh loss. Class 3 was also assigned to areas of "carpet" marsh which contain no or relatively insignificant tidal channels, creeks, or ponds but still provide aquatic organism habitat during tidal flooding. If the entire area is open water or contains a few small marsh islands, Class 5 interspersion was assigned (SI = 0.1).

Existing: The degree of marsh/waterbody interspersion was assessed for each wetland group within the restoration unit using the 2010 aerial imagery at the same scale as the photographs of class examples shown in the WVA marsh model (v2.0). Each wetland group was carefully examined and assigned interspersion classes by comparing them to the photographic examples. In some cases, the wetland groups contain wetlands of more than one interspersion class. The percentage of acreage exhibiting each class was entered in the spreadsheet, such that all added up to 100 percent.

FWOP: No change in interspersion was assumed for TY1. Given that interior marsh break-up usually results in conversion of marsh to shallow water initially and then later to deeper water, V_4 values were assumed to change roughly in proportion to decreases in V_1. Changes greater or equal to 1 percent were reflected in similar changes in interspersion classes.

FWP: For marsh restoration it was assumed that interspersion could be controlled by strategic placement of dredged material and the ratio of interspersion classes would remain nearly identical in the future due to adaptive management. If the percent of open water exceeds a certain threshold at any point during or outside of the 10-year cost-shared monitoring window, measures would be implemented to correct the deficiency returning the extent and type of interspersion to desired conditions.

2.4.4 Variable 4 (V_4): Percent of Open Water ≤ 1.5 Feet Deep in Relation to Marsh Surface

Shallow water areas are assumed to be more biologically productive than deeper water due to a general reduction in sunlight, oxygen, and temperature as water depth increases. Also, shallower water provides greater bottom accessibility for certain species of waterfowl, better foraging habitat for wading birds, and more favorable conditions for aquatic plant growth. Optimal open water conditions in a fresh/intermediate marsh are assumed to occur when 80 to 90 percent of the open water area is less than or equal to 1.5 feet deep. The value of deeper areas in providing drought refugia for fish, alligators and other marsh life is recognized by assigning an SI=0.6 (i.e., sub-optimal) if 100 percent of the open water is less than or equal to 1.5 feet deep.

[7] Smith, P. and D. Meden. 2017.

Shallow water areas in brackish marsh habitat are also important. However, brackish marsh generally exhibits deeper open water areas than fresh marsh due to tidal scouring. Therefore, the SI graph is constructed so that lower percentages of shallow water receive higher SI values relative to fresh/intermediate marsh. Optimal open water conditions in a brackish marsh are assumed to occur when 70 to 80 percent of the open water area is less than or equal to 1.5 feet deep.

The SI graph for the saline marsh model is similar to that for brackish marsh model, where optimal conditions are assumed to occur when 70 to 80 percent of the open water area is less than or equal to 1.5 feet deep. However, at 100 percent shallow water, the saline graph yields an SI= 0.5 rather than 0.6 as for the brackish model. That change reflects the increased abundance of tidal channels and generally deeper water conditions prevailing in a saline marsh due to increased tidal influences.

Existing: Baseline values for this variable were based largely upon previous observations in the area by modeling workgroup members, the team's knowledge of the open water areas and examination of 2010 aerial imagery and earlier historic images.

FWOP: No change in V_4 was assumed for TY1. RSLC of about 1.89 feet by TY51 is assumed to increase the depth of current shallow water and to inundate new areas. Therefore, V_4 values were assumed to change in proportion to decreases in V_1.

FWP: For marsh restoration measures, the target design would incorporate 75 percent of the open water areas to be less than 1.5 feet deep. It is assumed that this extent of shallow water would gradually decrease through TY30 in proportion to decreases in V_1. At TY30, marsh renourishment would fill in some of the deeper area and return the unit to the 75 percent target. After TY31, the trend in declining shallow water areas was assumed to resume in proportion to decreases in V_1 as RSLC continues.

2.4.5 Variable 5 (V_5): Salinity

This variable may appear to duplicate or overlap with V_1 because the functionality and potential land loss of the marsh vegetation are related to salinity. However, this variable was included as a separate variable in order to account for salinity impacts on fish and wildlife as well as on vegetation.

Salinity is one of the most important factors affecting coastal marsh loss. Salinity projections affect all of the other WVA variables with the exception of aquatic organism access. Small increases in mean salinity can adversely affect aquatic systems by reducing overall biological productivity. Productivity algorithms, based upon measurements of total biomass, stem/leaf elongation, and photosynthesis, were developed that predict changes in primary productivity for every part per thousand (ppt) change in salinity. Salinity and primary productivity were found to be inversely related, as salinity increases, primary productivity decreases by different amounts dependent upon the salinity tolerance of the vegetation community.

It is assumed that periods of high salinity are most detrimental in a fresh/intermediate marsh when they occur during the growing season (defined as March through November, based on dates of first and last frost contained in Natural Resource Conservation Service soil surveys for coastal Louisiana). Therefore, mean salinity during the growing season (March-November) is used as the salinity parameter for the fresh/intermediate marsh model. For the brackish and saline marsh models, average annual salinity is used as the salinity parameter.

Optimum salinity ranges assumed by the WVA model for the various habitat types are as follows: fresh marsh ≤0.5 ppt, intermediate marsh ≤2.5 ppt, brackish marsh ≤10 ppt, and saline marsh ≤21 ppt. The SI graph for brackish and saline marsh is constructed to represent optimal conditions when salinities are between 0 ppt and the maximum salinity to be considered optimal. Average annual salinities below 5 ppt will effectively define a marsh as fresh or intermediate, not brackish. Likewise, average annual salinities below 10 ppt will effectively define a marsh as brackish, not saline. However, the suitability index graph makes allowances for lower salinities to account for occasions when there is a trend of decreasing salinities through time toward a more fresh/intermediate or brackish condition. The assumption is that lower salinities are not detrimental to the marsh type. The brackish marsh does not consider salinities greater than 16 ppt as this would make the habitat convert to saline marsh. For the saline SI curve, salinities greater than 21 ppt are assumed to be slightly stressful to saline marsh vegetation.

Existing: Baseline salinities for marsh areas were taken from baseline salinities reported by the 3-D hydrodynamic-salinity model for the Sabine-Neches Waterway Channel Improvement Project (SNWW CIP)[8], Texas Parks and Wildlife (TPWD) data, and from Texas Commission on Environmental Quality water quality monitoring stations. Model values were obtained from the nearest model output node.

FWOP: Future salinity rates in the focused study area were obtained from the hydrodynamic model results for the SNWW CIP future with-project condition and the construction of inverted siphons[9]. Both model outputs accounted for RSLC, although at slightly lower/slower rates of increase. The SNWW CIP project would increase salinities in eastern half of the focused study area, while construction of the inverted siphons would negate the increases, thereby maintaining brackish marsh in the eastern half of the focused study area. In the western half of the study area, it was assumed that under RSLC, salinities would not increase to a level greater than 16 ppt due to relatively low salinities for brackish marsh in the existing condition. Therefore, the values for V_5 were kept constant through TY51.

FWP: It was assumed that the restoration unit would remain brackish through the entire planning horizon; therefore, the values for V_5 were kept constant. If RSLC or other factors affect salinities differently than expected, adaptive management would be employed if higher than optimal conditions are reached. Measures would be implemented to reduce salinities to optimal conditions.

2.4.6 Variable 6 (V_6): Aquatic Organism Access

Access by aquatic organisms, particularly estuarine-dependent fishes and shellfishes, is considered to be a critical component in assessing the quality of a given marsh system. Additionally, a marsh with a relatively high degree of access by default also exhibits a relatively high degree of hydrologic connectivity with adjacent systems, and therefore may be considered to contribute more to nutrient exchange than would a marsh exhibiting a lesser degree of access. The SI for V_6 is determined by

[8] United States Army Corps of Engineers (USACE). 2011. Final Feasibility Report for Sabine-Neches Waterway Channel Improvement Project Southeast Texas and Southwest Louisiana. Vol 1-4. Southwest Division, Galveston District. Galveston, TX.

[9] Pothina, D. and C. Guthrie. 2009. Evaluating inverted siphons as a means of mitigating salinity intrusion in the Keith Lake/Salt Bayou System, Jefferson County, Texas. Prepared by the Texas Water Development Board. Grant No. MX-96401704. US Environmental Protection Agency. Gulf of Mexico Program.

calculating an "access value" based on the interaction between the percentage of the project area wetlands considered accessible by aquatic organisms during normal tidal fluctuations, and the type of man-made structures (if any) across identified points of ingress/egress (bayous, canals, etc.). Standardized procedures for calculating the Access Value have been established in the WVA Marsh v2.0 Manual. It should be noted that access ratings for man-made structures were determined by consensus and that scientific research has not been conducted to determine the actual access value for each of those structures. Optimal conditions are assumed to exist when all of the study area is accessible and the access points are entirely open and unobstructed.

A fresh marsh with no access is assigned an SI=0.3, reflecting the assumption that, while fresh marshes are important to some species of estuarine-dependent fishes and shellfish, such a marsh lacking access continues to provide benefits to a wide variety of other wildlife and fish species, and is not without habitat value. An intermediate marsh with no access is assigned an SI=0.2, reflecting that intermediate marshes are somewhat more important to estuarine-dependent organisms than fresh marshes. The general rationale and procedure behind the V_6 SI graph for the brackish marsh model is identical to that established for the fresh/intermediate model. However, brackish marshes are assumed to be more important as habitat for estuarine-dependent fish and shellfish than fresh/intermediate marshes. Therefore, a brackish marsh providing no access is assigned an SI of 0.1. The SI graph for aquatic organism access in the saline marsh model is the same as that in the brackish marsh model.

Existing: Baseline values for this variable were based largely upon previous observations in the area by modeling workgroup members, the team’s knowledge of existing water control structures in the area and examination of 2010 aerial imagery and earlier historic images. The V_6 calculator included in the Marsh Model Spreadsheet was used to calculate access value.

FWOP: The review group has no knowledge of planned water control structures, impoundments, or other impediments that would affect fisheries access through the period of analysis. No changes to the fisheries access value is projected TY1 though TY51.

FWP: Implementation of any ecosystem restoration measures are not expected to affect fisheries access including hardened structures (e.g. breakwaters) which have been designed in such a way to allow fisheries access. No changes to the fisheries access value is projected TY1 though TY51.

2.5 Model Results

Results of running the WVA Marsh Model for each of the 11 fully formed plans is shown in Table 2 and

Table 3. Attachment 1 shows the raw data used to compute HSI scores.

Table 2. WVA Marsh Model Results in AAHUs.

	FWOP	FWP	Net Change in AAHUs
1A/1Abu	6,347	12,658	+6,312
1B/1Bbu	6,347	12,658	+6,312
2A/2Abu	6,347	12,683	+6,337
2B	6,347	8,087	+1,741

3/3bu	5,752	11,671	+5,920
4A/4Abu	3,531	7,516	+3,985
4B	3,531	4,479	+948
6A	4,474	9,586	+5,112
6B	4,474	9,586	+5,112
10/10bu	5,586	11,305	+5,719
13/13bu	6,347	12,683	+6,337

Table 3. Detailed Results of the WVA Marsh Model.

Alternative 1A/1Abu

Condition: FWOP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	13715	0.81	11042.36	
1	13765	0.67	9248.24	10146.41
11	11950	0.69	8219.89	87389.05
21	10136	0.70	7125.26	76771.46
31	8321	0.67	5535.18	63187.97
41	6507	0.68	4403.44	49727.90
51	4692	0.62	2919.23	36448.31
Max TY=	**51**		**AAHUs=**	**6346.5**

Condition: FWP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	13715	0.81	11109.15	
1	13765	0.88	12113.20	11610.59
11	13716	0.90	12361.19	122373.70
21	13661	0.89	12121.24	122410.90
31	13610	0.95	12991.18	125567.80
41	13558	0.98	13246.81	131191.86
51	13506	0.98	13235.88	132413.68
Max TY=	**51**		**AAHUs=**	**12658.2**

Alternative 1B/1bu

Condition: FWOP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	13715	0.81	11042.36	
1	13765	0.67	9248.24	10146.41
11	11950	0.69	8219.89	87389.05
21	10136	0.70	7125.26	76771.46
31	8321	0.67	5535.18	63187.97
41	6507	0.68	4403.44	49727.90
51	4692	0.62	2919.23	36448.31
Max TY=	**51**		**AAHUs=**	**6346.5**

Condition: FWP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	13715	0.81	11109.15	
1	13765	0.88	12113.20	11610.59
11	13716	0.90	12361.19	122373.70
21	13661	0.89	12121.24	122410.90
31	13610	0.95	12991.18	125567.80
41	13558	0.98	13246.81	131191.86
51	13506	0.98	13235.88	132413.68
Max TY=	**51**		**AAHUs=**	**12658.2**

Alternative 2A/2Abu

Condition: FWOP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	13715	0.81	11042.36	

Condition: FWP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	13715	0.81	11109.15	

1	13765	0.67	9248.24	10146.41	1	13765	0.88	12113.20	11610.59
11	11950	0.69	8219.89	87389.05	11	13716	0.90	12361.19	122373.70
21	10136	0.70	7125.26	76771.46	21	13661	0.89	12121.24	122410.90
31	8321	0.67	5535.18	63187.97	31	13610	0.95	12991.18	125567.80
41	6507	0.68	4403.44	49727.90	41	13558	0.98	13246.81	131191.86
51	4692	0.62	2919.23	36448.31	51	13765	0.98	13489.70	133681.51
Max TY=	**51**		**AAHUs=**	**6346.5**	**Max TY=**	**51**		**AAHUs=**	**12683.1**

Alternative 2B

Condition: FWOP					Condition: FWP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**	**TY**	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	13715	0.81	11042.36		0	13715	0.81	11042.36	
1	13765	0.67	9248.24	10146.41	1	13765	0.67	9248.24	10146.41
11	11950	0.69	8219.89	87389.05	11	11950	0.90	10769.63	100783.17
21	10136	0.70	7125.26	76771.46	21	10136	0.89	8993.55	98773.78
31	8321	0.67	5535.18	63187.97	31	8321	0.95	7942.66	84884.46
41	6507	0.68	4403.44	49727.90	41	6507	0.98	6357.65	71569.59
51	4692	0.62	2919.23	36448.31	51	4956	0.62	3083.48	46288.27
Max TY=	**51**		**AAHUs=**	**6346.5**	**Max TY=**	**51**		**AAHUs=**	**8087.2**

Alternative 3/3bu

Condition: FWOP					Condition: FWP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**	**TY**	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	12485	0.81	10052.05		0	12485	0.81	10112.85	
1	12573	0.67	8447.38	9251.67	1	12573	0.88	11064.24	10587.52
11	10888	0.69	7489.39	79728.74	11	12573	0.90	11331.09	111976.67
21	9203	0.70	6469.39	69836.35	21	12573	0.89	11155.87	112434.83
31	7519	0.67	5001.68	57249.40	31	12573	0.95	12001.33	115786.00
41	5835	0.68	3948.68	44784.13	41	12573	0.98	12284.41	121428.70
51	4150	0.62	2582.01	32500.25	51	12573	0.98	12321.54	123029.77
Max TY=	**51**		**AAHUs=**	**5752.0**	**Max TY=**	**51**		**AAHUs=**	**11671.4**

Alternative 4A/4Abu

Condition: FWOP					Condition: FWP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**	**TY**	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	8159	0.81	6569.06		0	8159	0.81	6608.79	
1	8212	0.67	5517.37	6044.39	1	8212	0.88	7226.56	6917.06
11	6973	0.69	4796.43	51602.00	11	8166	0.90	7359.40	72931.42

21	5743	0.70	4037.13	44198.78	21	8120	0.89	7204.78	72819.82
31	4495	0.67	2990.10	35057.62	31	8073	0.95	7705.93	74558.83
41	3256	0.68	2203.41	25991.34	41	8027	0.98	7842.76	77745.18
51	2017	0.62	1254.92	17179.00	51	7981	0.98	7821.38	78320.91
Max TY=	**51**		**AAHUs=**	**3530.8**	**Max TY=**	**51**		**AAHUs=**	**7515.6**

Alternative 4B

Condition: FWOP					Condition: FWP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**	**TY**	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	8159	0.81	6569.06		0	8159	0.81	6569.06	
1	8212	0.67	5517.37	6044.39	1	8212	0.67	5517.37	6044.39
11	6973	0.69	4796.43	51602.00	11	6973	0.90	6284.24	59481.64
21	5743	0.70	4037.13	44198.78	21	5743	0.89	5095.70	56871.09
31	4495	0.67	2990.10	35057.62	31	4495	0.95	4290.62	47071.44
41	3256	0.68	2203.41	25991.34	41	3256	0.98	3181.27	37405.92
51	2017	0.62	1254.92	17179.00	51	2044	0.62	1271.72	21548.07
Max TY=	**51**		**AAHUs=**	**3530.8**	**Max TY=**	**51**		**AAHUs=**	**4478.9**

Alternative 6A

Condition: FWOP					Condition: FWP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**	**TY**	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	10428	0.81	8395.90		0	10428	0.81	8446.68	
1	10456	0.67	7025.04	7711.09	1	10456	0.88	9201.28	8823.65
11	8866	0.69	6098.54	65660.26	11	10404	0.90	9376.34	92889.93
21	7276	0.70	5114.78	56106.65	21	10352	0.89	9185.21	92806.51
31	5685	0.67	3781.69	44382.24	31	10301	0.95	9832.63	95094.90
41	4097	0.68	2772.54	32801.63	41	10249	0.98	10013.76	99233.88
51	2507	0.62	1559.78	21517.03	51	10197	0.98	9993.06	100034.34
Max TY=	**51**		**AAHUs=**	**4474.1**	**Max TY=**	**51**		**AAHUs=**	**9585.9**

Alternative 6B

Condition: FWOP					Condition: FWP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**	**TY**	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	10428	0.81	8395.90		0	10428	0.81	8446.68	
1	10456	0.67	7025.04	7711.09	1	10456	0.88	9201.28	8823.65
11	8866	0.69	6098.54	65660.26	11	10404	0.90	9376.34	92889.93
21	7276	0.70	5114.78	56106.65	21	10352	0.89	9185.21	92806.51
31	5685	0.67	3781.69	44382.24	31	10301	0.95	9832.63	95094.90

41	4097	0.68	2772.54	32801.63
51	2507	0.62	1559.78	21517.03
Max TY=	**51**		AAHUs=	**4474.1**

41	10249	0.98	10013.76	99233.88
51	10197	0.98	9993.06	100034.34
Max TY=	**51**		AAHUs=	**9585.9**

Alternative 10/10bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	12137	0.81	9771.87	
1	12220	0.67	8210.21	8992.88
11	10580	0.69	7277.53	77482.39
21	8940	0.70	6284.51	67851.52
31	7300	0.67	4856.00	55599.37
41	5661	0.68	3830.93	43466.12
51	4021	0.62	2501.75	31514.29
Max TY=	**51**		AAHUs=	**5586.4**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	12137	0.81	9830.97	
1	12221	0.88	10754.48	10291.75
11	12204	0.90	10998.54	108765.71
21	12187	0.89	10813.38	109059.21
31	12170	0.95	11616.65	112152.05
41	12153	0.98	11874.05	117454.16
51	12136	0.98	11893.28	118836.75
Max TY=	**51**		AAHUs=	**11305.1**

Alternative 13/13bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	13715	0.81	11042.36	
1	13765	0.67	9248.24	10146.41
11	11950	0.69	8219.89	87389.05
21	10136	0.70	7125.26	76771.46
31	8321	0.67	5535.18	63187.97
41	6507	0.68	4403.44	49727.90
51	4692	0.62	2919.23	36448.31
Max TY=	**51**		AAHUs=	**6346.5**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	13715	0.81	11109.15	
1	13765	0.88	12113.20	11610.59
11	13716	0.90	12361.19	122373.70
21	13661	0.89	12121.24	122410.90
31	13610	0.95	12991.18	125567.80
41	13558	0.98	13246.81	131191.86
51	13765	0.98	13489.70	133681.51
Max TY=	**51**		AAHUs=	**12683.1**

3.0 BARRIER HEADLAND COMMUNITY MODEL

The barrier headland model was developed to determine the wetland benefits of headland restoration projects. The model was developed for determining the suitability of barrier headland habitat along the Louisiana coast in providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species.

