APPENDIX H: WVA MODEL ASSUMPTIONS

Wetland Value Assessment Methodology

The Wetland Value Assessment (WVA) methodology operates under the assumption that optimal conditions for general 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 yield an index of habitat quality. Habitat quality is estimated or expressed through the use of a mathematical model developed specifically for each wetland 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 Index) and different variable values, and; (3) a mathematical formula that combines the Suitability Index for each variable into a single value for wetland habitat quality. That single value is referred to as the Habitat Suitability Index, or HSI.

The following WVA models were used for the Plaquemines New Orleans to Venice and Non Federal Levee mitigation effort:

- Coastal Wetlands Planning, Protection and Restoration Act, Wetland Value Assessment Methodology, Bottomland Hardwood Community Model (4/4/11 model version).
- Coastal Wetlands Planning, Protection and Restoration Act, Wetland Value Assessment Methodology, Coastal Marsh Community Model for Fresh/Intermediate Marsh, Brackish Marsh, and Saline Marsh (1/19/12 model version 1.1).).
- Coastal Wetlands Planning, Protection and Restoration Act, Wetland Value Assessment Methodology, Swamp Community Model (4/4/11 model version).

The WVA models assess the suitability of each habitat type for providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. This standardized, multi-species, habitat-based methodology facilitates the assessment of project-induced impacts on fish and wildlife resources. The coastal marsh WVA models consists of six variables: (1) percent of wetland area covered by emergent vegetation; (2) percent of open water area covered by aquatic vegetation; (3) marsh edge and interspersion; (4) percent of open water area $\leq$ 1.5 feet deep in relation to marsh surface; (5) salinity, and; (6) aquatic organism access. The swamp WVA model consists of four variables: (1) stand structure; (2) stand maturity; (3) water regime, and; (4) salinity. The bottomland hardwood model, which was used for both bottomland hardwood-wet and bottomland hardwood-dry features, consists of seven variables: (1) stand structure; (2) stand maturity; (3) understory/midstory; (4) hydrology; (5) size of contiguous forests areas; (6) suitability and traversability of surrounding land uses, and; (7) disturbance.

Values for the model variables are derived for existing conditions and are estimated for conditions projected into the future if no restoration efforts are applied (i.e., future-without-project), and for conditions projected into the future if the proposed restoration project is implemented (i.e., future-with-project), providing an index of quality or habitat suitability of the habitat for the given time period. The habitat suitability index (HSI) is combined with the acres of habitat to get a number that is referred to as "habitat units". Expected project benefits are estimated as the difference in habitat units between the future-with-project (FWP) scenario and the future-without-project (FWOP) scenario. To allow comparison of WVA benefits to project costs for overall project evaluation, total benefits are averaged over a 57-year period (the project life), with the result reported as Average Annual Habitat Units (AAHUs).

Site visits are being planned or have occurred to obtain existing conditions data for proposed mitigation features at the NF O5a.1 swamp site, the Flemming property swamp site, the Big Branch brackish marsh site, the Fritchie brackish marsh site, the Coleman brackish marsh site, the Defelice brackish marsh, and the Delta National Wildlife Refuge intermediate/brackish marsh mitigation sites. If direct access was not available for an area, then data was gathered from nearby areas where access was available and inferences were made concerning existing conditions present in areas. Existing conditions data for these sites were collected via observations of the site, and through estimations based on the aerial observations and working knowledge of similar habitats in the immediate area.

CEMVN and members of the Interagency Team developed general assumptions applicable to some of the variables contained in each of the three WVA models employed. These assumptions were primarily applicable to the assignment of values to and/or treatment of variables under the FWP scenario for the different types of mitigation proposed (ex. swamp restoration, BLH-wet restoration, etc.). The assumptions were used in running the WVA models in order to help ensure a uniform approach to model inputs.

For use in the WVA models, projected Relative Sea Level Rise (RSLR) estimates were developed according to EC 1165-2-211 (USACE, 2009), using reference gages situated within the deltaic plain project area. Data from Gage 8761724 near Grand Isle and Gage 85700 near Rigolets Lake Pontchartrain, were used to develop a low, intermediate, and high rate of Sea Level Rise (SLR). The resulting SLR data are provided in Appendix D. Based on MVD planning guidance, the Intermediate rate was used for the purpose of WVA modeling and alternative comparison.

The following is an explanation of the application of the RSLR projections, originally developed by evaluation of the Bayou Barataria at Barataria Gage (gage #82750), in the Wetland Value Assessment habitat modeling. Projected land loss rates were developed by USGS for the subunits within the NOV study area. A hyper-temporal approach used land/water data from 2006 to 2063 to develop a linear regression relationship to estimate recent historic land loss rates. These land loss rates were assumed to have occurred under a constant low SLR rate, and were assumed to be the future loss rates under the low RLSR Scenario. For the accelerated RSLR scenarios (i.e. Intermediate and High scenarios), the subunit land loss rates were gradually increased by multiplying the 2006-2063 annual wetland loss rates by adjustment factors developed by USFWS. The annual wetland loss rate adjustment factors were based on a positive relationship observed between wetland loss rates and RSLR rates from coastwide Louisiana non-fresh marshes. In this relationship, RSLR was calculated as the sum of subsidence per statewide subsidence zones plus a eustatic SLR rate of 1.7 mm/yr. Recent land loss rates in percent per year were plotted against RSLR determined for those subsidence zones. A linear regression was used to predict land loss rates from subsidence rates. According to this relationship, the land loss rate is zero when RSLR = 1.09 mm/yr.

Therefore, a constant was subtracted from all project-specific predicted RSLR rates such that the WVA model Target Year (TY) 1 rate = 1.09 mm/yr. The correlation formula describing the relationship was then used to predict a land loss rate increase for post-TY1 RSLR increases, and a value of 1.0 was added to the result to produce the wetland loss rate adjustment factor. Using these procedures, the base year TY1 would have an adjustment factor of 1.0 (i.e., no increase in land loss rate) and the factor would increase with time. This factor was multiplied by the historic (Low) land loss rate, thus increasing the land loss rates over time in proportion to increasing RSLR rates.

The complete WVA models and accompanying Project Information Sheets are available upon request by contacting the Environmental Manager, Laura Lee Wilkinson, via email (Laura.L.Wilkinson@usace.army.mil) or by phone (504-862-1212).

It is important to understand the basis of the WVA models and the associated approach used in developing 35% design plans for the mitigation features proposed at the various mitigation sites. The first step in the process involved generating preliminary design plans. The size of the mitigation features (mitigation polygons) used in the preliminary plans was based on assumed mitigation potentials (e.g. the net gain in AAHUs that would be generated by each acre of the mitigation feature, or AAHUs/acre) for the various proposed habitats and types of mitigation (restoration or enhancement). These assumed mitigation potentials were based on the results of WVA models run for similar mitigation projects in the general region, using an average of the mitigation potentials derived from these models. Table H-1 provides a listing of the assumed mitigation potentials. The size of mitigation features thus was determined by multiplying the assumed mitigation potential times the number of AAHUs necessary to compensate for habitat impacts to yield the estimated acreage required.

Table H-1. Mitigation potentials used in generating preliminary 35% design plans.

Proposed Habitat	Mitigation Type	Mitigation Potential (AAHUs/acre)
Fresh Marsh	Restore	0.5
BLH-Dry	Restore	0.21 to 0.4
BLH-Wet	Restore	0.43 to 0.6
Swamp	Restore	0.43 to 0.54
Brackish Marsh	Restore	0.27 to 0.45

Once the preliminary design plans were completed, the WVA models were run based on the mitigation features as depicted in these plans. The outputs from the WVA models were examined to determine the actual mitigation potential associated with these mitigation features, as opposed to the assumed mitigation potentials used to develop the preliminary plans. These actual mitigation potentials were then used to “reshape” or “resize” the proposed mitigation features at each mitigation site such that the features would provide the number of AAHUs required. In some cases, this exercise required increasing the size of one or more mitigation features or even adding mitigation features. In other cases, this process required reducing the size of mitigation features or even eliminating some mitigation features entirely.

As a hypothetical example, assume the number of AAHUs necessary to mitigate for brackish marsh impacts was 27 AAHUs. In preparing the preliminary design plans, the total acres of fresh marsh restoration features required was determined using the assumed mitigation potential of 0.27 AAHUs/acre. Hence, the total acres of marsh features proposed at a particular mitigation site was at least 100 acres (27 AAHUs needed / (0.27 AAHUs/ac.) = 100 ac.). Now assume the WVA model run for these marsh features at a particular mitigation site indicated the actual mitigation potential was 0.50 AAHUs/acre. Based on this, the total acres of marsh features actually needed at the mitigation site was 54 acres (27 AAHUs needed / (0.50 AAHUs/ac.) = 54 ac.), rather than the 100 acres used in the preliminary design plan. The preliminary design plan for the mitigation site would be revised in this example such that the proposed marsh features totaled at least 54 acres.