The barrier headland model should be applied to shoreline areas along the coast which consist of beach, dune, and supratidal habitat and which naturally decrease in elevation to intertidal marsh. By nature, barrier headlands are contiguous with the mainland marsh and have not yet detached and begun formation of a barrier island. The model has been designed to function at a community level and therefore attempts to define an optimal combination of habitat conditions for all fish and wildlife species utilizing barrier headlands.

The barrier headland model v1.0 was approved for regional use in coastal Louisiana and eastern Texas on November 9, 2011.

3.1 Period of Analysis/Target Years

The environmental period of analysis for the study is 50 years. HSI values are determined for each target year. Target years, determined by the model user, represent when significant changes in habitat quality or quantity were expected during the 50-year period of analysis, under future with-project and future without-project conditions. For this study, target years were for TY0, TY1, and TY51. This model was not run in 10 year intervals like the marsh models because it is assumed that beach renourishment would occur on a 10-year cycle and would therefore revert the variable values back to TY1. In determining future with-project conditions, all project-related direct (construction) impacts were assumed to occur in TY1.

3.2 Area of Application

The barrier headland model was applied along the barrier headland restoration units. The area of application was bound from east to west by the length of the restoration measure that would be implemented in and/or benefit that area. Elevation data was used to bound the area of application in a north/south direction starting at 2.0 feet NAVD88 and moving landward to the limit of the reardune. Acreage was calculated within the area of application. Restoration of the headland would not affect the actual acreage being considered, like in the marsh model where the amount of land and water is different in each year, so the acreage was held constant for the FWOP and FWP conditions.

3.3 Model Variables

Barrier headlands consist of many different habitat components including surf zone, beach, dune, supratidal marsh (i.e., swale), woody areas, and unvegetated flats or washover areas. A key assumption in model development was that for a barrier headland to provide optimal conditions for fish and wildlife, all of the above habitat components should exist. Unlike the barrier island model which encompasses intertidal and subtidal habitats, this model does not. Those habitat types exist landward of the headland and should be evaluated using the appropriate marsh model.

The variables selected for this model were those variables within the barrier island model which could be applied to barrier headland habitat. The model development group agreed that barrier headlands provide many of the same functions as barrier islands such as nesting and resting sites for birds and other wildlife, storm surge protection of interior marshes, and proximity to gulf/marine foraging habitat. Furthermore, barrier headlands consist of many of the same habitat components as barrier islands such as surf zone, beach, dune, swale, and woody areas. Therefore, the group agreed that those variables within the barrier island model which address dune and supratidal habitats, vegetative cover, woody vegetation, and beach zone features should be included in the barrier headland model. The final list of variables included in this model are: V_1) percent of the subaerial area that is classified as dune habitat; V_2) percent of the subaerial area that is classified as supratidal habitat; V_3) percent vegetative cover of dune and supratidal habitats; V_4) percent vegetative cover by woody species; and V_5) beach/surf zone features.

3.3.1 Variable 1 (V_1) and 2 (V_2): Percent of the Subaerial Area that is Classified as Dune Habitat and Supratidal Habitat

Dune habitat is defined as subaerial habitat $\geq$ 5 feet NAVD88 and encompasses foredune, dune, and reardune. Although dune habitat occurs at elevations below 5 feet NAVD88, lower-elevation dunes are more ephemeral and more frequently overwashed, which reduces their habitat value. Lower-elevation dunes often consist of vegetation more commonly associated with swale habitat and lack a high percentage of “typical” dune species.

The primary utility of dunes for barrier headland birds is to serve as a refuge during times of high water, either for chicks of seabirds nesting on barrier headlands or for other species that do not swim well. While this may serve a very important role at critical times of flooding risk, there is no evidence to suggest that such short-term refugia need to be large in size. In the right circumstances areas elevated above 5 feet might also serve as nesting locations for some species of waterbirds- especially if covered with woody vegetation.

Supratidal habitat occurs from 2.0 feet NAVD88 to 4.9 feet NAVD88. This habitat type primarily encompasses swale and may include low-elevation dune and beach habitat. These habitats are important to birds because: when sufficiently isolated this habitat serves as nesting substrate for colonies of water birds; serves as potential nesting area for shorebirds; and may be favored roosting habitat of shorebirds that feed in nearby intertidal areas.

The target areal coverage value of supratidal is greater than for dunes because supratidal habitat provides for a broader range of resource needs of the barrier headland avifauna. While high dunes are primarily useful as high-water refugia, supratidal habitats are the normal context for nest placement in the water bird colonies that occur on Louisiana’s outer coast. This can be seen in the SI curves in which optimal cover (SI=1.0) of supratidal habitat (V_2) is between 70 and 85 percent compared to 15 and 30 percent cover for dune habitat (V_1).

In this model, if the area of dune makes up more than 55 percent of the restoration unit, habitat suitability is considered suboptimal (SI=0.1), to where the inverse in true for supratidal habitat, where less vegetation is less optimal and 100 percent supratidal cover is considered moderate in value (S=0.5).

Existing: Elevation data was used to determine the location of dune and supratidal habitat. Then GIS was used to calculate the area of each habitat type as identified by the workgroup based on the 2010 aerial imagery and general knowledge of the area. It was assumed that only 12 miles of 32 miles of shoreline has dunes. This includes newly created dunes in McFaddin NWR.

FWOP: The NOAA Marsh Migration 0.5-foot and 2.0-foot sea level rise data were used to determine the future percent of emergent vegetation in year 2027 and 2077, respectively, within each restoration unit in the absence of restoration. This rise data is slightly more aggressive than the USACE intermediate curve, which predicates a 0.43-foot and 1.89-foot sea level rise in 2027 and 2077, respectively. Additionally, Bureau of Economic Geology (BEG) shoreline change projections for year 2056 was used to help determine potential shoreline position in the future (BEG 2017). It was assumed that the distribution of habitat types change as headland erodes (i.e. dune is converted to supratidal, supratidal to intertidal and intertidal to supratidal as erosion and overwash occur). The workgroup concluded that less than 1 percent of the area would be made up of dune and supratidal habitat at TY51.

FWP: Beach nourishment and dune construction restoration measures are assumed to have a linear decrease in effectiveness beginning at TY1 to TY10, but not to a point lower than optimal conditions. Renourishment activities assumed to occur in 10-year intervals was assumed to increase the lift negating the decrease in effectiveness below optimal conditions; therefore, the percent of dune and supratidal habitat was assumed to stay at optimal conditions. If RSLC or erosion rates are greater than expected, adaptive management would be employed if the dune/supratidal habitat moves outside of the optimal range of conditions. Measures, such as more frequent or greater quantities of renourishment would be implemented to reduce salinities to optimal conditions.

For alternatives with breakwaters, it was assumed that the structure would prevent 80 percent of loss from shoreline erosion assuming the structure is maintained as described in the alternative.

For alternatives with the sand engine, it was assumed that the measure would reduce shoreline erosion but would not contribute to dune formation.

For alternatives with a feeder/nearshore berm, it was assumed that the measure would only maintain the existing condition and not create new dune or supratidal habitat. It was assumed that the supratidal habitat would increase by 15 percent at TY51 over the FWOP condition.

3.3.2 Variable 3 (V_3): Percent Vegetative Cover of Dune and Supratidal Habitats

Vegetative cover is important primarily because of the nest-site preferences of nesting water birds. Large waders make colonies in supratidal habitat often nesting in woody vegetation, while ducks prefer nesting in grasses. Conversely, some species benefit from reduced vegetation and others prefer moderate density. The relatively high ideal value of vegetative cover identified in the model also recognizes the value of barrier headlands to wintering and migrating small landbirds. In barrier headlands where the tallest woody species are small species such as wax myrtle (*Myrica cerifera*) and eastern baccharis (*Baccharis halimifolia*), the primary migrant and wintering species will be those of shrublands and early successional habitats. However, migrants are sometimes forced to land in whatever they can find. Optimal conditions in the model incorporate dune and supratidal cover that ranges between 70 and 90 percent, while an area with 100 percent vegetative cover provides moderate value (SI=0.5) and an area with 0 percent cover has low value (SI=0.1).

Existing: Baseline values for this variable were based largely upon previous observations in the area by modeling workgroup members, the team's knowledge of dune and supratidal vegetation in the area and examination of 2010 aerial imagery and earlier historic images.

FWOP: As RSLC reduces the subareal extent of dune and supratidal habitat, vegetative cover should decrease in proportion to decreases in V_1. However, when considering the potential height and width of the remaining due at TY51, the headlands were assumed to have slightly greater vegetative cover than the proportional rate of habitat loss (5% vs 1%). The slight increase is related to the height of the dune anticipated in the future and the type of species expected to persist. Higher elevation dunes are expected to be subjected to less frequent overtopping and has the ability to recover more quickly after storm events. Likewise, species that are more tolerant of more frequent overtopping are expected to persist longer than other species and contribute to the overall composition of the dune and supratidal habitat despite land loss.

FWP: With an appropriate planting design, vegetative cover is assumed to be 35% in each habitat type at TY1 and optimal by TY3, which is assumed to be maintained through TY51. Despite vegetative losses during storm events, cover is expected to return to optimal conditions the following year, thereby not significantly affecting the overall HSI.

3.3.3 Variable 4 (V_4): Percent Vegetative Cover by Woody Species

This variable is intended to capture the habitat value of areas vegetated by woody species. Woody vegetation is relevant chiefly to providing nesting substrates for large waders, though they do not require it strictly (Lowery 1974). Otherwise, density of vegetation for nesting water birds has trade-offs, being favored for concealed nesting by some species but shunned by others (Craik and Titman 2009, Spear et al. 2007, Mallach and Leberg 1999).

Woody thickets are also significant to the habitat needs of migrating and wintering small landbirds. Moore et al. (1990) compared the use of four habitats by spring migrants on Horn Island off the coast of Mississippi. Scrub/Shrub habitat was characterized by the greatest number of species, the highest species diversity, and the largest number of individuals. More migrants recorded their maximum abundance in scrub/shrub habitats than in the three other habitats combined (pine forest, marsh/meadow, and relict dune). The specification that woody cover constitutes at least two species is also relevant to use by passage migrants; greater plant diversity presumably gives migrants some variety to choose from in selecting cover and feeding substrates.

The model assigns equal importance to total vegetative cover and to woody vegetative cover. This is a reflection of the comparable levels of influence of these variables on the bird community. Total cover is relevant because cover is avoided by some nesting seabirds; on the other hand woody cover is favored by nesting large waders. Based on the lack of clear primacy of either variable, the model weights them equally. The SI graph assumes that cover by woody species should be a small percentage (15% to 35%) of the vegetative cover on a headland to realize optimal value. Woody species cover greater than 65 percent is considered to have very low value and is assigned SI=0.1. The suitability index is divided by two for headlands with only one woody species.

Existing: Baseline values for this variable were based largely upon previous observations in the area by modeling workgroup members, the team's knowledge of dune and supratidal vegetation in the area and examination of 2010 aerial imagery and earlier historic images.

FWOP: Projections for this variable are similar to those for the vegetative cover variables for dune and supratidal habitats except that woody cover is expected to drop lower than in V_3 due to the already very low presence of woody species under the existing condition.

FWP: With an appropriate planting design, woody cover is assumed to be 5% at TY1 and optimal by TY5, which is assumed to be maintained through TY51.

3.3.4 Variable 5 (V5): Beach/Surf Zone Features

This variable is intended to capture the habitat value of the beach/surf zone. Beaches are widely used by waterbirds for foraging. In Texas, 15 species of shorebirds used beach habitat, and some shorebird species used beaches in greater concentration than more protected intertidal habitats in New Jersey (Burger et al. 1977) and Connecticut (Placyck and Harrington 2004). Ocean beaches in Louisiana are also used for foraging by shorebirds, and for loafing by flocking gulls and terns.

Surf zone areas within the northern Gulf of Mexico are also important habitats for a number of fish (Modde and Ross 1983). These areas are particularly important as nurseries for juvenile fishes and in some regions of the world have proven to be sites of accumulation for estuary dependent larva, accounting for up to 97% of the surf zone catch (Watt-Pringle and Strydom 2003; Whitfield 1989). It has been determined that fish assemblages around surf zones vary seasonally (Modde and Ross 1981). In the northern Gulf of Mexico a majority of young fish species occur during the spring and summer while others which spawn in the fall and winter are present during the winter and spring (Modde and Ross 1981). It has also been determined that these fish show a diel pattern of usage for the surf zone with a majority of fish occurring during the early hours of dawn (Modde and Ross 1981). Most fish found in the surf zone habitats are small planktivorous fish that are using this harsh environment as a nursery ground, as it provides an abundance of food as well as protection from larger predators. The variability of the fish assemblages that occupy the surf-zone is minimal and remains relatively constant over large geographic areas (Modde and Ross 1981). However, some areas may host larger species that are not found in nearby surf-zone habitats.

The suitability index graph for this variable is based on the assumption that a natural beach/surf zone slope or profile provides optimal habitat conditions for fish and wildlife. Man-made features such as breakwaters, containment dikes, and shoreline protection provide sub-optimal conditions.

The SI values for this variable are based on one of five classes including:

- **Class 1= Natural Beach/Unconfined Disposal:** If the beach is allowed to remain in its natural state then this will be the optimal habitat for the fish assemblage that uses the surf-zone.
- **Class 2= Confined Disposal:** If sediment is confined during placement using berms, several consequences can occur which may be detrimental to the ecological value of the beach.
- **Class 3= Breakwaters:** The model assumes that the presence of breakwaters can drastically alter the fish assemblage which may result in a negative effect on the nursery benefits provided by a natural beach habitat
- **Class 4= Rock on Beach:** The addition of coastal armorment results in the loss of sandy habitat, this in turn is assumed to change the macroinvertebrate assemblage, resulting in a less diverse and abundant assemblage. Additionally, nursery benefits would be removed.

- **Class 5= Seawall/No Emergent Habitat:** The addition of a seawall results in the removal of any beach habitat, thus eliminating the entire surf zone. This essentially removes potential nursery benefits from the area by allowing the introduction of predator species and may change the water movement to the area which may alter the prey availability to the natural fish assemblage. While fish habitat would be available, it would not be suitable for the original surf-zone assemblages

3.4 Model Results

Results of running the WVA Barrier Headland Model for each of the 11 fully formed plans is shown in Table 4 and Table 5. Attachment 1 shows the raw data used to compute HSI scores.

Table 4. WVA Barrier Headland Model Results in AAHUs.

	FWOP	FWP	Net Change in AAHUs
1A/1Abu	100	105	6
1B/1Bbu	100	102	3
2A/2Abu	100	151	52
2B	100	151	52
3/3bu	100	151	52
4A/4Abu	100	100	0
4B	100	151	52
6A	100	151	52
6B	100	107	8
10/10bu	100	151	52
13/13bu	100	150	51

* Values may not add/subtract exactly due to a rounding difference for display within the table here and the actual values calculated in the spreadsheets.

Table 5. Detailed Results of the WVA Barrier Headland Model.

Alternative 1A/1Abu

Condition: FWOP					Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs	TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84		0	210	0.70	147.84	
1	210	0.65	136.50	142.17	1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00	51	210	0.34	72.24	5218.50
Max TY=	**51**		**AAHUs=**	**99.6**	**Max TY=**	**51**		**AAHUs=**	**105.1**

Alternative 1B/1Bbu

Condition: FWOP					Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs	TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84		0	210	0.70	147.84	
1	210	0.65	136.50	142.17	1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00	51	210	0.32	66.57	5076.75
Max TY=	**51**		**AAHUs=**	**99.6**	**Max TY=**	**51**		**AAHUs=**	**102.3**

Alternative 2A/2Abu

Condition: FWOP					Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs	TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84		0	210	0.70	147.84	
1	210	0.65	136.50	142.17	1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00	51	210	0.79	166.53	7575.75
Max TY=	**51**		**AAHUs=**	**99.6**	**Max TY=**	**51**		**AAHUs=**	**151.3**

Alternative 2B

Condition: FWOP					Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs	TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84		0	210	0.70	147.84	
1	210	0.65	136.50	142.17	1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00	51	210	0.79	166.53	7575.75
Max TY=	**51**		**AAHUs=**	**99.6**	**Max TY=**	**51**		**AAHUs=**	**151.3**

Alternative 3/3bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00
Max TY=	**51**		**AAHUs=**	**99.6**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.79	166.53	7575.75
Max TY=	**51**		**AAHUs=**	**151.3**

Alternative 4A/4Abu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00
Max TY=	**51**		**AAHUs=**	**99.6**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00
Max TY=	**51**		**AAHUs=**	**99.6**

Alternative 4B

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00
Max TY=	**51**		**AAHUs=**	**99.6**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.79	166.53	7575.75
Max TY=	**51**		**AAHUs=**	**151.3**

Alternative 6A

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00
Max TY=	**51**		**AAHUs=**	**99.6**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.79	166.53	7575.75
Max TY=	**51**		**AAHUs=**	**151.3**

Alternative 6B

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00
Max TY=	51		AAHUs=	99.6

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.37	76.65	5328.75
Max TY=	51		AAHUs=	107.3

Alternative 10/10bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00
Max TY=	51		AAHUs=	99.6

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.79	166.53	7575.75
Max TY=	51		AAHUs=	151.3

Alternative 13/13bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.29	60.90	4935.00
Max TY=	51		AAHUs=	99.6

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
51	210	0.78	164.64	7528.50
Max TY=	51		AAHUs=	150.4

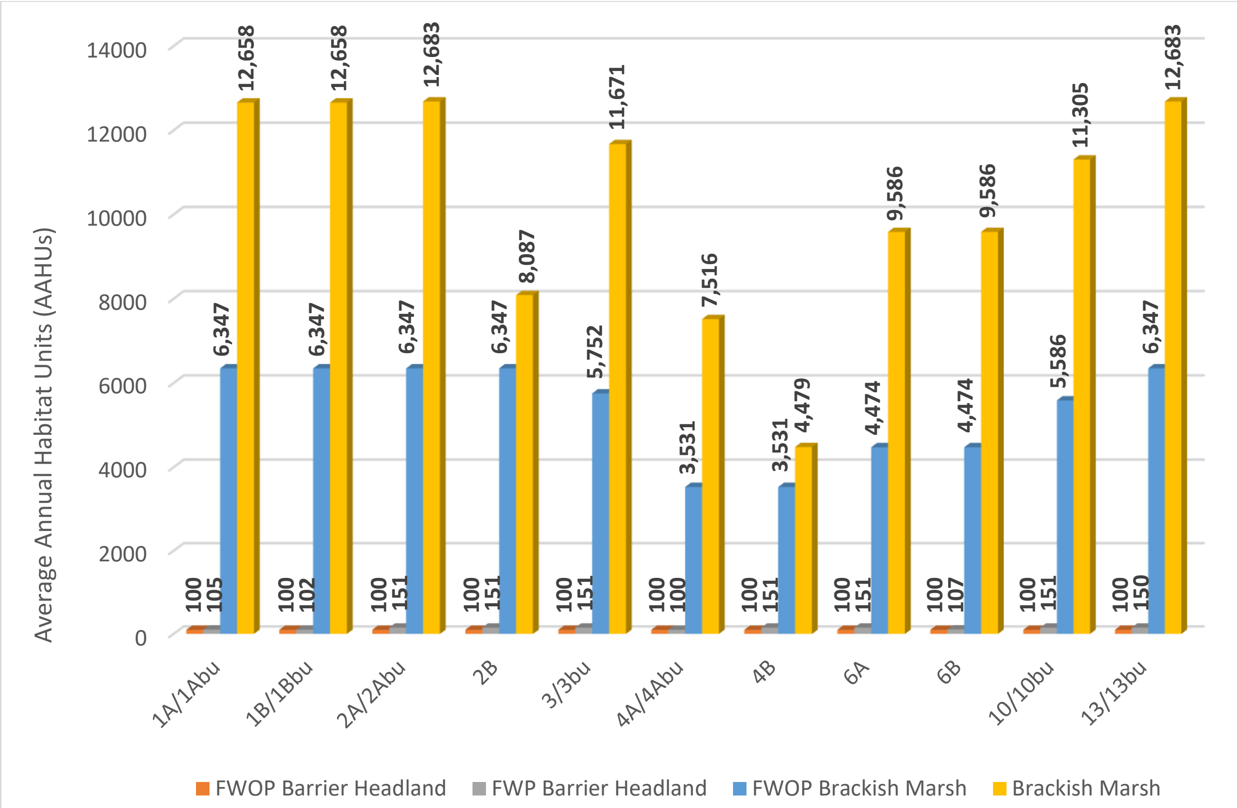
4.0 SUMMARY

Table 6 displays the environmental benefits and Figure 1 shows WVA results that provided the estimated net Average Annual Habitat Unit (AAHU) increases over the FWOP condition. The net AAHU numbers were then used in the CE/ICA analysis.