The final 35% design plans presented in the EAR represent the modified designs based on the "reshaping/resizing" process discussed above. These modifications resulted in significant changes to the proposed mitigation features depicted in the final 35% design plans as compared to the features depicted in the preliminary 35% design plans. In some cases, such changes not only involved revisions to the size of mitigation features but also involved spatial reconfigurations of mitigation features in an effort to optimize the design.

This scenario occurs in cases where one or more mitigation features shown in the preliminary 35% design plan were eliminated in the final 35% design plan due to the eliminated features not being necessary to meet the AAHU requirement.

The resizing process discussed above was based on the assumption that the mitigation potentials produced by the WVA models run using the preliminary design plans would not change substantially if these models were re-run using the final design plans. It was recognized that a WVA model run for a particular mitigation feature as shown in the final plan would indeed likely produce a mitigation potential value for the feature that is different than the mitigation potential value for the same feature as generated by the WVA model run based on the preliminary plan. However, it was assumed that the magnitude of this difference would be essentially the same for all mitigation alternatives as grouped based on the mitigation feature type. Thus, the ranking order of mitigation alternatives would not have changed had new WVA models been run based on the final 35% design plans. Also for the EAR because the levee construction project is undergoing minor design changes, a 10% buffer was added to increase project size to account for additional wetland impacts not yet quantified.

Table H-2 provides a summary of the results of the WVA models, indicating the mitigation potential for features within each mitigation site (expressed in net AAHUs generated per acre of mitigation feature) as well as the minimum acreage necessary to satisfy mitigation requirements. In certain cases this table indicates a range of mitigation potentials for a particular mitigation site. This is a result of there being multiple proposed mitigation features at the mitigation site, with the various mitigation features having differing mitigation potentials.

Table H-2. Mitigation potentials predicted by WVA models and minimum acreage needed to fulfill mitigation requirements.

Project Group (Mitigation Site)	Proposed Habitat & Type of Mitigation	Acres to be created w/10% buffer	Mitigation Potential (AAHUs/ac.)	Total Net AAHUs Generated
Swamp Impacts (mitigation required: 33.9 AAHUs)				
NF NOV 05a.1 Swamp	Swamp (restore)	86.72	0.43	33.9
Mitigation Bank	Swamp Credit Purchase	0 to 322	0.2 to 0.63	33.9
Brackish Marsh (includes Saline Marsh) Impacts (mitigation required: 106.9 AAHUs)				
Big Branch Brackish Marsh	Brackish Marsh (restore)	391.97	0.30	106.9
Fritchie Marsh Brackish Marsh	Brackish Marsh (restore)	261.31 to 350	0.45	106.9
Coleman Brackish Marsh	Brackish Marsh (restore)	379.32	0.31	106.9
Defelice Brackish Marsh	Brackish Marsh (restore)	345.85	0.34	106.9
Delta National Wildlife Refuge (DNWR) Main Pass 1 Brackish Marsh	Brackish Marsh (restore)	435.52	0.27	106.9
DNWR Main Pass 2 Brackish Marsh	Brackish Marsh (restore)	511.26	0.23	106.9
DNWR Delta Bend Brackish Marsh	Brackish Marsh (restore)	367.47	0.32	106.9
Mitigation Bank/ILF	Brackish Marsh Credit Purchase	0 to 228.97	0.2 to 0.63	106.9

WVA models have been applied in accordance with the guidance provided in "Memorandum for CEMVN-PD, Subject: Wetlands Value Assessment (WVA) Models, Guidance for Application, dated 21 March 2011" (Staebell, 2011). Spring 2012 versions of the WVA models were used, as addressed in the preceding section. All WVA models are approved for use and considered certified as planning models for USACE studies in accordance with EC 1105-2-412 (https://cw-environment.erdc.dren.mil/model-library.cfm?CoP=Restore&Option=View&Id=1 and Kitch, 2012). Attachment H-1 "Plaquemines New Orleans to Venice (NOV) and Non Federal Levee (NFL) Mitigation: Wetland Value Assessment Model Assumptions and Related Guidance (Revised/Updated: 31 January 2017)" gives a detailed description of the assumptions utilized for the WVA assessments for the Plaquemines mitigation project and was updated using lessons learned from reviews and sensitivity analysis made on the Lake Pontchartrain and Vicinity (LPV) and Westbank and Vicinity (WBV) Hurricane Storm Damage Risk Reduction System WVAs.

References

Kitch, Harry. 2012. Memorandum for Director, ECO-PCX, Subject: Wetland Value Assessment Models – Coastal Marsh Module Version 1.0 – Approval for Use. USACE, Planning and Policy Division, Directorate of Civil Works, Washington DC.

Staebell, Jodi. 2011. Memorandum for CEMVN-PD, Subject: Wetland Value Assessment (WVA) models, guidance for application. USACE, Mississippi Valley Division, Ecosystem Restoration Planning Center of Expertise, Vicksburg, MS.

US Army Corps of Engineers (USACE). 2009. EC 1165-2-211; Water policies and authorities incorporating sea-level change considerations in civil works programs. USACE, Washington, DC.

US Army Corps of Engineers (USACE). 2011. EC 1105-2-412; Assuring quality of planning models. USACE, Washington, DC.

ATTACHMENT H-1
Plaquemines New Orleans to Venice (NOV) and Non Federal Levee (NFL) Mitigation: WETLAND VALUE ASSESSMENT (WVA) MODEL ASSUMPTIONS AND RELATED GUIDANCE

(Revised/Updated: 25 September 2018)

PREFACE

Several of the assumptions set forth in this document are based on mitigation implementation schedules. Many sections include specified WVA model target years (TYs) and calendar years applicable to assumptions, and a few sections outline anticipated mitigation construction (i.e. mitigation implementation) schedules. It is critical for the WVA analyst to understand that this document has not been revised to account for changes to the mitigation implementation/construction schedules. It is therefore imperative for the analyst to obtain the most recent mitigation implementation/construction schedule for a particular mitigation project from CEMVN prior to running WVA models. The analyst may then need to modify some of the WVA model assumptions and guidelines presented herein to account for differences between the present mitigation implementation/construction schedule and the schedule(s) that were assumed in generating this document.

This document should be applied when conducting WVA analyses for the Engineering Alternatives Report and the Tentatively Selected Plans (TSPs) selected for meeting Plaquemines NOV and NFL mitigation needs.

1.1 SWAMP MODEL – GENERAL ASSUMPTIONS

V1 – Stand Structure (percent closure or Cover: overstory, midstory, herbaceous)

Swamp restore, FWP scenario --
Assumptions applicable to restoration features built in existing open water areas and for any restoration features that require deposition of fill to achieve target grades. If construction involves substantial excavation and grading rather than filling, use the next assumptions table rather than this one.

TY	Year	Assumption
0	2021	Baseline conditions (site-specific)
1	2022	Class 1
2	2023	Class 1
3	2024	Class 2
15	2036	Class 6
35	2056	Class 6
50	2071	Refer to Note 1

Notes:

1. Over time, sea-level rise and possibly subsidence could adversely affect the hydrologic regime (increased flooding duration, increased depth of inundation). Salinity could increase in some areas concurrent with sea-level rise. These factors are anticipated to adversely affect plant growth and survival. Thus, cover in the midstory and herbaceous (ground cover) strata are anticipated to decrease over time, as could percent cover in the canopy stratum to a lesser degree. This potential reduction must be evaluated on a site-specific basis, factoring in considerations such as the proposed grade of the mitigation polygon relative to the projected sea-level rise elevation, changes in salinity, etc. As a general “rule of thumb”, one may anticipate the stand structure to decrease from Class 6 in TY35 to Class 4 by TY50. However, it is emphasized that the decrease in class score over time must be evaluated on a case-by-case basis.

Swamp restore, FWP scenario --
Assumptions applicable to restoration features involving substantial excavation and grading as part of the initial construction efforts. If fill is required via pumping of sediments into the feature, use the preceding assumptions table.

TY	Year	Assumption
0	2021	Baseline conditions (site-specific)
1	2022	Class 1
2	2023	Class 1
15	2036	Class 6
35	2056	Class 6
52	2073	Refer to Note 1 in preceding assumptions table

General Notes:

- Include the cover accounted for by Chinese tallow and other invasive plant species when working with this variable (for FWOP scenario in all model target years and for FWP scenario at TY0).
- For swamp enhancement features, FWP scenario --- The evaluation of existing canopy, midstory, and understory will be done via field data collection for this variable. The growth of planted species will be estimated from a growth calculator that is based on pertinent research. Assumptions will have to be made about the correlation between plant growth and observed coverage. The values will be averaged to get a single HSI for this variable. Planted canopy species should not be factored into the overstory coverage estimate until TY15. They will be considered either as part of understory cover (earlier) or midstory cover (later) prior to TY15.