Table 6. Environmental Benefits

Plan	Future Without Project (AAHUs)			Future With Project (AAHUs)			Benefits (AAHUs)*		
	Barrier Headland	Brackish Marsh	Total	Barrier Headland	Brackish Marsh	Total	Barrier Headland	Brackish Marsh	Total
1A/1Abu	100	6,347	6,447	105	12,658	12,763	6	6,312	6,318
1B/1Bbu	100	6,347	6,447	102	12,658	12,760	3	6,312	6,315
2A/2Abu	100	6,347	6,447	151	12,683	12,809	52	6,337	6,389
2B	100	6,347	6,447	151	8,087	8,238	52	1,741	1,793
3/3bu	100	5,752	5,852	151	11,671	11,822	52	5,919	5,971
4A/4Abu	100	3,531	3,631	100	7,516	7,616	0	3,985	3,985
4B	100	3,531	3,631	151	4,479	4,630	52	948	1,000
6A	100	4,474	4,574	151	9,586	9,737	52	5,112	5,164
6B	100	4,474	4,574	107	9,586	9,693	8	5,112	5,120
10/10bu	100	5,586	5,686	151	11,305	11,456	52	5,719	5,771
13/13bu	100	6,347	6,447	150	12,683	12,833	51	6,337	6,388

Figure 1. WVA Results



5.0 POST-DRAFT REPORT MODIFICATIONS

Alternative 4Abu was identified as the National Ecosystem Restoration (NER) Plan and the Tentatively Selected Plan (TSP) based on the ability of the plan to reasonably maximize benefits when compared to overall cost. The AAHU calculations, presented in the previous sections, were used to identify cost effective plans based on the same level of detail for all plans. During the feasibility-level analysis, the TSP was refined in response to more detailed design and policy guidance received from the vertical team. Since the 2018 Draft IFR-EA, two significant changes were applied to the TSP including the removal of the assumption that continuing construction (outyear nourishment) would be completed throughout the project life for marsh/shoreline measures and removal of private lands.

After review by a number of individuals and offices of the vertical team, it was determined that for purposes of this study the outyear nourishment actions should not be included in the recommendation to Congress. As a result, the recommended plan includes only actions that would be constructed during initial construction (i.e. one initial placement of material in each of the marsh and/or shoreline restoration units and construction of any other measures such as breakwaters).

The second change was at the request of the NFS. The NFS notified the USACE they did not intend to purchase private lands nor did they intend to initiate condemnation if necessary. Therefore, the PDT was instructed to remove all private lands from the plans.

As a result, the WVA brackish marsh and barrier headland models were re-run for all alternatives omitting outyear nourishment and reducing the acreage to account for the loss of private lands. These results were then used to validate that the array of cost-effective plans remained the same as presented in the June 2018 Draft IFR-EA and that the NER/TSP plan remained the same.

5.1 Brackish Marsh Re-Run

The WVA Brackish Marsh model was re-run to determine the change in AAHUs with the omission of outyear nourishment and private lands.

The future with project condition AAHU calculations presented in the June 2018 DIFR-EA were based on the incorporation of outyear marsh nourishment at roughly year 30. The outyear nourishment was intended to provide additional lift in the absence of a reliable natural sediment input through the study area and sustain the restored marshes as RSLC accelerates. Year 30 was assumed to be threshold in which the measure could perform under the intermediate scenario, based on the H&H calculations, the RSLC curve and a daily tidal range of ±1.0-foot, before the marsh steadily degrades and converts to open water, resulting in a loss of marsh function and reversal of benefits gained in the first 30 years of the project life. After year 30, it is assumed that the rate of accretion and previous marsh nourishment actions would not perform as a self-regulating system and would steadily degrade over the remaining 20 years, thus the incorporation of outyear nourishment at year 30.

Since outyear nourishment could not be incorporated into the recommended plan, the following assumptions were applied when calculating HSI values and acreages for the second model run:

- Year 30 is the threshold in which the measure could perform under the intermediate scenario;
- After year 30, the system would steadily degrade and convert to saline marsh or open water and no longer function as a brackish marsh under future RSLC conditions;
- HSI scores did not change from those presented in section 2.5;
- Conversion of restoration unit to open water was linear and accounts for some of the change in acreage;
- Private lands excluded from acreage calculations; and
- USFWS would implement measures on their lands.

Results of running the WVA Marsh Model for each of the 11 fully formed plans is shown in Table 7 and Table 8. Attachment 1 shows the raw data used to compute HSI scores. The HSI scores were the same as used in the first run of the WVA; only the acreage changed.

Table 7. WVA Marsh Model Results without Continuing Construction and Private Lands (in AAHUs)

	FWOP	FWP	Net Change in AAHUs
1A/1Abu	4936	9182	4246
1B/1Bbu	4936	9182	4246
2A/2Abu	4936	9182	4246
2B	4936	6323	1387
3/3bu	2853	5097	2244
4A/4Abu	2737	5432	2695
4B	2737	3508	771
6A	3387	6769	3382
6B	3387	6769	3382
10/10bu	4480	8455	3974
13/13bu	4936	9182	4246

Table 8. Detailed Results of the WVA Marsh Model without Continuing Construction and Private Lands

Alternative 1A/1Abu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	10666	0.81	8587.52	
1	10705	0.67	7192.33	7890.79
11	9293	0.69	6392.26	67960.57
21	7883	0.70	5541.48	59704.19
31	6471	0.67	4304.55	49141.27
41	5060	0.68	3424.22	38670.91
51	3649	0.62	2270.30	28344.32
Max TY=	**51**		**AAHUs=**	**4935.5**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	10666	0.81	8587.52	
1	10705	0.88	9383.26	8984.93
11	10667	0.90	9613.36	94984.66
21	10624	0.89	9426.55	95198.54
31	10584	0.87	9169.47	92978.68
41	10543	0.84	8850.20	90096.51
51	10503	0.80	8353.25	86014.31
Max TY=	**51**		**AAHUs=**	**9181.5**

Alternative 1B/1Bbu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	10666	0.81	8587.52	
1	10705	0.67	7192.33	7890.79
11	9293	0.69	6392.26	67960.57
21	7883	0.70	5541.48	59704.19
31	6471	0.67	4304.55	49141.27
41	5060	0.68	3424.22	38670.91
51	3649	0.62	2270.30	28344.32
Max TY=	**51**		**AAHUs=**	**4935.5**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	10666	0.81	8587.52	
1	10705	0.88	9383.26	8984.93
11	10667	0.90	9613.36	94984.66
21	10624	0.89	9426.55	95198.54
31	10584	0.87	9169.47	92978.68
41	10543	0.84	8850.20	90096.51
51	10503	0.80	8353.25	86014.31
Max TY=	**51**		**AAHUs=**	**9181.5**

Alternative 2A/2Abu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	10666	0.81	8587.52	
1	10705	0.67	7192.33	7890.79
11	9293	0.69	6392.26	67960.57
21	7883	0.70	5541.48	59704.19
31	6471	0.67	4304.55	49141.27
41	5060	0.68	3424.22	38670.91
51	3649	0.62	2270.30	28344.32
Max TY=	**51**		**AAHUs=**	**4935.5**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	10666	0.81	8587.52	
1	10705	0.88	9383.26	8984.93
11	10667	0.90	9613.36	94984.66
21	10624	0.89	9426.55	95198.54
31	10584	0.87	9169.47	92978.68
41	10543	0.84	8850.20	90096.51
51	10503	0.80	8353.25	86014.31
Max TY=	**51**		**AAHUs=**	**9181.5**

Alternative 2B

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	10666	0.81	8587.52	
1	10705	0.67	7192.33	7890.79
11	9293	0.69	6392.26	67960.57
21	7883	0.70	5541.48	59704.19
31	6471	0.67	4304.55	49141.27
41	5060	0.68	3424.22	38670.91
51	3649	0.62	2270.30	28344.32
Max TY=	**51**		**AAHUs=**	**4935.5**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	10666	0.81	8587.52	
1	10705	0.88	9383.26	8984.93
11	9293	0.90	8375.08	88849.80
21	7883	0.89	6994.49	76815.10
31	6471	0.87	5606.16	62954.00
41	5060	0.84	4247.56	49205.32
51	3649	0.80	2902.12	35644.66
Max TY=	**51**		**AAHUs=**	**6322.6**

Alternative 3/3bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	6593	0.81	5308.22	
1	6636	0.67	4458.51	4884.32
11	5634	0.69	3875.39	41696.17
21	4641	0.70	3262.46	35714.27
31	3632	0.67	2416.03	28328.96
41	2631	0.68	1780.46	21001.64
51	1630	0.62	1014.14	13881.98
Max TY=	**51**		**AAHUs=**	**2853.1**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	6593	0.81	5308.22	
1	6636	0.88	5816.66	5561.93
11	6599	0.90	5947.18	58820.70
21	6562	0.89	5822.38	58846.96
31	6524	0.87	5652.08	57370.99
41	4726	0.84	3967.19	48015.68
51	2928	0.80	2328.70	31347.22
Max TY=	**51**		**AAHUs=**	**5097.3**

Alternative 4A/4Abu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	6325	0.81	5092.45	
1	6366	0.67	4277.10	4685.69
11	5406	0.69	3718.56	40003.87
21	4452	0.70	3129.60	34264.82
31	3485	0.67	2318.24	27178.37
41	2524	0.68	1708.05	20149.90
51	1564	0.62	973.08	13318.34
Max TY=	**51**		**AAHUs=**	**2737.3**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	6325	0.81	5092.45	
1	6336	0.88	5553.70	5322.94
11	6330	0.90	5704.75	56292.48
21	6295	0.89	5585.48	56450.33
31	6258	0.87	5421.63	55034.25
41	6223	0.84	5223.83	53225.72
51	6187	0.80	4920.65	50719.72
Max TY=	**51**		**AAHUs=**	**5432.3**

Alternative 4B

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	6325	0.81	5092.45	
1	6366	0.67	4277.10	4685.69
11	5406	0.69	3718.56	40003.87
21	4452	0.70	3129.60	34264.82
31	3485	0.67	2318.24	27178.37
41	2524	0.68	1708.05	20149.90
51	1564	0.62	973.08	13318.34
Max TY=	51		AAHUs=	2737.3

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	6325	0.81	5092.45	
1	6366	0.88	5579.99	5335.73
11	5406	0.90	4872.02	52299.57
21	4452	0.89	3950.21	44088.97
31	3485	0.87	3019.24	34813.47
41	2524	0.84	2118.74	25646.79
51	1564	0.80	1243.88	16742.53
Max TY=	51		AAHUs=	3508.4

Alternative 6A

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	7894	0.81	6355.70	
1	7915	0.67	5317.82	5837.23
11	6712	0.69	4616.90	49705.66
21	5508	0.70	3871.94	42474.49
31	4304	0.67	2863.05	33599.13
41	3101	0.68	2098.52	24830.91
51	1898	0.62	1180.88	16287.62
Max TY=	51		AAHUs=	3387.0

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	7894	0.81	6355.70	
1	7915	0.88	6937.74	6646.47
11	7876	0.90	7098.04	70180.51
21	7836	0.89	6952.79	70253.23
31	7798	0.87	6755.81	68541.68
41	7758	0.84	6512.37	66339.09
51	7719	0.80	6139.08	63254.34
Max TY=	51		AAHUs=	6768.9

Alternative 6B

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	7894	0.81	6355.70	
1	7915	0.67	5317.82	5837.23
11	6712	0.69	4616.90	49705.66
21	5508	0.70	3871.94	42474.49
31	4304	0.67	2863.05	33599.13
41	3101	0.68	2098.52	24830.91
51	1898	0.62	1180.88	16287.62
Max TY=	51		AAHUs=	3387.0

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	7894	0.81	6355.70	
1	7915	0.88	6937.74	6646.47
11	7876	0.90	7098.04	70180.51
21	7836	0.89	6952.79	70253.23
31	7798	0.87	6755.81	68541.68
41	7758	0.84	6512.37	66339.09
51	7719	0.80	6139.08	63254.34
Max TY=	51		AAHUs=	6768.9

Alternative 10/10bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	9734	0.81	7837.14	
1	9801	0.67	6584.96	7212.54
11	8485	0.69	5836.47	62142.23
21	7170	0.70	5040.27	54416.78
31	5855	0.67	3894.78	44592.46
41	4540	0.68	3072.32	34860.76
51	3225	0.62	2006.50	25274.57
Max TY=	**51**		**AAHUs=**	**4480.4**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	9734	0.81	7837.14	
1	9801	0.88	8590.88	8213.21
11	9788	0.90	8821.18	87060.83
21	9774	0.89	8672.35	87467.36
31	9760	0.87	8455.59	85639.25
41	9747	0.84	8182.01	83187.43
51	9733	0.80	7740.85	79613.27
Max TY=	**51**		**AAHUs=**	**8454.5**

Alternative 13/13bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	10666	0.81	8587.52	
1	10705	0.67	7192.33	7890.79
11	9293	0.69	6392.26	67960.57
21	7883	0.70	5541.48	59704.19
31	6471	0.67	4304.55	49141.27
41	5060	0.68	3424.22	38670.91
51	3649	0.62	2270.30	28344.32
Max TY=	**51**		**AAHUs=**	**4935.5**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	10666	0.81	8587.52	
1	10705	0.88	9383.26	8984.93
11	10667	0.90	9613.36	94984.66
21	10624	0.89	9426.55	95198.54
31	10584	0.87	9169.47	92978.68
41	10543	0.84	8850.20	90096.51
51	10503	0.80	8353.25	86014.31
Max TY=	**51**		**AAHUs=**	**9181.5**

5.2 Barrier Headland Re-Run

The barrier headland model was more complicated than the marsh model to run without the continuing construction (outyear nourishments). Under the initial conceptual designs, the sediment placed on the beach or in the nearshore was intended to act as sacrificial sediment in order to slow the rate of shoreline loss. The outyear nourishment interval was anticipated based on the current rate of erosion and the design considerations needed to "hold the line" through the 50-year period of analysis. With continuing construction, it was assumed that the HSI value would remain constant through the 50-year period of analysis considering that when the system began to lose value a renourishment cycle would occur.

Under the guidance of removing continuing construction from the recommended plan, new assumptions had to be developed. It is assumed that without regular interval renourishments, the system would steadily degrade defaulting to the historic rate of erosion which would result in the shoreline retreating landward. In order to predict how each measure would perform under RSLC given the current and projected rate of erosion, H&H developed some conceptualized designs, which were then used to estimate the values for each variable. This resulted in a non-linear reduction in function.

In order to accurately capture the variability after initial construction and one O&M cycle, the barrier headland model target years were expanded to calculate HSI values at 10-year intervals. Because of this, the FWOP also needed to be extrapolated out across the same time span. The inputs for the FWOP V1-V4 were determined based on a linear regression line. The resulting HSI values for each time period did not result in a linear reduction in overall HSI value for each interval. Instead some intervals increased over prior year intervals. This happened because some TY values achieved a higher HSI value for that variable even though there was a decline in value (i.e. for some variables, lower values were actually closer to optimal resulting in a higher HSI score for that variable). This then contributed to an average overall higher HSI value for the FWOP condition in that TY interval.

The assumptions used to develop the conceptual designs and estimate the inputs for HSI variable calculations for the FWP conditions are described below.

V1 and V2:

- *Beach nourishment, no breakwaters (Alternatives 2B, 3/3bu, 4B, 6A, and 13/13bu):* linear decrease in effectiveness beginning in TY1 to TY10 and again from TY11 to TY20, but not to a point lower than optimal conditions. From TY21-51, the rate of erosion was assumed to be 5 meters per year.
- *Beach nourishment with Breakwaters (Alternatives 2A/2Abu and 10/10bu):* a 20% loss in beach width would be expected between TY1 and 15, after that a 30% loss would be expected between TY15 and 51. These were determined using a linear regression of loss between the start and end dates and the total anticipated loss between that period.
- *Dune Construction (Alternatives 2A/2Abu, 2B, 3/3bu, 4B, 10/10bu, and 13/13bu):* dunes would be built to 9 feet; as erosion the beach retreated landward with erosion the toe of the dune would begin to erode. Although some dune building sediments would be introduced, it would not be at a rate sufficient to maintain the dune.
- *Sand engine (Alternatives 1B/1Bbu, 6B, and 13/13bu):* measure would reduce shoreline erosion with a TY51 shoreline position the same as the existing condition. This measure would not contribute to dune formation, but would maintain the existing condition through TY51. It is assumed that in TY1, there would be 100% supratidal. After than the area of supratidal would be reduced at the current rate of erosion of 5 meters/year.
- *Feeder Berm (Alternatives 1A/1Abu):* measure would maintain the existing condition shoreline position from TY1-20, then from TY21-51, the shoreline position would change at a rate of 5 meters per year and the dune would follow the FWOP conditions.

V3 and V4:

- *Beach nourishment, no breakwaters:* assume cover remains constant with the existing condition through TY21, except in TY1 and TY11 when a reduction in cover is expected from placement of material on existing vegetation. Cover would recover fairly quickly (couple of months to no more than 3 years to reach optimal). After TY21, cover is assumed to follow a linear reduction until the FWOP conditions are reached at TY41. FWOP conditions are assumed for TY51.

- *Beach nourishment with breakwaters:* assume cover remains constant with the existing condition through TY51, except in TY1 and TY11 where there would be a reduction in cover until plants fully reestablish, similar to beach nourishment, no breakwaters.
- *Sand Engine:* Because this measure has an extremely wide supratidal zone, it is assumed that the percent cover would be the equivalent to the existing condition plus 25 percent additional cover through TY 41. At TY51, it is assumed cover is commensurate with the existing condition. Woody vegetation would not be expected to exceed the existing condition.
- *Feeder Berm:* assume cover remains constant with the existing condition until TY21, which then is assumed to result in a linear reduction to the FWOP conditions at TY41. FWOP conditions are assumed in TY51.

V5:

- Beach nourishment, dune construction, sand engine and feeder berm measures (Alternatives 1A/1Abu, 1B/1Bbu, 2B, 3/3bu, 4B, 6A, 6B and 13/13bu) are considered a Class 1 feature.
- Beach nourishment with breakwaters (Alternatives 2A/2Abu and 10/10bu) are considered a Class 3 feature.

Acreage:

- There were no private lands along the barrier headland area of application, so there was no change in acreage.
- The percent area of a variable was determined by setting a bounds from 0-250 feet from the landward toe. The only exception was made when the dune and supratidal migrated landward resulting in a negative distance from the landward toe. This was only calculated for the first interval in which negative values occurred (i.e. In TY11 the dune and supratidal were still a positive distance from the landward dune toe, but in TY 21 erosion caused it to migrate into the negative distances from the landward dune toe. Calculations were made for this year but all future year intervals reverted to the FWOP variable values for those years.)
- It is assumed USFWS would implement measures which are located on their land or primarily benefit their property.

Results of running the WVA Barrier Headland Model for each of the 11 fully formed plans is shown in Table 9 and Table 10. Attachment 2 shows the conceptual designs and raw data used to compute HSI scores.

Table 9. WVA Barrier Headland Model Re-Run Results (in AAHUs).

	FWOP	FWP	Net Change in AAHUs
1A/1Abu	119	131	12
1B/1Bbu	119	152	33
2A/2Abu	119	162	42
2B	119	121	2
3/3bu	90	99	8
4A/4Abu	119	119	0
4B	30	28	-2
6A	30	28	-2
6B	30	34	5
10/10bu	119	161	42
13/13bu	119	158	39

Table 10. Detailed Results of the WVA Barrier Headland Model Re-Run.

Alternative 1A/1Abu

Condition: FWOP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
10	210	0.69	144.27	1263.47
11	210	0.69	145.32	144.80
21	210	0.64	134.61	1399.65
31	210	0.59	123.48	1290.45
41	210	0.44	91.98	1077.30
51	210	0.29	60.90	764.40
Max TY=	**51**		**AAHUs=**	**119.3**

Condition: FWP				
TY	**Acres**	**HSI**	**Total HUs**	**Cumulative HUs**
0	210	0.70	147.84	
1	210	0.81	169.68	158.76
10	210	0.78	164.01	1501.61
11	210	0.70	146.79	155.40
21	210	0.75	156.66	1517.25
31	210	0.65	135.87	1462.65
41	210	0.44	91.98	1139.25
51	210	0.29	60.90	764.40
Max TY=	**51**		**AAHUs=**	**131.4**

Alternative 1B/1Bbu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
10	210	0.69	144.27	1263.47
11	210	0.69	145.32	144.80
21	210	0.64	134.61	1399.65
31	210	0.59	123.48	1290.45
41	210	0.44	91.98	1077.30
51	210	0.29	60.90	764.40
Max TY=	**51**		**AAHUs=**	**119.3**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.73	153.09	150.47
10	210	0.73	153.09	1377.81
11	210	0.73	153.09	153.09
21	210	0.73	153.09	1530.90
31	210	0.73	153.09	1530.90
41	210	0.73	153.09	1530.90
51	210	0.69	144.27	1486.80
Max TY=	**51**		**AAHUs=**	**152.2**

Alternative 2A/2Abu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
10	210	0.69	144.27	1263.47
11	210	0.69	145.32	144.80
21	210	0.64	134.61	1399.65
31	210	0.59	123.48	1290.45
41	210	0.44	91.98	1077.30
51	210	0.29	60.90	764.40
Max TY=	**51**		**AAHUs=**	**119.3**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.66	138.18	143.01
10	210	0.81	169.05	1382.54
11	210	0.71	149.94	159.50
21	210	0.80	168.42	1591.80
31	210	0.80	167.16	1677.90
41	210	0.79	165.90	1665.30
51	210	0.75	157.29	1615.95
Max TY=	**51**		**AAHUs=**	**161.5**

Alternative 2B

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
10	210	0.69	144.27	1263.47
11	210	0.69	145.32	144.80
21	210	0.64	134.61	1399.65
31	210	0.59	123.48	1290.45
41	210	0.44	91.98	1077.30
51	210	0.29	60.90	764.40
Max TY=	**51**		**AAHUs=**	**119.3**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.68	141.96	144.90
10	210	0.66	139.44	1266.30
11	210	0.69	144.48	141.96
21	210	0.63	133.14	1388.10
31	210	0.63	133.14	1331.40
41	210	0.44	91.98	1125.60
51	210	0.29	60.90	764.40
Max TY=	**51**		**AAHUs=**	**120.8**

Alternative 3/3bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	159	0.70	111.94	
1	159	0.65	103.35	107.64
10	159	0.69	109.23	956.62
11	159	0.69	110.03	109.63
21	159	0.64	101.92	1059.74
31	159	0.59	93.49	977.06
41	159	0.44	69.64	815.67
51	159	0.29	46.11	578.76
Max TY=	51		AAHUs=	90.3

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	159	0.70	111.94	
1	159	0.68	107.96	109.95
10	159	0.79	125.61	1051.07
11	159	0.68	107.96	116.79
21	159	0.79	125.61	1167.86
31	159	0.65	102.87	1142.42
41	159	0.44	69.64	862.58
51	159	0.29	46.11	578.76
Max TY=	51		AAHUs=	98.6

Alternative 4A/4Abu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
10	210	0.69	144.27	1263.47
11	210	0.69	145.32	144.80
21	210	0.64	134.61	1399.65
31	210	0.59	123.48	1290.45
41	210	0.44	91.98	1077.30
51	210	0.29	60.90	764.40
Max TY=	51		AAHUs=	119.3

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
10	210	0.69	144.90	1266.30
11	210	0.69	144.90	144.90
21	210	0.64	134.40	1396.50
31	210	0.59	123.90	1291.50
41	210	0.44	92.40	1081.50
51	210	0.29	60.90	766.50
Max TY=	51		AAHUs=	119.4

Alternative 4B

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	52	0.70	36.61	
1	52	0.65	33.80	35.20
10	52	0.69	35.72	312.86
11	52	0.69	35.98	35.85
21	52	0.64	33.33	346.58
31	52	0.59	30.58	319.54
41	52	0.44	22.78	266.76
51	52	0.29	15.08	189.28
Max TY=	51		AAHUs=	29.5

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	52	0.70	36.61	
1	52	0.67	35.00	35.80
10	52	0.53	27.30	280.33
11	52	0.69	35.78	31.54
21	52	0.53	27.30	315.38
31	52	0.60	30.94	291.20
41	52	0.44	22.78	268.58
51	52	0.29	15.08	189.28
Max TY=	51		AAHUs=	27.7

Alternative 6A

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	52	0.70	36.61	
1	52	0.65	33.80	35.20
10	52	0.69	35.72	312.86
11	52	0.69	35.98	35.85
21	52	0.64	33.33	346.58
31	52	0.59	30.58	319.54
41	52	0.44	22.78	266.76
51	52	0.29	15.08	189.28
Max TY=	**51**		**AAHUs=**	**29.5**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	52	0.70	36.61	
1	52	0.67	35.00	35.80
10	52	0.53	27.30	280.33
11	52	0.69	35.78	31.54
21	52	0.53	27.30	315.38
31	52	0.60	30.94	291.20
41	52	0.44	22.78	268.58
51	52	0.29	15.08	189.28
Max TY=	**51**		**AAHUs=**	**27.7**

Alternative 6B

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	52	0.70	36.61	
1	52	0.65	33.80	35.20
10	52	0.69	35.72	312.86
11	52	0.69	35.98	35.85
21	52	0.64	33.33	346.58
31	52	0.59	30.58	319.54
41	52	0.44	22.78	266.76
51	52	0.29	15.08	189.28
Max TY=	**51**		**AAHUs=**	**29.5**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	52	0.70	36.61	
1	52	0.61	31.62	34.11
10	52	0.67	34.68	298.35
11	52	0.67	34.68	34.68
21	52	0.67	34.68	346.84
31	52	0.67	34.68	346.84
41	52	0.67	34.68	346.84
51	52	0.65	33.90	342.94
Max TY=	**51**		**AAHUs=**	**34.3**

Alternative 10/10bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
10	210	0.69	144.27	1263.47
11	210	0.69	145.32	144.80
21	210	0.64	134.61	1399.65
31	210	0.59	123.48	1290.45
41	210	0.44	91.98	1077.30
51	210	0.29	60.90	764.40
Max TY=	**51**		**AAHUs=**	**119.3**

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.66	138.18	143.01
10	210	0.80	168.42	1379.70
11	210	0.71	149.94	159.18
21	210	0.80	168.42	1591.80
31	210	0.80	167.16	1677.90
41	210	0.79	165.90	1665.30
51	210	0.75	157.29	1615.95
Max TY=	**51**		**AAHUs=**	**161.4**

Alternative 13/13bu

Condition: FWOP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.65	136.50	142.17
10	210	0.69	144.27	1263.47
11	210	0.69	145.32	144.80
21	210	0.64	134.61	1399.65
31	210	0.59	123.48	1290.45
41	210	0.44	91.98	1077.30
51	210	0.29	60.90	764.40
Max TY=	51		AAHUs=	119.3

Condition: FWP				
TY	Acres	HSI	Total HUs	Cumulative HUs
0	210	0.70	147.84	
1	210	0.78	164.01	155.93
10	210	0.79	165.48	1482.71
11	210	0.73	153.09	159.29
21	210	0.70	146.16	1496.25
31	210	0.77	162.12	1541.40
41	210	0.77	161.70	1619.10
51	210	0.75	157.50	1596.00
Max TY=	51		AAHUs=	157.9

5.3 Summary of Re-Run Results

Table 11 shows a summary of the results of the WVA model re-run, which excludes continuing construction and private lands.

Table 11. Summary of Benefits for Each Alternative in the Final Array Excluding Continuing Construction and Private Lands..

Plan	Future Without Project (AAHUs)			Future With Project (AAHUs)			Benefits (AAHUs)*		
	Barrier Headland	Brackish Marsh	Total	Barrier Headland	Brackish Marsh	Total	Barrier Headland	Brackish Marsh	Total
1A/1Abu	119	4936	5055	131	9182	9313	12	4246	4258
1B/1Bbu	119	4936	5055	152	9182	9334	33	4246	4279
2A/2Abu	119	4936	5055	162	9182	9344	42	4246	4288
2B	119	4936	5055	121	6323	6444	2	1387	1389
3/3bu	90	2853	2943	99	5097	5196	8	2244	2253
4A/4Abu	119	2737	2856	119	5432	5551	0	2695	2695
4B	30	2737	2767	28	3508	3536	-2	771	769
6A	30	3387	3417	28	6769	6797	-2	3382	3385
6B	30	3387	3417	34	6769	6803	5	3382	3387
10/10bu	119	4480	4599	161	8455	8616	42	3974	4016
13/13bu	119	4936	5055	158	9182	9340	39	4246	4285

Attachment 1 – Initial WVA Model Run

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: Jefferson County Ecosystem Restoration Feasibility Study   Acres: 210

Condition: Future Without Project

Variable		TY Value	0 SI	TY Value	1 SI	TY Value	51 SI
V1	% Dune	35	0.82	35	0.82	1	0.16
V2	% Supratidal	29	0.48	29	0.48	1	0.11
V3	% Vegetative Cover	35	0.56	35	0.56	5	0.17
V4	% Woody Cover	10	0.70	5	0.40	0	0.10
V5	Beach/surf Zone	atural Beach/Unconfined Dispos	1.00	atural Beach/Unconfined Dispos	1.00	atural Beach/Unconfined Dispos	1.00
		HSI =	0.704	HSI =	0.650	HSI =	0.290

Variable 5 Lookup Table

Class Description	Class number	SI
Natural Beach/Unconfined Disposal	1	1
Confined Disposal	2	0.8
Breakwaters	3	0.9
Rock on Beach	4	0.2
Seawall/No emergent habitat	5	0.1

Project: y Ecosystem Restoration Feasibility Study   Acres: 210

FWOP

Variable		TY Value	SI	TY Value	SI	TY Value	SI
V1	% Dune						
V2	% Supratidal						
V3	% Vegetative Cover						
V4	% Woody Cover						
V5	Beach/surf Zone						
		HSI =		HSI =		HSI =	

Project: y Ecosystem Restoration Feasibility Study   Acres: 210

FWOP

Variable		TY Value	SI	TY Value	SI	TY Value	SI
V1	% Dune						
V2	% Supratidal						
V3	% Vegetative Cover						
V4	% Woody Cover						
V5	Beach/surf Zone						
		HSI =		HSI =		HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: y Ecosystem Restoration Feasibility Study   Acres: 210

Condition: Future With Project

Variable		TY Value	0 SI	TY Value	1 SI	TY Value	51 SI
V1	% Dune	35	0.82	35	0.82	35	0.82
V2	% Supratidal	29	0.48	29	0.48	29	0.48
V3	% Vegetative Cover	35	0.56	35	0.56	50	0.75
V4	% Woody Cover	10	0.70	10	0.70	20	1.00
V5	Beach/surf Zone	atural Beach/Unconfined Dispos	1.00	atural Beach/Unconfined Dispos	1.00	atural Beach/Unconfined Dispos	1.00
		HSI =	0.704	HSI =	0.704	HSI =	0.793

Project: y Ecosystem Restoration Feasibility Study   Acres: 210

FWP

Variable		TY Value	SI	TY Value	SI	TY Value	SI
V1	% Dune						
V2	% Supratidal						
V3	% Vegetative Cover						
V4	% Woody Cover						
V5	Beach/surf Zone						
		HSI =		HSI =		HSI =	

Project: y Ecosystem Restoration Feasibility Study   Acres: 210

FWP

Variable		TY Value	SI	TY Value	SI	TY Value	SI
V1	% Dune						
V2	% Supratidal						
V3	% Vegetative Cover						
V4	% Woody Cover						
V5	Beach/surf Zone						
		HSI =		HSI =		HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Brackish Marsh

Project: Jefferson County Ecosystem Restoration Feasibility Study

FWOP

AAHUs = 0.00

Project Area (ac)												
Target Year (TY)	0	1	11	21	31	41	51					
V1: % Emergent	50	40	40	40	35	35	30					
V2: % Aquatic	20	10	10	5	5	0	0					
V3: Interspersion Class 1	30	20	20	15	10	5	5					
V3: Interspersion Class 2	25	15	15	15	10	10	5					
V3" Interspersion Class 3	25	25	20	15	15	15	10					
V3: Interspersion Class 4	20	20	15	10	5	0	0					
V3: Interspersion Class 5	0	20	30	45	60	70	80					
V4: %OW <= 1.5ft	30	30	25	20	15	10	5					
V5: Salinity (ppt)	10.25	10.25	10.25	10.25	10.25	10.25	10.25					
V6: Access Value	0.64	0.48	0.58	0.71	0.84	0.97	1.00					
	0	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR					

FWP

Project Area (ac)												
Target Year (TY)	0	1	11	21	31	41	51					
V1: % Emergent	50	65	60	55	65	60	65					
V2: % Aquatic	20	20	25	35	45	50	50					
V3: Interspersion Class 1	30	30	30	30	30	30	30					
V3: Interspersion Class 2	25	60	60	60	60	60	60					
V3" Interspersion Class 3	25	10	10	10	10	10	10					
V3: Interspersion Class 4	20	0	0	0	0	0	0					
V3: Interspersion Class 5	0	0	0	0	0	0	0					
V4: %OW <= 1.5ft	30	75	70	65	75	70	75					
V5: Salinity (ppt)	10	10.25	10.25	10.25	10.25	10.25	10.25					
V6: Access Value	0.64	0.48	0.58	0.71	0.84	0.97	1.00					
		ERROR	ERROR	ERROR	ERROR	ERROR	ERROR					

Intermediate Calculations (FWOP)

	Intermediate Calculations			Intermediate Calculations		
TY						
	0.75	0.75	0.75	0.75	0.75	0.75
	1	1	1	1	1	1
	0.5	0.5	0.5	0.5	0.5	0.5
	0.2	0.2	0.2	0.2	0.2	0
	0	0.1	0.1	0.1	0.1	0.1
TY						
	0.75	0	0	0	0	0
	1	0	0	0	0	0
	0.5	0	0	0	0	0
	0	0	0	0	0	0
	0.1	0	0	0	0	0

Intermediate Calculations (FWP)

	Intermediate Calculations			Intermediate Calculations		
TY						
	0.75	0.75	0.75	0.75	0.75	0.75
	1	1	1	1	1	1
	0.5	0.5	0.5	0.5	0.5	0.5
	0.2	0	0	0	0	0
	0	0	0	0	0	0
TY						
	0.75	0	0	0	0	0
	1	0	0	0	0	0
	0.5	0	0	0	0	0
	0	0	0	0	0	0
	0	0	0	0	0	0

Computed SIs - do not enter data here !

FWOP SIs

Project Area (ac)												
Target Year (TY)	0	1	11	21	31	41	51					
V1: % Emergent	0.85	0.70	0.70	0.70	0.63	0.63	0.55					
V2: % Aquatic	0.32	0.21	0.21	0.15	0.15	0.10	0.10					
V3 Interspersion	0.64	0.49	0.46	0.40	0.32	0.28	0.22					
V4: %OW <= 1.5ft	0.49	0.49	0.42	0.36	0.29	0.23	0.16					
V5: Salinity (ppt)	0.96	0.96	0.96	0.96	0.96	0.96	0.96					
V6: Access Value	0.68	0.53	0.62	0.74	0.86	0.97	1.00					
Emergent Marsh HSI =	**0.81**	**0.67**	**0.69**	**0.70**	**0.67**	**0.68**	**0.62**					
Open Water HSI =	**0.49**	**0.38**	**0.39**	**0.35**	**0.36**	**0.30**	**0.29**					

FWP SIs

Project Area (ac)												
Target Year (TY)	0	1	11	21	31	41	51					
V1: % Emergent	0.85	1.00	1.00	0.93	1.00	1.00	1.00					
V2: % Aquatic	0.32	0.32	0.37	0.48	0.59	0.65	0.65					
V3 Interspersion	0.64	0.88	0.88	0.88	0.88	0.88	0.88					
V4: %OW <= 1.5ft	0.49	1.00	1.00	0.94	1.00	1.00	1.00					
V5: Salinity (ppt)	0.96	0.96	0.96	0.96	0.96	0.96	0.96					
V6: Access Value	0.68	0.53	0.62	0.74	0.86	0.97	1.00					
Emergent Marsh HSI =	**0.81**	**0.88**	**0.90**	**0.89**	**0.95**	**0.98**	**0.98**					
Open Water HSI =	**0.49**	**0.51**	**0.57**	**0.65**	**0.74**	**0.80**	**0.81**					

V6 Table		
	Structure Type	Structure Rating R
a	Open system	1
b	Rock weir set at 1ft below marsh level (BML), w/ boat bay	0.8
c	Rock weir with boat bay	0.6
d	Rock weir set at > 1 ft BML	0.6
e	Slotted weir with boat bay	0.6
f	Open culverts	0.5
g	Weir with boat bay	0.5
h	Weir set at > 1 ft BML	0.5
i	Slotted weir	0.4
j	Flap-gated culvert with slotted weir	0.35
k	Variable crest weir	0.3
l	Flap-gated variable crest weir	0.25
m	Flap-gated culvert	0.2
n	Rock weir	0.15
o	Fixed crest weir	0.1
p	Solid plug	0.0001

NOTE	**Where multiple openings <u>equally</u> affect a common "accessible unit", the Structure Rating (R) of the structure proposed for the "major" access point for the unit will be used to calculate the Access Value. The designation of "major" will be made by the HET.**
NOTE	**1) In the case of a "hybrid" structure or a unique application of one of the above-listed types (including unique or "non-standard" operational schemes), the WVA analyst(s) may assign an appropriate Structure Rating between 0.0001 and 1.0 that most closely approximates the relative degree to which the structure in question would allow ingress/egress of estuarine organisms. In those cases, the rationale used in developing the new Structure Rating shall be documented. 2) Use drop down list to enter value for Structure Rating (R calc) when structure is in V6 Table above; if structure is not included in V6 Table, then Structure Rating (R calc) may be entered manually (0 to 1).**
Notes are from the Procedural Manual. See "Procedure for Calculating Access Value" Section in WVA Marsh Models Manual (pages 38-41) for example V6 calculations and further details.	