V2 – Stand Maturity (average DBH of canopy trees; plus total basal area all trees)

Swamp restore, FWP scenario --
Assumptions applicable to restoration features built in existing open water areas and for any restoration features that require deposition of fill to achieve target grades. If construction involves substantial excavation and grading rather than filling, use the next assumptions table rather than this one.

TY	Year	Assumptions – Density of Trees	Assumptions – DBH of Planted Trees
0	2021	Baseline conditions.	N/A
1	2022	0 trees/ac.	N/A
2	2023	538 trees/ac. (trees installed, initial density)	Cypress = 0.2” // Tupelo = 0.3”
3	2024	269 trees/ac. (50% survival of planted trees)	Cypress = 0.2” // Tupelo = 0.5”
4	2036	258 trees/ac. (48% survival of planted trees)	
15	2056	215 trees/ac. (40% survival of planted trees)	Cypress = 3.5” // Tupelo = 4.1”
35	2071	161 trees/ac. (30% survival of planted trees)	Cypress = 8.2” // Tupelo = 9.6”
50	2021	161 trees/ac. (30% survival of planted trees)	Cypress = 11.9” // Tupelo = 14.0”

Swamp restore, FWP scenario --
Assumptions applicable to restoration features, or the portions thereof, involving substantial excavation and grading as part of the initial construction efforts. If fill is required via pumping of sediments into the feature, use the preceding assumptions table concerning tree densities.

TY	Year	Assumptions – Density of Trees	Assumptions – DBH of Planted Trees
0	2021	Baseline conditions.	N/A
1	2022	538 trees/ac. (trees installed; initial density)	Cypress = 0.2” // Tupelo = 0.3”
2	2023	269 trees/ac. (50% survival of planted trees)	Cypress = 0.2” // Tupelo = 0.5”
3	2036	258 trees/ac. (48% survival of planted trees)	
15	2056	215 trees/ac. (40% survival of planted trees)	Cypress = 3.5” // Tupelo = 4.1”
35	2073	161 trees/ac. (30% survival of planted trees)	Cypress = 8.2” // Tupelo = 9.6”
52	2021	161 trees/ac. (30% survival of planted trees)	Cypress = 11.9” // Tupelo = 14.0”

Swamp restore, FWP scenario ---

- Assume 70% of the trees planted will be cypress and that 30% of the trees planted will be tupelo or other non-cypress species. Assume that this ratio will remain constant over time once the trees are planted.

Swamp enhance, FWP scenario ---

- Do not factor planted trees into the site DBH calculations until TY15. Prior to TY15, the planted trees will be considered as being in the understory or midstory strata.

General Notes:

- Factors such as sea-level rise and increased salinity over time may adversely affect the growth and/or survival of planted trees and existing trees. These factors must be considered when assessing this variable and may require adjustments to the assumed density of planted trees (as regards survival of trees) and the assumed dbh of planted trees indicated in the preceding tables. The FWS spreadsheet used to predict tree growth (reference the "BLH Site Ingrowth" spreadsheet) includes correction factors used to adjust typical growth rates to account for trees subject to stressors like excessive inundation or salinity. These correction factors should be used for target years in which one anticipates the stress factors may significant enough to affect tree growth. The stage in the project life that the effects become significant must be determined on a case-by-case basis.

V3 – Water Regime (flooding duration and water flow/exchange)

Swamp restore, FWP scenario --
Assumptions applicable to restoration features built in existing open water areas and for any restoration features that require deposition of fill to achieve target grades. If construction involves substantial excavation and grading rather than filling, use the next assumptions table rather than this one.

TY	Year	Assumption
0	2021	Baseline conditions (score based on existing hydrology)
1	2022	Duration = permanent // Exchange = none
2	2023	Duration = seasonal Refer to Note 1
15	2036	Duration = seasonal Refer to Note 1
35	2056	Duration = seasonal or semi-permanent Refer to Notes 1 and 2
50	2071	Duration = semi-permanent or permanent Refer to Notes 1 and 2

Notes:

1. Scoring of water flow/exchange component of hydrology must be based on site-specific conditions anticipated.
2. During the latter portions of the project life, flooding duration may be affected by sea-level rise. Swamp mitigation features are designed to have seasonal flooding once the features are constructed and have reached the desired target grade elevation. Sea-level rise will likely increase the duration of flooding. This effect will be site-specific and must be evaluated on a case-by-case basis. Sea-level rise will also likely affect the water flow/exchange. For a site that has limited exchange during early years, this may actually improve exchange for a period of years (ex. increase from low exchange in TY2 to moderate exchange in TY15). As the sea-level rise continues over time, however, the effect may be to reduce exchange (ex. decrease from moderate exchange in TY35 to low exchange in TY50). The degree to which sea-level rise affects flow/exchange over time must also be evaluated on a case-by-case basis.