FWOP V6 Calculator		TY	TY	TY	TY	TY	TY	TY	TY	TY	TY	TY	TY	Notes: Please provide a brief description of assumptions and structure type
	Total Access Value V_6	**0**												
Opening 1	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)	a	a	a	a	a	a	a						
	% Wetland accessible by all access points (P calc)	10	5	25	45	65	85	100						
	V_6: Access Value	1	1	1	1	1	1	1						
Opening 2	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)	b	b	b	b	b	b							
	% Wetland accessible by all access points (P calc)	60	40	30	25	20	15							
	V_6: Access Value	0.8	0.8	0.8	0.8	0.8	0.8							
Opening 3	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)	m	m	m	m	m								
	% Wetland accessible by all access points (P calc)	30	55	45	30	15								
	V_6: Access Value	0.2	0.2	0.2	0.2	0.2								
Opening 4	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 5	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 6	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 7	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 8	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 9	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 10	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
	Total FWOP Access Value V_6	0.64	0.48	0.58	0.71	0.84	0.97	1.00						

FWP V6 Calculator		TY	TY	TY	TY	TY	TY	TY	TY	TY	TY	TY	TY	Notes: Please provide a brief description of assumptions and structure type
	Total Access Value V_6	**0**												
Opening 1	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)	a	a	a	a	a	a	a						
	% Wetland accessible by all access points (P calc)	10	5	25	45	65	85	100						
	V_6: Access Value	1	1	1	1	1	1	1						
Opening 2	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)	b	b	b	b	b	b							
	% Wetland accessible by all access points (P calc)	60	40	30	25	20	15							
	V_6: Access Value	0.8	0.8	0.8	0.8	0.8	0.8							
Opening 3	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)	m	m	m	m	m								
	% Wetland accessible by all access points (P calc)	30	55	45	30	15								
	V_6: Access Value	0.2	0.2	0.2	0.2	0.2								
Opening 4	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 5	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 6	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 7	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 8	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													
Opening 9	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)													
	% Wetland accessible by all access points (P calc)													
	V_6: Access Value													

Opening 10	Structure Rating (R calc) (see V6 Table above and user manual for letter descriptions)												
	% Wetland accessible by all access points (P calc)												
	V_6: Access Value												
Total FWP Access Value V_6		0.64	0.48	0.58	0.71	0.84	0.97	1.00					

Attachment 2 –

Barrier Headland Model HSI Calculations Excluding Continuing Construction and Private Lands

and

Conceptual Design Projections of the FWP of Shoreline Measures

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: JCER Alt 1A -- Feeder Berm Both Sites　　Acres: 210

Condition: Future Without Project

Variable		TY Value	0	TY Value	1 SI	TY Value	10 SI
V1	% Dune	35	0.82	35	0.82	29	1.00
V2	% Supratidal	29	0.48	29	0.48	24	0.41
V3	% Vegetative Cover	35	0.56	35	0.56	30	0.49
V4	% Woody Cover	10	0.70	5	0.40	7	0.52
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.650	HSI =	0.687

Project: Alt 1A -- Feeder Berm Both Sites　　Acres: 210

FWOP

Variable		TY Value	11 SI	TY Value	21 SI	TY Value	31 SI
V1	% Dune	28	1.00	21	1.00	15	1.00
V2	% Supratidal	23	0.40	18	0.33	12	0.26
V3	% Vegetative Cover	29	0.48	23	0.40	17	0.32
V4	% Woody Cover	8	0.58	6	0.46	4	0.34
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.692	HSI =	0.641	HSI =	0.588

Project: Alt 1A -- Feeder Berm Both Sites　　Acres: 210

FWOP

Variable		TY Value	41 SI	TY Value	51 SI	TY Value	SI
V1	% Dune	8	0.58	1	0.16		
V2	% Supratidal	6	0.18	1	0.11		
V3	% Vegetative Cover	11	0.24	5	0.17		
V4	% Woody Cover	2	0.22	0	0.10		
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00		
		HSI =	0.438	HSI =	0.290	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: Alt 1A -- Feeder Berm Both Sites　　Acres: 210

Condition: Future With Project

Variable		TY Value	0 SI	TY Value	1 SI	TY Value	10 SI
V1	% Dune	35	0.82	18	1.00	16	1.00
V2	% Supratidal	29	0.48	50	0.75	41	0.63
V3	% Vegetative Cover	35	0.56	35	0.56	35	0.56
V4	% Woody Cover	10	0.70	10	0.70	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.808	HSI =	0.781

Project: Alt 1A -- Feeder Berm Both Sites　　Acres: 210

FWP

Variable		TY Value	11 SI	TY Value	21 SI	TY Value	31 SI
V1	% Dune	11	0.76	19	1.00	15	1.00
V2	% Supratidal	32	0.52	29	0.48	20	0.36
V3	% Vegetative Cover	35	0.56	35	0.56	23	0.40
V4	% Woody Cover	10	0.70	10	0.70	6	0.46
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.699	HSI =	0.746	HSI =	0.647

Project: Alt 1A -- Feeder Berm Both Sites　　Acres: 210

FWP

Variable		TY Value	41 SI	TY Value	51 SI	TY Value	SI
V1	% Dune	8	0.58	1	0.16		
V2	% Supratidal	6	0.18	1	0.11		
V3	% Vegetative Cover	11	0.24	5	0.17		
V4	% Woody Cover	2	0.22	0	0.10		
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00		
		HSI =	0.438	HSI =	0.290	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: JCER Alt 1b -- Sand Engine Both Sites   Acres: 210

Condition: Future Without Project

Variable		TY Value	0	TY Value	1 SI	TY Value	10 SI
V1	% Dune	35	0.82	35	0.82	29	1.00
V2	% Supratidal	29	0.48	29	0.48	24	0.41
V3	% Vegetative Cover	35	0.56	35	0.56	30	0.49
V4	% Woody Cover	10	0.70	5	0.40	7	0.52
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.650	HSI =	0.687

Project: Alt 1b -- Sand Engine Both Sites   Acres: 210

FWOP

Variable		TY Value	11 SI	TY Value	21 SI	TY Value	31 SI
V1	% Dune	28	1.00	21	1.00	15	1.00
V2	% Supratidal	23	0.40	18	0.33	12	0.26
V3	% Vegetative Cover	29	0.48	23	0.40	17	0.32
V4	% Woody Cover	8	0.58	6	0.46	4	0.34
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.692	HSI =	0.641	HSI =	0.588

Project: Alt 1b -- Sand Engine Both Sites   Acres: 210

FWOP

Variable		TY Value	41 SI	TY Value	51 SI	TY Value	SI
V1	% Dune	8	0.58	1	0.16		
V2	% Supratidal	6	0.18	1	0.11		
V3	% Vegetative Cover	11	0.24	5	0.17		
V4	% Woody Cover	2	0.22	0	0.10		
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00		
		HSI =	0.438	HSI =	0.290	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: Alt 1b -- Sand Engine Both Sites   Acres: 210

Condition: Future With Project

Variable		TY Value	0 SI	TY Value	1 SI	TY Value	10 SI
V1	% Dune	35	0.82	9	0.64	9	0.64
V2	% Supratidal	29	0.48	92	0.77	92	0.77
V3	% Vegetative Cover	35	0.56	35	0.56	35	0.56
V4	% Woody Cover	10	0.70	10	0.70	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.729	HSI =	0.729

Project: Alt 1b -- Sand Engine Both Sites   Acres: 210

FWP

Variable		TY Value	11 SI	TY Value	21 SI	TY Value	31 SI
V1	% Dune	9	0.64	9	0.64	9	0.64
V2	% Supratidal	92	0.77	92	0.77	92	0.77
V3	% Vegetative Cover	35	0.56	35	0.56	35	0.56
V4	% Woody Cover	10	0.70	10	0.70	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.729	HSI =	0.729	HSI =	0.729

Project: Alt 1b -- Sand Engine Both Sites   Acres: 210

FWP

Variable		TY Value	41 SI	TY Value	51 SI	TY Value	SI
V1	% Dune	9	0.64	40	0.64		
V2	% Supratidal	92	0.77	37	0.58		
V3	% Vegetative Cover	35	0.56	35	0.56		
V4	% Woody Cover	10	0.70	10	0.70		
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00		
		HSI =	0.729	HSI =	0.687	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: JCER Alt 2A & 10 -- Beach Nourishment, Dune Construction & Breakwaters   Acres: 210

Condition: Future Without Project

		TY	0	TY	1	TY	10
Variable		Value		Value	SI	Value	SI
V1	% Dune	35	0.82	35	0.82	29	1.00
V2	% Supratidal	29	0.48	29	0.48	24	0.41
V3	% Vegetative Cover	35	0.56	35	0.56	30	0.49
V4	% Woody Cover	10	0.70	5	0.40	7	0.52
V5	Beach/surf Zone	atural Beach/Unconfined Dispos	1.00	atural Beach/Unconfined Dispos	1.00	atural Beach/Unconfined Dispos	1.00
		HSI =	0.704	HSI =	0.650	HSI =	0.687

Project: ch Nourishment, Dune Construction & Breakwaters   Acres: 210

FWOP

		TY	11	TY	21	TY	31
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	28	1.00	21	1.00	15	1.00
V2	% Supratidal	23	0.40	18	0.33	12	0.26
V3	% Vegetative Cover	29	0.48	23	0.40	17	0.32
V4	% Woody Cover	8	0.58	6	0.46	4	0.34
V5	Beach/surf Zone	atural Beach/Unconfined Dispos	1.00	atural Beach/Unconfined Dispos	1.00	atural Beach/Unconfined Dispos	1.00
		HSI =	0.692	HSI =	0.641	HSI =	0.588

Project: ch Nourishment, Dune Construction & Breakwaters   Acres: 210

FWOP

		TY	41	TY	51	TY	
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	8	0.58	1	0.16		
V2	% Supratidal	6	0.18	1	0.11		
V3	% Vegetative Cover	11	0.24	5	0.17		
V4	% Woody Cover	2	0.22	0	0.10		
V5	Beach/surf Zone	atural Beach/Unconfined Dispos	1.00	atural Beach/Unconfined Dispos	1.00		
		HSI =	0.438	HSI =	0.290	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: ch Nourishment, Dune Construction & Breakwaters   Acres: 210

Condition: Future With Project

		TY	0	TY	1	TY	10
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	35	0.82	15	1.00	17	1.00
V2	% Supratidal	29	0.48	54	0.80	54	0.80
V3	% Vegetative Cover	35	0.56	15	0.30	35	0.56
V4	% Woody Cover	10	0.70	1	0.16	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispos	1.00	Breakwaters	0.90	Breakwaters	0.90
		HSI =	0.704	HSI =	0.658	HSI =	0.802

Project: ch Nourishment, Dune Construction & Breakwaters   Acres: 210

FWP

		TY	11	TY	21	TY	31
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	15	1.00	17	1.00	16	1.00
V2	% Supratidal	57	0.84	54	0.80	52	0.78
V3	% Vegetative Cover	35	0.56	35	0.56	35	0.56
V4	% Woody Cover	1	0.16	10	0.70	10	0.70
V5	Beach/surf Zone	Breakwaters	0.90	Breakwaters	0.90	Breakwaters	0.90
		HSI =	0.714	HSI =	0.802	HSI =	0.796

Project: ch Nourishment, Dune Construction & Breakwaters   Acres: 210

FWP

		TY	41	TY	51	TY	
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	16	1.00	22	1.00		
V2	% Supratidal	50	0.75	36	0.57		
V3	% Vegetative Cover	35	0.56	35	0.56		
V4	% Woody Cover	10	0.70	10	0.70		
V5	Beach/surf Zone	Breakwaters	0.90	Breakwaters	0.90		
		HSI =	0.790	HSI =	0.749	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: JCER Alt 2B -- Beach Nourishment and Dune Construction Both Sites   Acres: 210

Condition: Future Without Project

		TY	0	TY	1	TY	10
Variable		Value		Value	SI	Value	SI
V1	% Dune	35	0.82	35	0.82	29	1.00
V2	% Supratidal	29	0.48	29	0.48	24	0.41
V3	% Vegetative Cover	35	0.56	35	0.56	30	0.49
V4	% Woody Cover	10	0.70	5	0.40	7	0.52
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.650	HSI =	0.687

Project: Nourishment and Dune Construction Both Sites   Acres: 210

FWOP

		TY	11	TY	21	TY	31
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	28	1.00	21	1.00	15	1.00
V2	% Supratidal	23	0.40	18	0.33	12	0.26
V3	% Vegetative Cover	29	0.48	23	0.40	17	0.32
V4	% Woody Cover	8	0.58	6	0.46	4	0.34
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.692	HSI =	0.641	HSI =	0.588

Project: Nourishment and Dune Construction Both Sites   Acres: 210

FWOP

		TY	41	TY	51	TY	
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	8	0.58	1	0.16		
V2	% Supratidal	6	0.18	1	0.11		
V3	% Vegetative Cover	11	0.24	5	0.17		
V4	% Woody Cover	2	0.22	0	0.10		
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00		
		HSI =	0.438	HSI =	0.290	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: Nourishment and Dune Construction Both Sites   Acres: 210

Condition: Future With Project

		TY	0	TY	1	TY	10
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	35	0.82	15	1.00	38	0.71
V2	% Supratidal	29	0.48	54	0.80	24	0.41
V3	% Vegetative Cover	35	0.56	15	0.30	35	0.56
V4	% Woody Cover	10	0.70	1	0.16	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.676	HSI =	0.664

Project: Nourishment and Dune Construction Both Sites   Acres: 210

FWP

		TY	11	TY	21	TY	31
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	15	1.00	38	0.71	14	0.94
V2	% Supratidal	58	0.85	24	0.41	20	0.36
V3	% Vegetative Cover	15	0.30	35	0.56	23	0.40
V4	% Woody Cover	1	0.16	10	0.70	6	0.46
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.688	HSI =	0.664	HSI =	0.634

Project: Nourishment and Dune Construction Both Sites   Acres: 210

FWP

		TY	41	TY	51	TY	
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	8	0.58	1	0.16		
V2	% Supratidal	6	0.18	1	0.11		
V3	% Vegetative Cover	11	0.24	5	0.17		
V4	% Woody Cover	2	0.22	0	0.10		
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00		
		HSI =	0.438	HSI =	0.290	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: JCER Alt 3 -- Beach Nourishment and Dune Construction McFaddin Only   Acres: 159

Condition: Future Without Project

Variable		TY Value	0	TY Value	1	TY Value	10
					SI		SI
V1	% Dune	35	0.82	35	0.82	29	1.00
V2	% Supratidal	29	0.48	29	0.48	24	0.41
V3	% Vegetative Cover	35	0.56	35	0.56	30	0.49
V4	% Woody Cover	10	0.70	5	0.40	7	0.52
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.650	HSI =	0.687

Project: urishment and Dune Construction McFaddin Only   Acres: 159

FWOP

Variable		TY Value	11 SI	TY Value	21 SI	TY Value	31 SI
V1	% Dune	28	1.00	21	1.00	15	1.00
V2	% Supratidal	23	0.40	18	0.33	12	0.26
V3	% Vegetative Cover	29	0.48	23	0.40	17	0.32
V4	% Woody Cover	8	0.58	6	0.46	4	0.34
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.692	HSI =	0.641	HSI =	0.588

Project: urishment and Dune Construction McFaddin Only   Acres: 159

FWOP

Variable		TY Value	41 SI	TY Value	51 SI	TY Value	SI
V1	% Dune	8	0.58	1	0.16		
V2	% Supratidal	6	0.18	1	0.11		
V3	% Vegetative Cover	11	0.24	5	0.17		
V4	% Woody Cover	2	0.22	0	0.10		
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00				
		HSI =	0.438	HSI =		HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: urishment and Dune Construction McFaddin Only   Acres: 159

Condition: Future With Project

Variable		TY Value	0 SI	TY Value	1 SI	TY Value	10 SI
V1	% Dune	35	0.82	15	1.00	24	1.00
V2	% Supratidal	29	0.48	55	0.82	44	0.67
V3	% Vegetative Cover	35	0.56	15	0.30	35	0.56
V4	% Woody Cover	10	0.70	1	0.16	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.679	HSI =	0.790

Project: urishment and Dune Construction McFaddin Only   Acres: 159

FWP

Variable		TY Value	11 SI	TY Value	21 SI	TY Value	31 SI
V1	% Dune	15	1.00	24	1.00	13	0.88
V2	% Supratidal	55	0.82	44	0.67	29	0.48
V3	% Vegetative Cover	15	0.30	35	0.56	23	0.40
V4	% Woody Cover	1	0.16	10	0.70	6	0.46
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.679	HSI =	0.790	HSI =	0.647

Project: urishment and Dune Construction McFaddin Only   Acres: 159

FWP

Variable		TY Value	41 SI	TY Value	51 SI	TY Value	SI
V1	% Dune	8	0.58	1	0.16		
V2	% Supratidal	6	0.18	1	0.11		
V3	% Vegetative Cover	11	0.24	5	0.17		
V4	% Woody Cover	2	0.22	0	0.10		
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00		
		HSI =	0.438	HSI =	0.290	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: JCER Alt 4B & 6A -- Beach Nourishment & Dune Construction TX Point Only Acres: 52

Condition: Future Without Project

Variable		TY Value	0	TY Value	1 SI	TY Value	10 SI
V1	% Dune	35	0.82	35	0.82	29	1.00
V2	% Supratidal	29	0.48	29	0.48	24	0.41
V3	% Vegetative Cover	35	0.56	35	0.56	30	0.49
V4	% Woody Cover	10	0.70	5	0.40	7	0.52
V5	Beach/surf Zone	ıtural Beach/Unconfined Dispo:	1.00	ıtural Beach/Unconfined Dispo:	1.00	ıtural Beach/Unconfined Dispo:	1.00
		HSI =	0.704	HSI =	0.650	HSI =	0.687

Project: :h Nourishment & Dune Construction TX Point Only Acres: 52

FWOP

Variable		TY Value	11 SI	TY Value	21 SI	TY Value	31 SI
V1	% Dune	28	1.00	21	1.00	15	1.00
V2	% Supratidal	23	0.40	18	0.33	12	0.26
V3	% Vegetative Cover	29	0.48	23	0.40	17	0.32
V4	% Woody Cover	8	0.58	6	0.46	4	0.34
V5	Beach/surf Zone	ıtural Beach/Unconfined Dispo:	1.00	ıtural Beach/Unconfined Dispo:	1.00	ıtural Beach/Unconfined Dispo:	1.00
		HSI =	0.692	HSI =	0.641	HSI =	0.588

Project: :h Nourishment & Dune Construction TX Point Only Acres: 52

FWOP

Variable		TY Value	41 SI	TY Value	51 SI	TY Value	SI
V1	% Dune	8	0.58	1	0.16		
V2	% Supratidal	6	0.18	1	0.11		
V3	% Vegetative Cover	11	0.24	5	0.17		
V4	% Woody Cover	2	0.22	0	0.10		
V5	Beach/surf Zone	ıtural Beach/Unconfined Dispo:	1.00	ıtural Beach/Unconfined Dispo:	1.00		
		HSI =	0.438	HSI =	0.290	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: :h Nourishment & Dune Construction TX Point Only Acres: 52

Condition: Future With Project

Variable		TY Value	0 SI	TY Value	1 SI	TY Value	10 SI
V1	% Dune	35	0.82	15	1.00	52	0.21
V2	% Supratidal	29	0.48	53	0.79	3	0.14
V3	% Vegetative Cover	35	0.56	15	0.30	52	0.78
V4	% Woody Cover	10	0.70	1	0.16	10	0.70
V5	Beach/surf Zone	ıtural Beach/Unconfined Dispo:	1.00	ıtural Beach/Unconfined Dispo:	1.00	ıtural Beach/Unconfined Dispo:	1.00
		HSI =	0.704	HSI =	0.673	HSI =	0.525

Project: :h Nourishment & Dune Construction TX Point Only Acres: 52

FWP

Variable		TY Value	11 SI	TY Value	21 SI	TY Value	31 SI
V1	% Dune	15	1.00	52	0.21	14	0.94
V2	% Supratidal	58	0.85	3	0.14	11	0.24
V3	% Vegetative Cover	15	0.30	52	0.78	32	0.52
V4	% Woody Cover	1	0.16	10	0.70	3	0.28
V5	Beach/surf Zone	ıtural Beach/Unconfined Dispo:	1.00	ıtural Beach/Unconfined Dispo:	1.00	ıtural Beach/Unconfined Dispo:	1.00
		HSI =	0.688	HSI =	0.525	HSI =	0.595

Project: :h Nourishment & Dune Construction TX Point Only Acres: 52

FWP

Variable		TY Value	41 SI	TY Value	51 SI	TY Value	SI
V1	% Dune	8	0.58	1	0.16		
V2	% Supratidal	6	0.18	1	0.11		
V3	% Vegetative Cover	11	0.24	5	0.17		
V4	% Woody Cover	2	0.22	0	0.10		
V5	Beach/surf Zone	ıtural Beach/Unconfined Dispo:	1.00	ıtural Beach/Unconfined Dispo:	1.00		
		HSI =	0.438	HSI =	0.290	HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: JCER Alt 6B -- Sand Engine TX Point Only　　Acres: 52

Condition: Future Without Project

Variable		TY Value	0	TY Value	1 SI	TY Value	11 SI
V1	% Dune	35	0.82	35	0.82	33	0.89
V2	% Supratidal	29	0.48	29	0.48	29	0.48
V3	% Vegetative Cover	35	0.56	35	0.56	40	0.62
V4	% Woody Cover	10	0.70	5	0.40	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.650	HSI =	0.732

Project: lt 6B -- Sand Engine TX Point Only　　Acres: 52

FWOP

Variable		TY Value	21 SI	TY Value	31 SI	TY Value	41 SI
V1	% Dune	31	0.96	29	1.00	27	1.00
V2	% Supratidal	27	0.45	25	0.43	23	0.40
V3	% Vegetative Cover	45	0.69	40	0.62	35	0.56
V4	% Woody Cover	15	1.00	10	0.70	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.809	HSI =	0.745	HSI =	0.728

Project: lt 6B -- Sand Engine TX Point Only　　Acres: 52

FWOP

Variable		TY Value	51 SI	TY Value	SI	TY Value	SI
V1	% Dune	25	1.00				
V2	% Supratidal	20	0.36				
V3	% Vegetative Cover	30	0.49				
V4	% Woody Cover	5	0.40				
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00				
		HSI =	0.653	HSI =		HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: lt 6B -- Sand Engine TX Point Only　　Acres: 52

Condition: Future With Project

Variable		TY Value	0 SI	TY Value	1 SI	TY Value	11 SI
V1	% Dune	35	0.82	3	0.28	3	0.28
V2	% Supratidal	29	0.48	97	0.60	97	0.60
V3	% Vegetative Cover	35	0.56	35	0.56	60	0.88
V4	% Woody Cover	10	0.70	10	0.70	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.608	HSI =	0.667

Project: lt 6B -- Sand Engine TX Point Only　　Acres: 52

FWP

Variable		TY Value	21 SI	TY Value	31 SI	TY Value	41 SI
V1	% Dune	3	0.28	3	0.28	3	0.28
V2	% Supratidal	97	0.60	97	0.60	97	0.60
V3	% Vegetative Cover	60	0.88	60	0.88	60	0.88
V4	% Woody Cover	10	0.70	10	0.70	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.667	HSI =	0.667	HSI =	0.667

Project: lt 6B -- Sand Engine TX Point Only　　Acres: 52

FWP

Variable		TY Value	51 SI	TY Value	SI	TY Value	SI
V1	% Dune	5	0.40				
V2	% Supratidal	44	0.67				
V3	% Vegetative Cover	35	0.56				
V4	% Woody Cover	10	0.70				
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00				
		HSI =	0.652	HSI =		HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: JCER Alt 13 -- Sand Engine TX Point, Beach/Dune/Breakwater McFaddin   Acres: 210

Condition: Future Without Project

		TY	0	TY	1	TY	11
Variable		Value		Value	SI	Value	SI
V1	% Dune	35	0.82	35	0.82	33	0.89
V2	% Supratidal	29	0.48	29	0.48	29	0.48
V3	% Vegetative Cover	35	0.56	35	0.56	40	0.62
V4	% Woody Cover	10	0.70	5	0.40	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.704	HSI =	0.650	HSI =	0.732

Project: gine TX Point, Beach/Dune/Breakwater McFaddin   Acres: 210

FWOP

		TY	21	TY	31	TY	41
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	31	0.96	29	1.00	27	1.00
V2	% Supratidal	27	0.45	25	0.43	23	0.40
V3	% Vegetative Cover	45	0.69	40	0.62	35	0.56
V4	% Woody Cover	15	1.00	10	0.70	10	0.70
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00	atural Beach/Unconfined Dispo	1.00
		HSI =	0.809	HSI =	0.745	HSI =	0.728

Project: gine TX Point, Beach/Dune/Breakwater McFaddin   Acres: 210

FWOP

		TY	51	TY		TY	
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	25	1.00				
V2	% Supratidal	20	0.36				
V3	% Vegetative Cover	30	0.49				
V4	% Woody Cover	5	0.40				
V5	Beach/surf Zone	atural Beach/Unconfined Dispo	1.00				
		HSI =	0.653	HSI =		HSI =	

WETLAND VALUE ASSESSMENT COMMUNITY MODEL
Barrier Headland

Project: gine TX Point, Beach/Dune/Breakwater McFaddin   Acres: 210

Condition: Future With Project

		TY	0	TY	1	TY	10
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	35	0.82	18	1.00	10	0.70
V2	% Supratidal	29	0.48	75	1.00	76	1.00
V3	% Vegetative Cover	35	0.56	25	0.43	39	0.61
V4	% Woody Cover	10	0.70	6	0.46	10	0.70
V5	Beach/surf Zone	Breakwaters	0.90	Breakwaters	0.90	Breakwaters	0.90
		HSI =	0.686	HSI =	0.781	HSI =	0.788

Project: gine TX Point, Beach/Dune/Breakwater McFaddin   Acres: 210

FWP

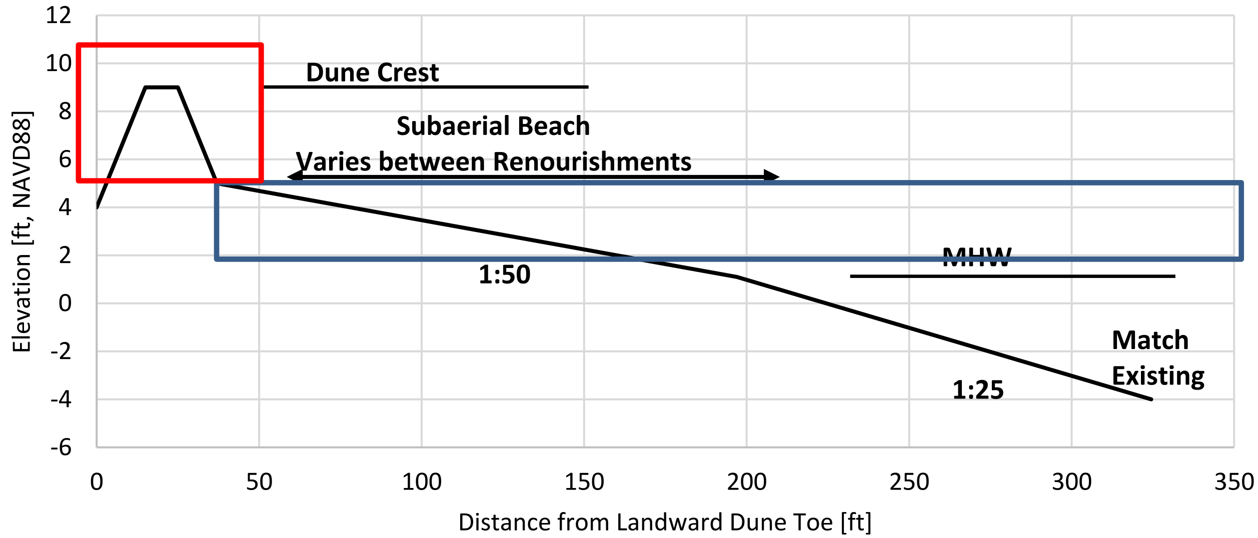
		TY	11	TY	21	TY	31
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	9	0.64	10	0.70	9	0.64
V2	% Supratidal	76	1.00	97	0.60	76	1.00
V3	% Vegetative Cover	38	0.59	39	0.61	38	0.59
V4	% Woody Cover	6	0.46	10	0.70	10	0.70
V5	Beach/surf Zone	Breakwaters	0.90	Breakwaters	0.90	Breakwaters	0.90
		HSI =	0.729	HSI =	0.696	HSI =	0.772

Project: gine TX Point, Beach/Dune/Breakwater McFaddin   Acres: 210

FWP

		TY	41	TY	51	TY	
Variable		Value	SI	Value	SI	Value	SI
V1	% Dune	9	0.64	26	1.00		
V2	% Supratidal	76	1.00	42	0.65		
V3	% Vegetative Cover	37	0.58	28	0.46		
V4	% Woody Cover	10	0.70	10	0.70		
V5	Beach/surf Zone	Breakwaters	0.90	Breakwaters	0.90		
		HSI =	0.770	HSI =	0.750	HSI =	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
197	1.1
324.5	-4



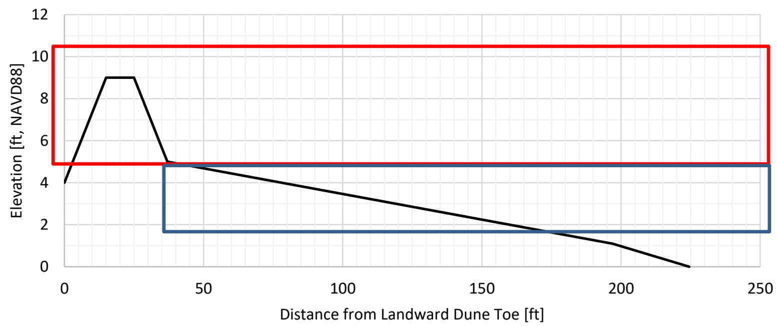
Dune: habitat above +5.0 ft NAVD88

Supratidal: habitat between +2.0 and +4.9 ft NAVD88

Intertidal: habitat below +2.0

MCFADDIN - FWP - BEACH NOURISHMENT
POST CONSTRUCTION

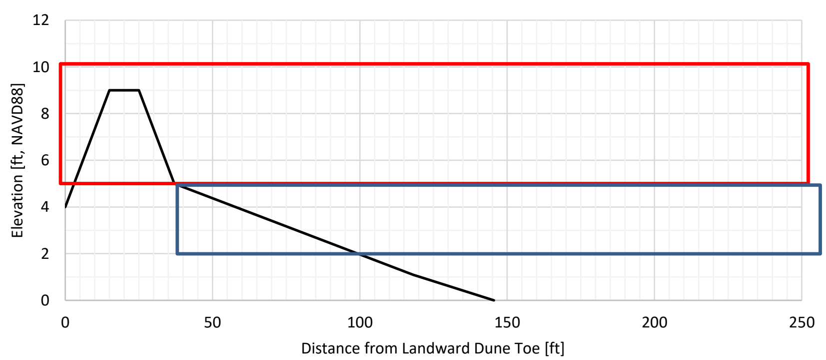
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
197	1.1
224.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	160	37	123	55%
Dune	37	3	34	15%
Intertidal	225	160	65	29%
Total Length			**222**	

YEAR 10

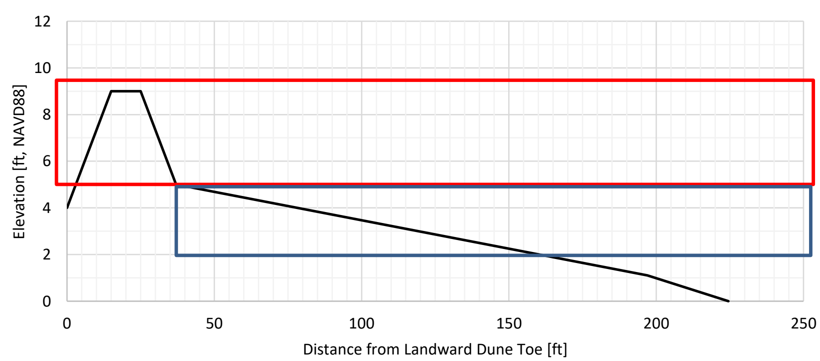
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
118	1.1
145.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	100	37	63	44%
Dune	37	3	34	24%
Intertidal	145	100	45	32%
Total Length			**142**	

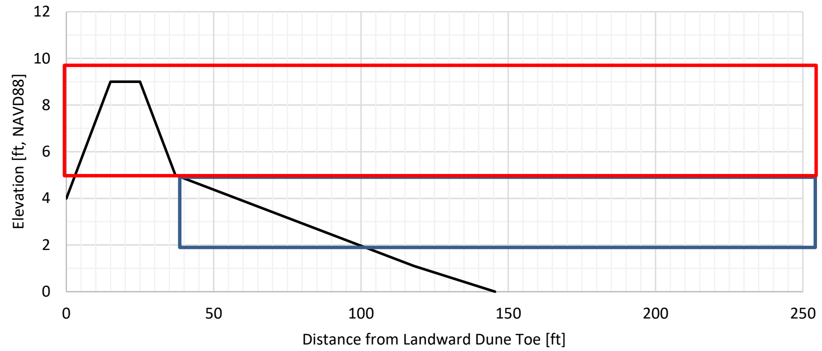
YEAR 11 (AFTER O&M RENOURISHMENT)

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
197	1.1
224.5	0



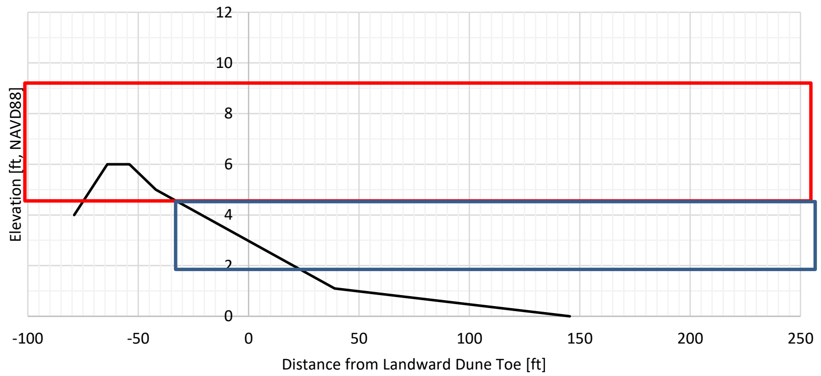
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	160	37	123	55%
Dune	37	3	34	15%
Intertidal	225	160	65	29%
Total Length			**222**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
118	1.1
145.5	0



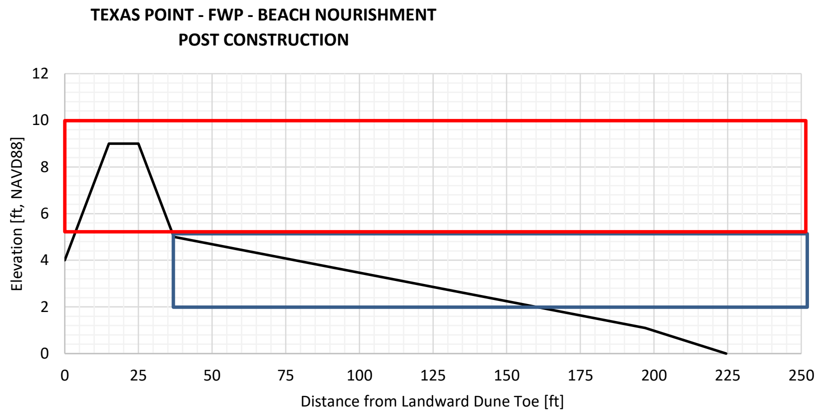
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	100	37	63	44%
Dune	37	3	34	24%
Intertidal	145	100	45	32%
Total Length			**142**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
-79	4
-64	6
-54	6
-42	5
39	1.1
145.5	0



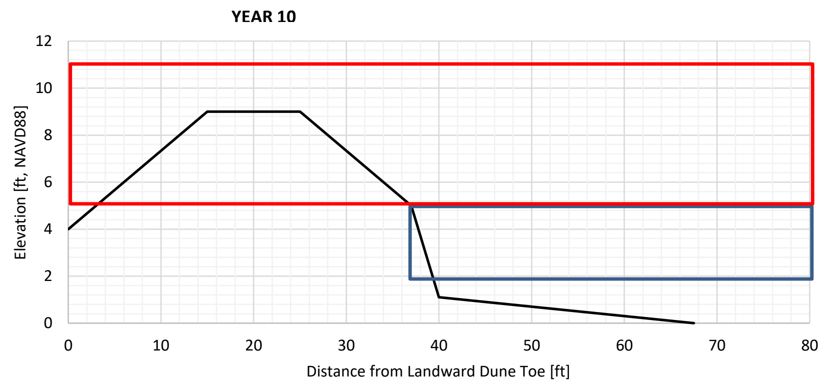
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal	0	-42	42	
	20	0	20	
Supratidal Total			**62**	29%
Dune	-42	-70	**28**	13%
Intertidal	145	20	125	58%
Total Length			**215**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
197	1.1
224.5	0



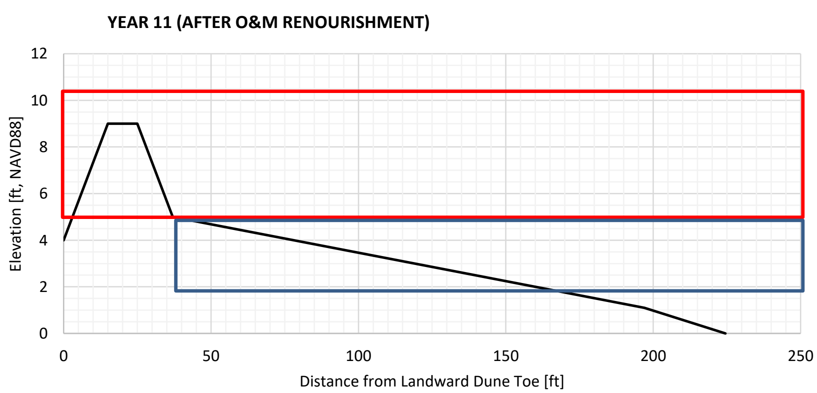
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	155	37	118	53%
Dune	37	3	34	15%
Intertidal	225	155	70	32%
Total Length			**222**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
40	1.1
67.5	0



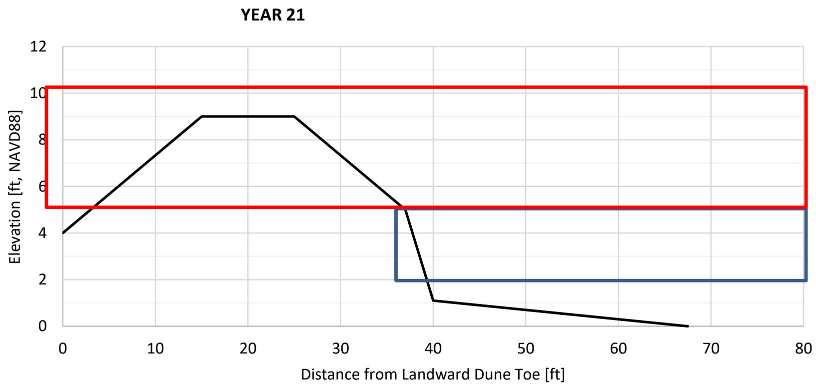
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	39	37	2	3%
Dune	37	3	34	53%
Intertidal	67	39	28	44%
Total Length			**64**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
197	1.1
224.5	0



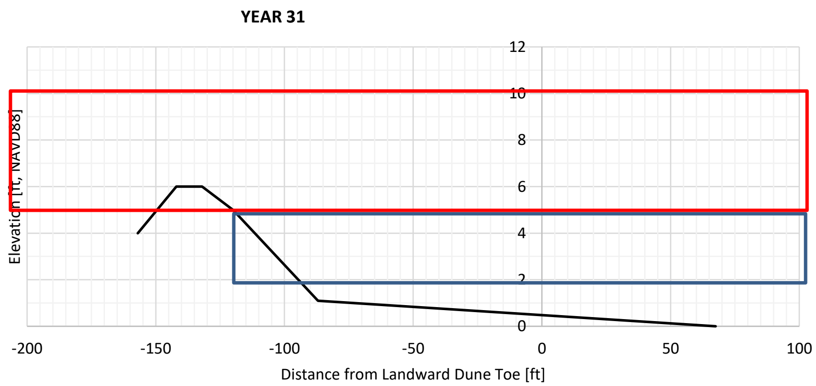
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	165	37	128	58%
Dune	37	3	34	15%
Intertidal	225	165	60	27%
Total Length			**222**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
40	1.1
67.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	39	37	2	3%
Dune	37	3	34	52%
Intertidal	68	39	29	45%
Total Length			**65**	

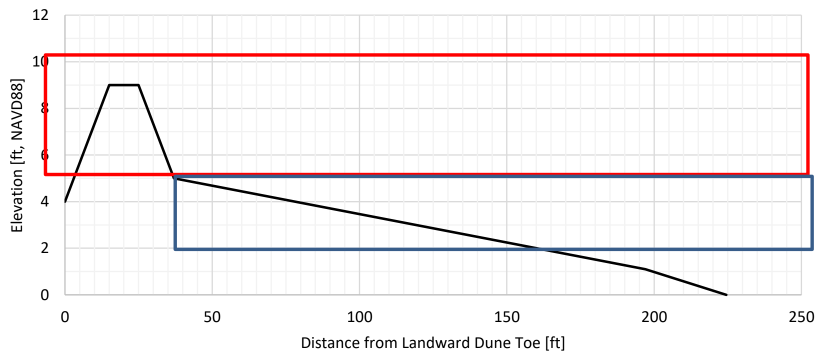
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
-157	4
-142	6
-132	6
-120	5
-87	1.1
67.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	-120	-95	**25**	11%
Dune	-150	-120	**30**	14%
Intertidal	-95	0	95	
	68	0	68	
Intertidal Total			163	75%
Total Length			**218**	

TEXAS POINT - FWP - BEACH NOURISHMENT W/ BREAKWATERS
POST CONSTRUCTION

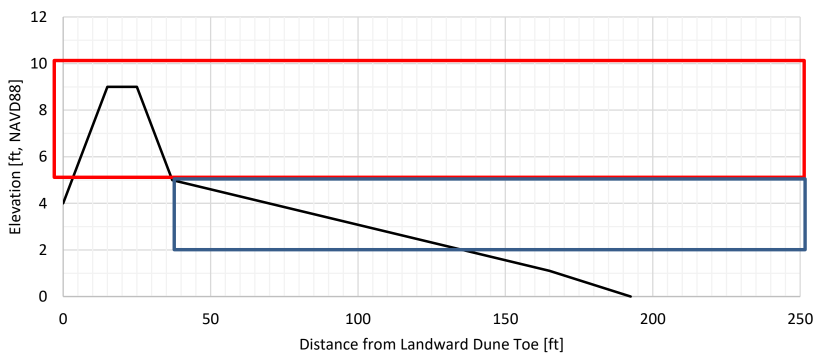
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
197	1.1
224.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal	155	37	118	54%
Dune	37	5	32	15%
Intertidal	225	155	70	32%
Total Length			**220**	

YEAR 10

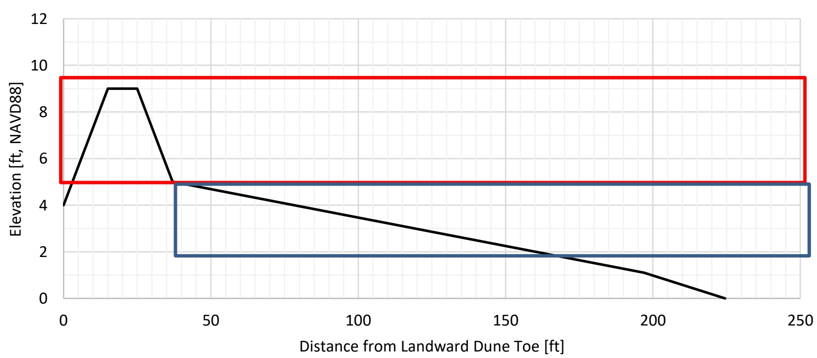
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
165	1.1
192.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	135	37	98	52%
Dune	37	5	32	17%
Intertidal	193	135	58	31%
Total Length			**188**	

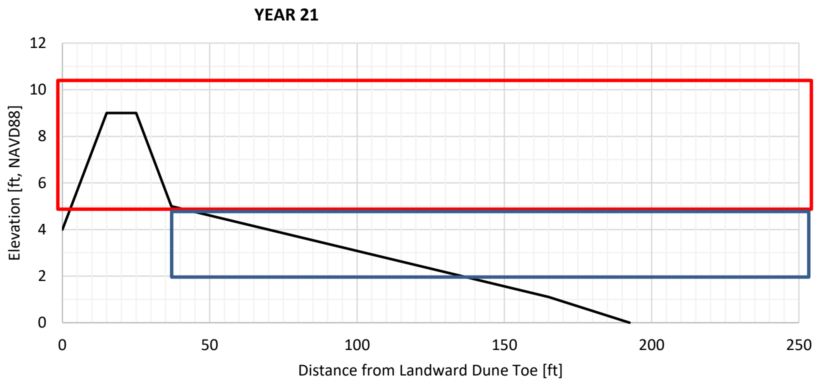
YEAR 11 (AFTER O&M RENOURISHMENT)

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
197	1.1
224.5	0



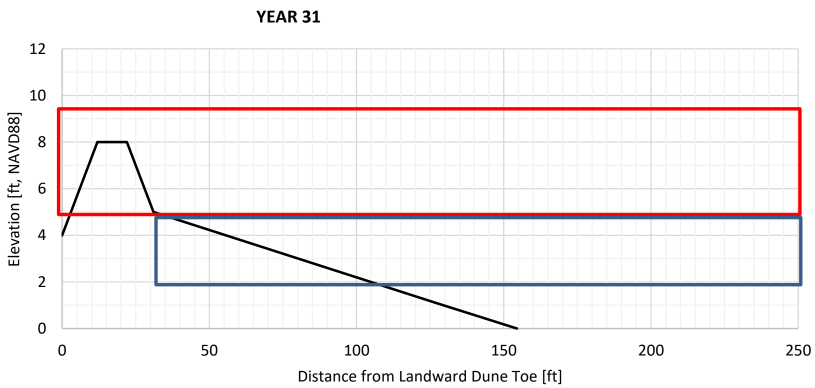
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	165	37	128	58%
Dune	37	5	32	15%
Intertidal	225	165	60	27%
Total Length			**220**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
165	1.1
192.5	0



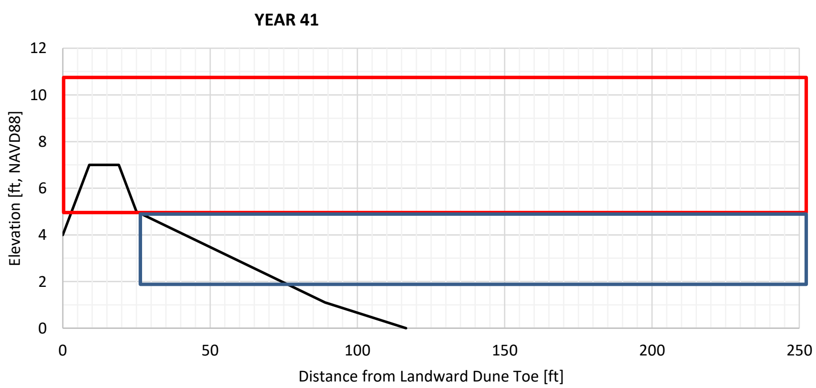
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	135	37	98	52%
Dune	37	5	32	17%
Intertidal	193	135	58	31%
Total Length			**188**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
12	8
22	8
31	5
127	1.1
154.5	0



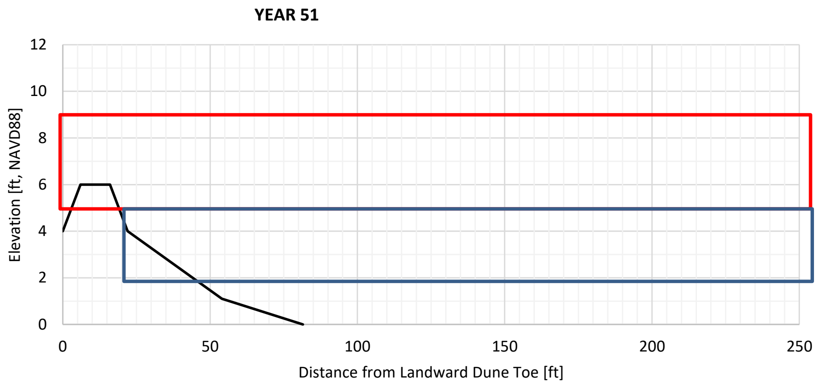
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	105	31	74	49%
Dune	31	5	26	17%
Intertidal	155	105	50	33%
Total Length			**150**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
9	7
19	7
25	5
89	1.1
116.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	75	25	50	45%
Dune	25	5	20	18%
Intertidal	117	75	42	38%
Total Length			**112**	

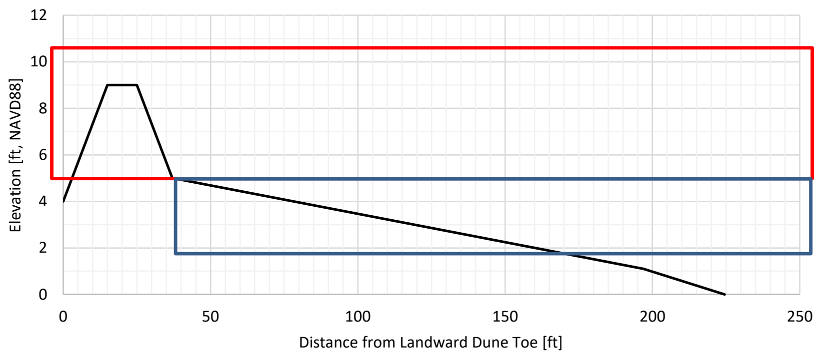
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
6	6
16	6
22	4
54	1.1
81.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	45	20	25	32%
Dune	20	3	17	22%
Intertidal	82	45	37	47%
Total Length			**79**	

MCFADDIN - FWP - BEACH NOURISHMENT W/ BREAKWATERS
POST CONSTRUCTION

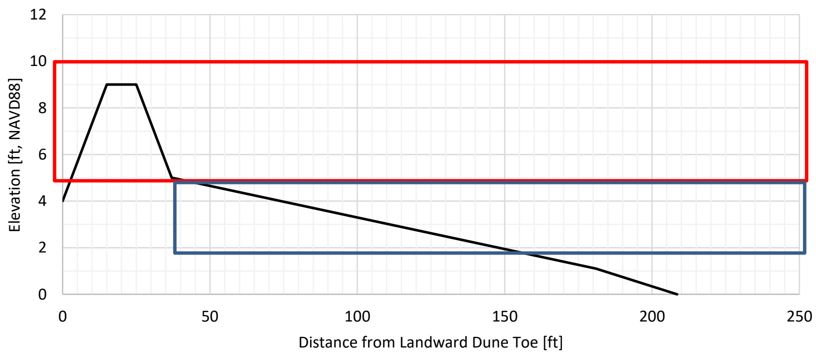
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
197	1.1
224.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal	160	37	123	53%
Dune	37	3	34	15%
Intertidal	225	150	75	32%
Total Length			**232**	

YEAR 10

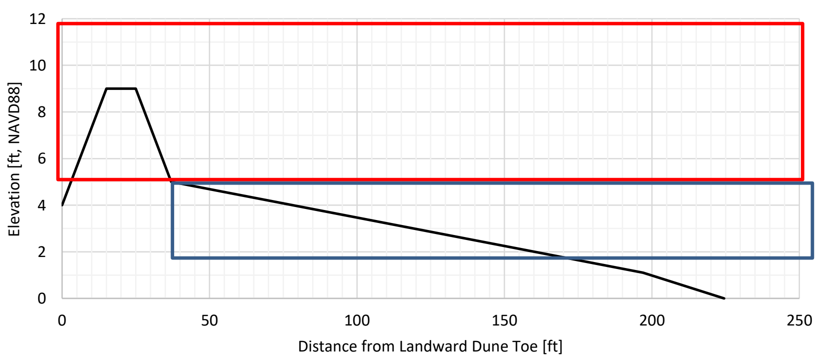
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
181	1.1
208.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	150	37	113	55%
Dune	37	3	34	17%
Intertidal	209	150	59	29%
Total Length			**206**	

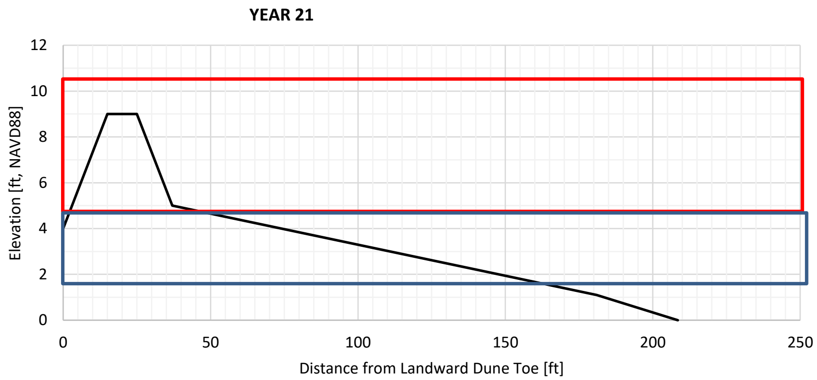
YEAR 11 (AFTER O&M RENOURISHMENT)

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
197	1.1
224.5	0



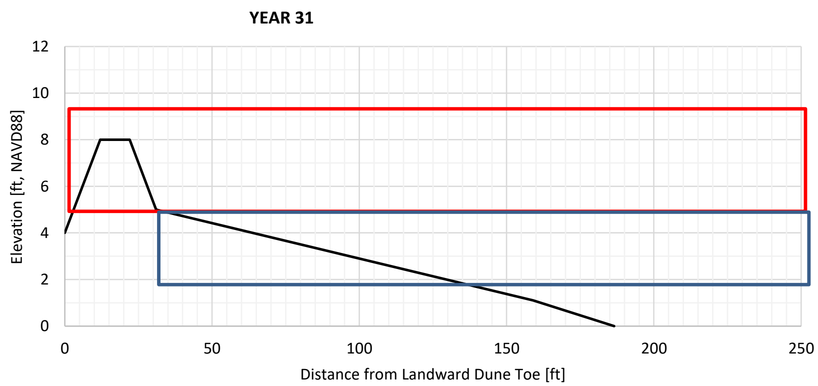
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	160	37	123	55%
Dune	37	3	34	15%
Intertidal	225	160	65	29%
Total Length			**222**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
181	1.1
208.5	0



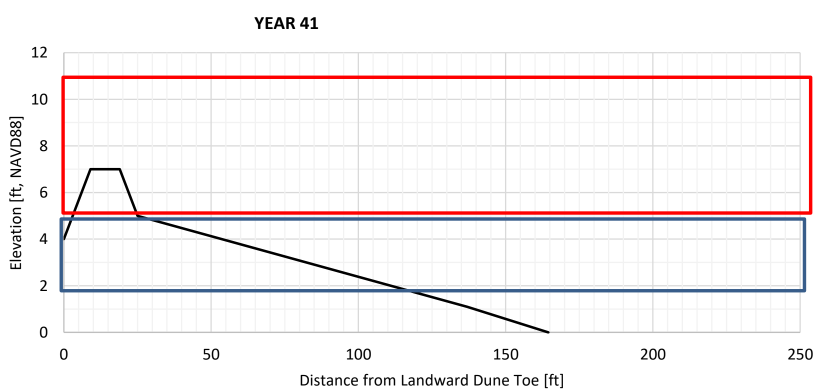
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	150	37	113	55%
Dune	37	3	34	17%
Intertidal	209	150	59	29%
Total Length			**206**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
12	8
22	8
31	5
159	1.1
186.5	0



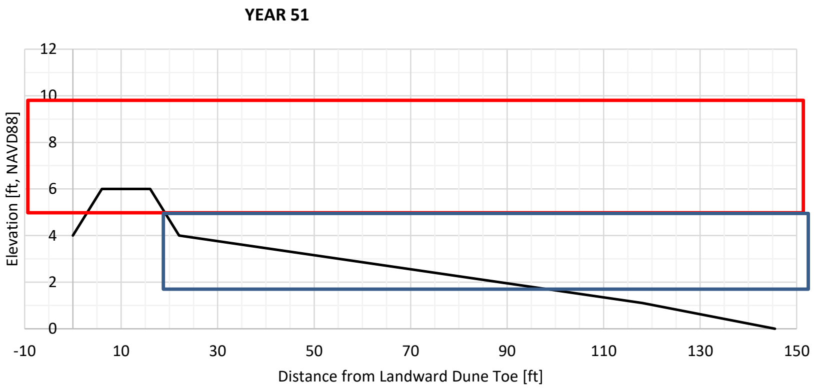
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	130	31	99	54%
Dune	31	4	27	15%
Intertidal	187	130	57	31%
Total Length			**183**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
9	7
19	7
25	5
137	1.1
164.5	0



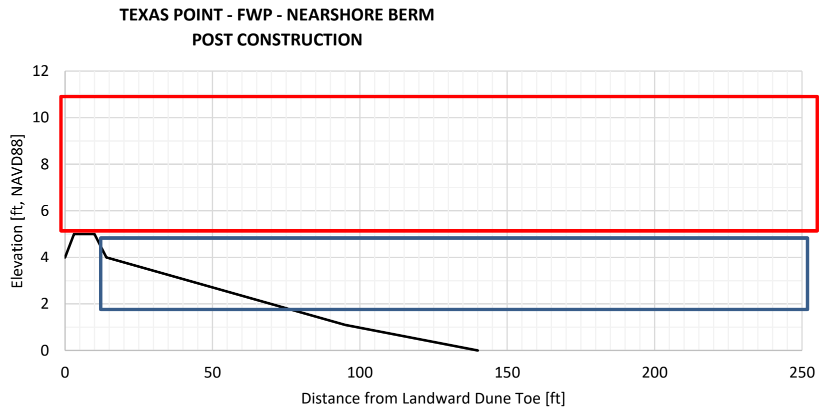
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	113	25	88	54%
Dune	25	3	22	14%
Intertidal	165	113	52	32%
Total Length			**162**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
6	6
16	6
22	4
118	1.1
145.5	0



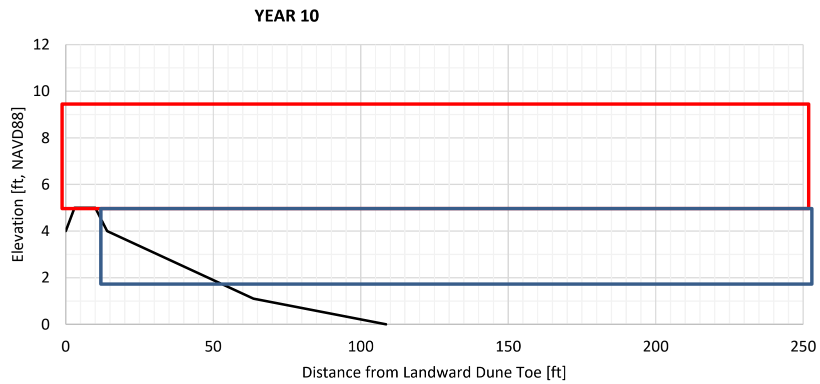
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	90	33	57	40%
Dune	33	3	30	21%
Intertidal	146	90	56	39%
Total Length			**143**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
3	5
10	5
14	4
95	1.1
140	0



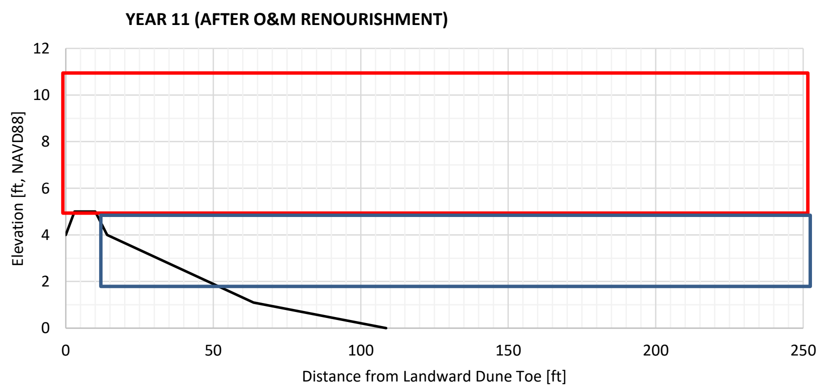
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal	70	10	60	44%
Dune	10	3	7	5%
Intertidal	140	70	70	51%
Total Length			**137**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
3	5
10	5
14	4
63.6	1.1
108.6	0



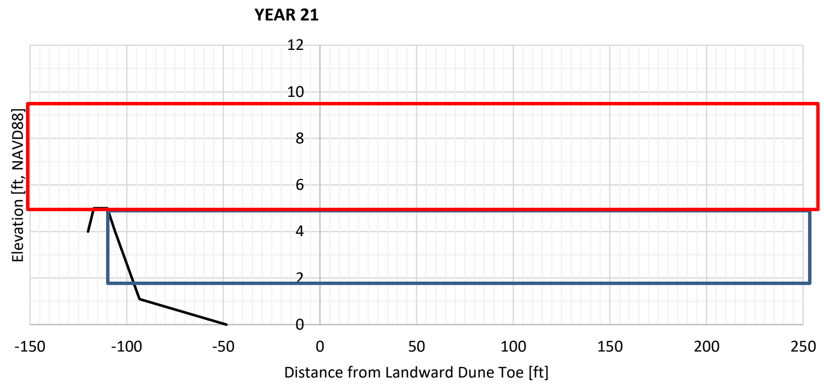
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	50	10	40	38%
Dune	10	3	7	7%
Intertidal	109	50	59	56%
Total Length			**106**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
3	5
10	5
14	4
63.6	1.1
108.6	0



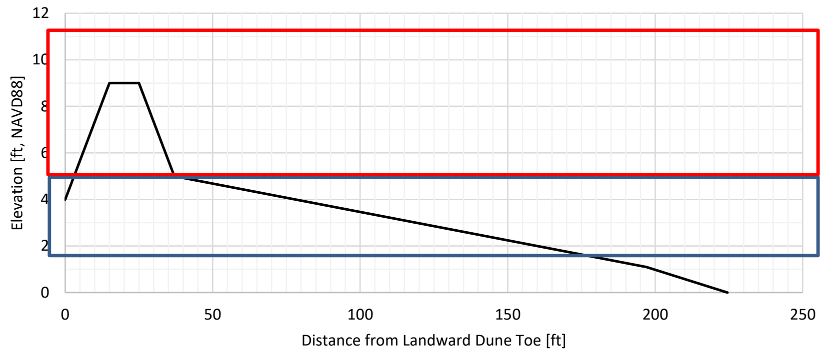
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	50	10	40	38%
Dune	10	3	7	7%
Intertidal	109	50	59	56%
Total Length			**106**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
-120	4
-117	5
-110	5
-106	4
-93.4	1.1
-48.4	0



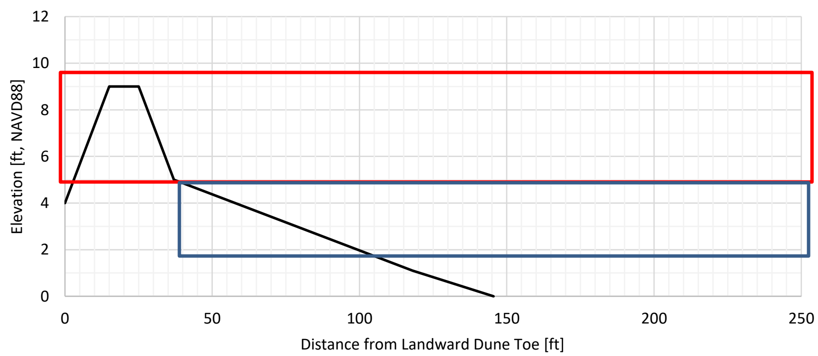
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	-97	-110	13	19%
Dune	-110	-117	7	10%
Intertidal	-49	-97	48	71%
Total Length			**68**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
197	1.1
224.5	0



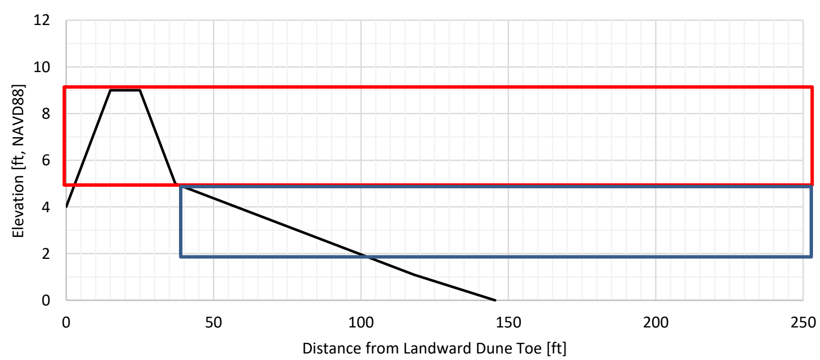
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal	160	37	123	55%
Dune	37	3	34	15%
Intertidal	225	160	65	29%
Total Length			**222**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
118	1.1
145.5	0



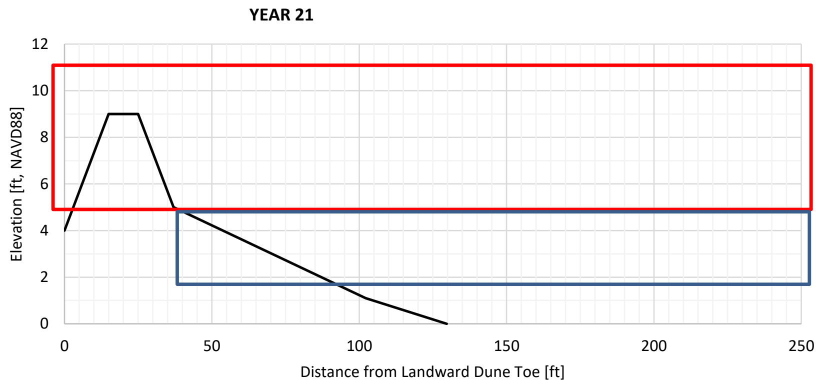
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	100	37	63	44%
Dune	37	3	34	24%
Intertidal	145	100	45	32%
Total Length			**142**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
118	1.1
145.5	0



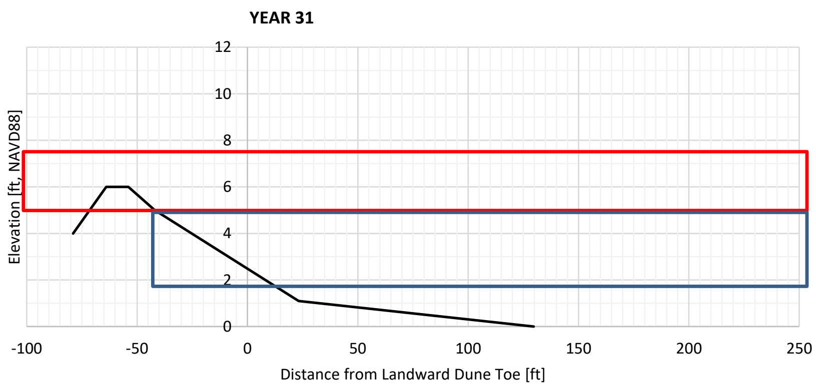
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	100	37	63	26%
Dune	37	3	34	14%
Intertidal	145		145	60%
Total Length			**242**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
102.2	1.1
129.7	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	87	37	50	39%
Dune	37	3	34	27%
Intertidal	130	87	43	34%
Total Length			**127**	

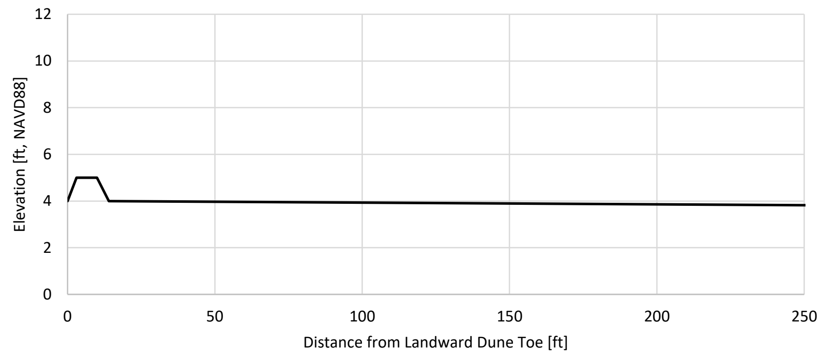
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
-79	4
-64	6
-54	6
-42	5
23.2	1.1
129.7	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	10	-42	52	26%
Dune	-42	-70	28	14%
Intertidal	130	10	120	60%
Total Length			**200**	

TEXAS POINT - FWP - SAND ENGINE
POST CONSTRUCTION

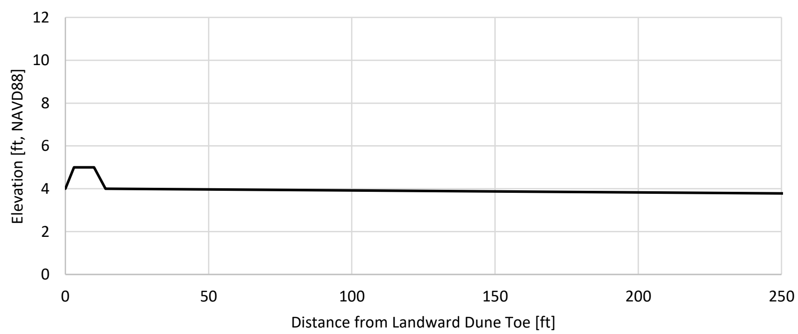
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
3	5
10	5
14	4
3925	1.1
4000	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal	250	10	240	97%
Dune	10	3	7	3%
Intertidal	0	0	0	0%
Total Length			**247**	

YEAR 10

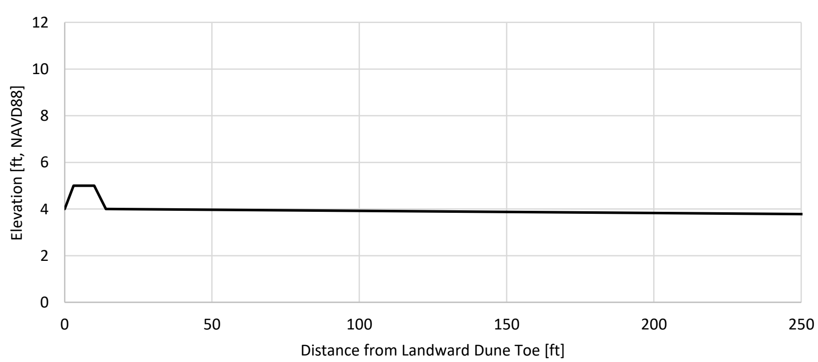
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
3	5
10	5
14	4
3140	1.1
3215	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	250	10	240	97%
Dune	10	3	7	3%
Intertidal			0	0%
Total Length			**247**	

YEAR 11

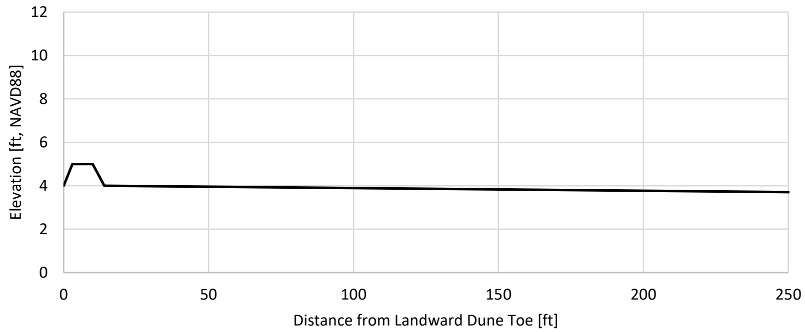
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
3	5
10	5
14	4
3140	1.1
3137	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	250	10	240	97%
Dune	10	3	7	3%
Intertidal			0	0%
Total Length			**247**	

YEAR 21

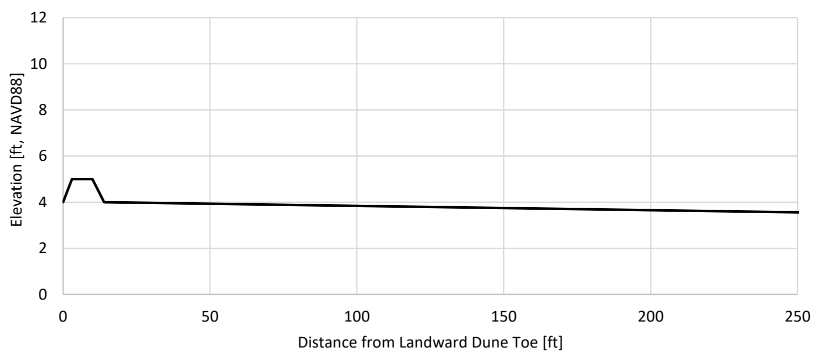
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
3	5
10	5
14	4
2355	1.1
2430	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	250	10	240	97%
Dune	10	3	7	3%
Intertidal			0	0%
Total Length			**247**	

YEAR 31

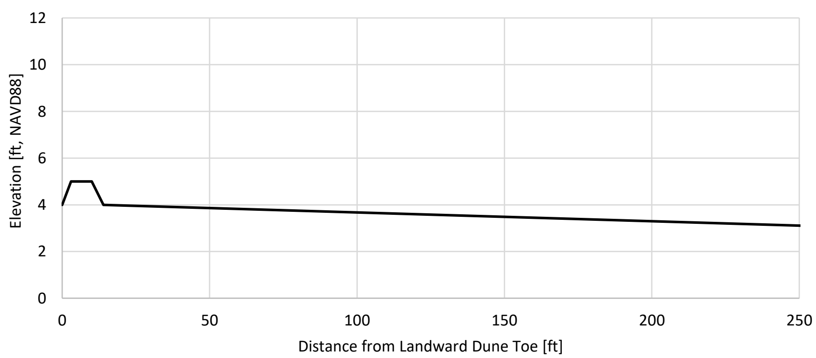
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
3	5
10	5
14	4
1570	1.1
1645	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	250	10	240	97%
Dune	10	3	7	3%
Intertidal			0	0%
Total Length			**247**	

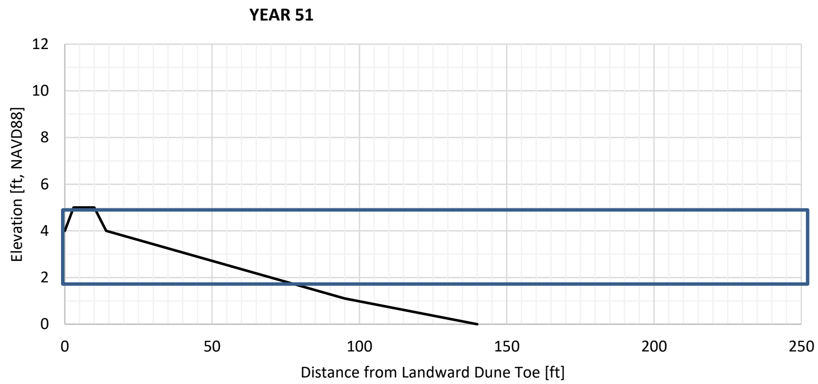
YEAR 41

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
3	5
10	5
14	4
785	1.1
860	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	250	10	240	97%
Dune	10	3	7	3%
Intertidal			0	0%
Total Length			**247**	

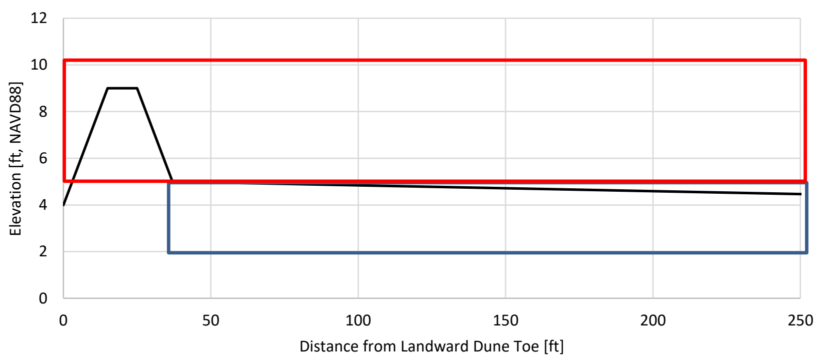
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
3	5
10	5
14	4
95	1.1
140	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	70	10	60	44%
Dune	10	3	7	5%
Intertidal	140	70	70	51%
Total Length			**137**	

TEXAS POINT - FWP - SAND ENGINE WITH ASSUMPTION MCFADDIN BEACH BERM IS IN PLACE
POST CONSTRUCTION

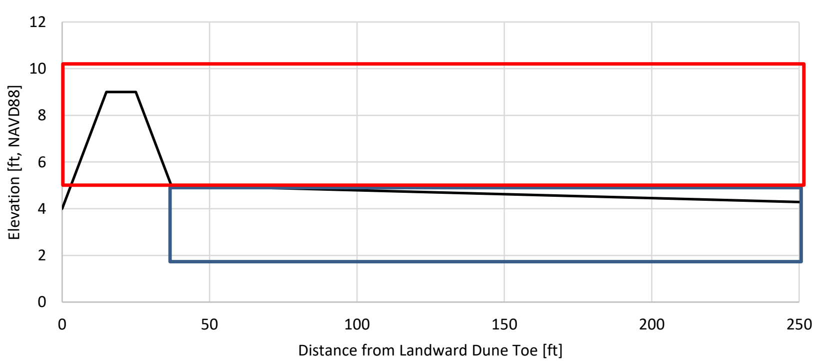
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
1600	1.1
1627.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	250	37	213	86%
Dune	37	3	34	14%
Intertidal			0	0%
Total Length			**247**	

YEAR 11

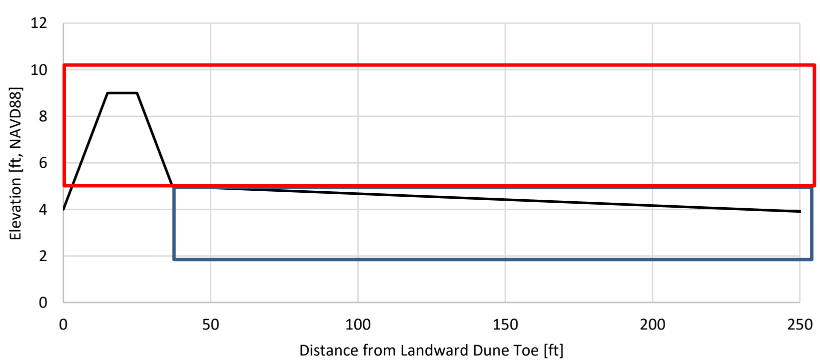
Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
1200	1.1
1227.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	250	37	213	86%
Dune	37	3	34	14%
Intertidal			0	0%
Total Length			**247**	

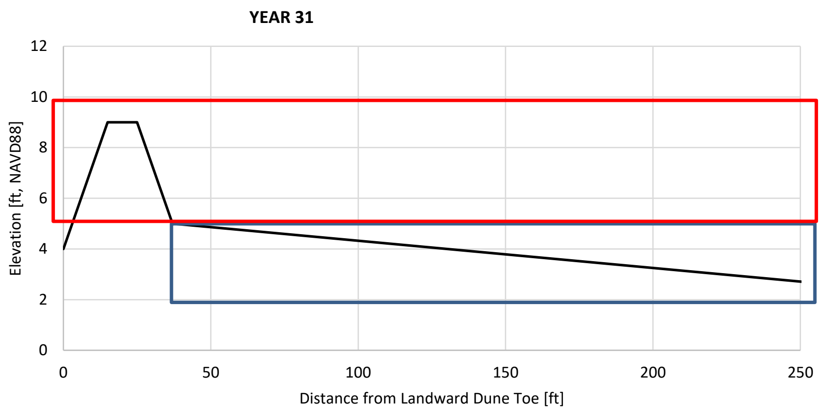
YEAR 21

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
800	1.1
827.5	0



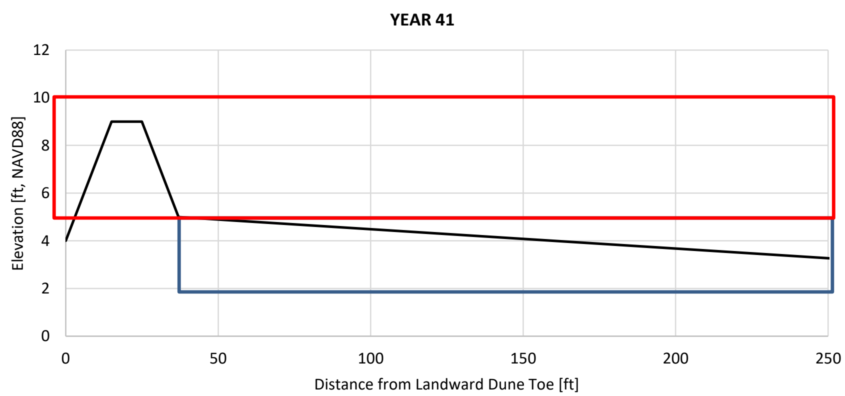
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	250	37	213	86%
Dune	37	3	34	14%
Intertidal			0	0%
Total Length			**247**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
400	1.1
427.5	0



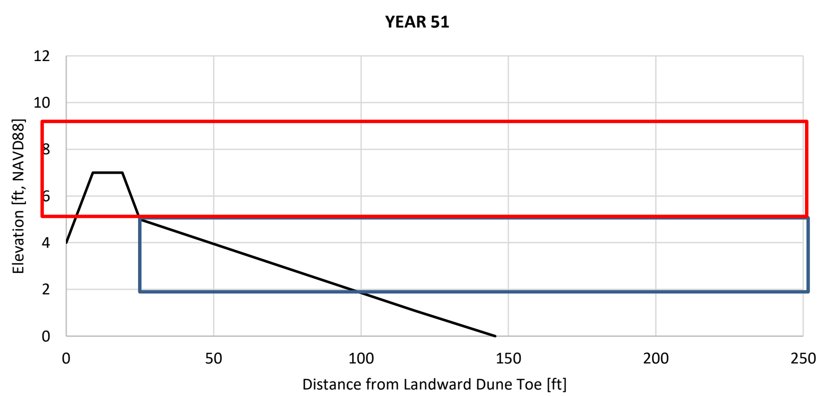
	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	250	37	213	86%
Dune	37	3	34	14%
Intertidal			0	0%
Total Length			**247**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
15	9
25	9
37	5
518	1.1
545.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	250	37	213	86%
Dune	37	3	34	14%
Intertidal			0	0%
Total Length			**247**	

Distance From Landward Dune Toe [ft]	Elevation [ft, NAVD88]
0	4
9	7
19	7
25	5
118	1.1
145.5	0



	End Elevation	Start Elevation	Distance Between	% of Unit
Supratidal Total	100	25	75	52%
Dune	25	3	22	15%
Intertidal	146	100	46	32%
Total Length			**143**	