Swamp restore, FWP scenario --
Assumptions applicable to restoration features, or the portions thereof, involving substantial excavation and grading as part of the initial construction efforts. If fill is required via pumping of sediments into the feature, use the preceding assumptions table.

TY	Year	Assumption
0	2021	Baseline conditions (score based on existing hydrology)
1	2022	Duration = seasonal Refer to Note 1
2	2023	Duration = seasonal Refer to Note 1
15	2036	Duration = seasonal Refer to Note 1
35	2056	Duration = seasonal or semi-permanent

		Refer to Notes 1 and 2
50	2071	Duration = semi-permanent or permanent Refer to Notes 1 and 2

Notes:
Notes 1 and 2 are the same as in the preceding table.

V4 – Mean High Salinity During the Growing Season (salinity re baldcypress & other trees)

General Notes:

- For current and near-term salinities, use the Coastwide Reference Monitoring System (CRMS) data (website http://www.lacoast.gov/crms%5Fviewer/) and USGS gage data (website http://waterdata.usgs.gov/la/nwis/rt) where available. Future salinities should be forecast using reasonable estimates and best professional judgment (in the absence of hydrologic and hydrodynamic modeling).

Other WVA Swamp Model Guidance

The WVA procedural manual and Swamp Community Model text advises that habitat classification data and aerial photos should be used to determine a conversion rate of swamp to marsh. Based on this evaluation, the guidance states that areas of swamp converting to fresh marsh should be evaluated as open water habitat using the fresh marsh model. The determination of appropriate conversion rates would be quite complicated in the project area. Hence, this issue will not be addressed as part of the WVA analyses.

1.2 NOTES REGARDING CONSTRUCTION & PLANTING OF SWAMP MITIGATION AREAS

Typical Estimated Project Construction Timelines -----

All projects – Begin construction around June 2021.

For swamp restoration areas built in existing open water features and for any other swamp restoration areas that require deposition of fill material as part of the construction process:

- June 2021 – Begin construction.
- Feb. 2022 – Complete construction.
- Feb. 2023 – Initial grade settles to desired target grade (1 year after end of construction). If applicable, perimeter dikes constructed are degraded or gapped at this time.
- Sept. 2023 – Install plants.

For swamp restoration areas involving extensive excavation and earthwork but that do not require deposition of fill as part of the construction process:

- June. 2021 – Begin construction.
- Dec. 2021 – End construction (subsequent grading may be required in some areas after an as-built survey completed in order to correct any deficiencies).
- Sept. 2021 – Install plants.

For swamp enhancement areas:

- June 2021 – Begin construction (includes start of invasive plant eradication).
- Oct. 2021 – End construction.
- Dec. 2021 – Install plants.

Note: All of the above timelines are preliminary and are subject to refinement as plans are refined for a particular mitigation site.

Planting of Swamp Restoration Areas -----

Initial plantings will be:

- Canopy species: plant on 9-foot centers (538 trees/acre); of total trees planted, approximately 70% will be cypress while the remaining trees will consist of tupelo and other non-cypress species.
- Midstory species (shrubs and small trees): plant on 20-foot centers (109 seedlings per acre).
- Stock size (minimums): Canopy species = 1 year old, 3 feet tall, 0.5" root collar; Midstory species = 1 year old, 3 feet tall.

Planting of Swamp Enhancement Areas -----

Initial plantings will follow the same guidelines as for swamp restoration areas regarding the general density of installed plants and the stock used. Where initial enhancement activities include the eradication of invasive and nuisance plant species, significant numbers of native canopy and/or midstory species may remain, but in a spatial distribution that leaves relatively large "gaps" in the canopy stratum and/or the midstory stratum. In such cases, areas measuring approximately 25 feet by 25 feet that are devoid of native canopy species should be planted and areas measuring approximately 45 feet by 45 feet that are devoid of native midstory species should be planted.

The typical guideline of having roughly 70% of the canopy species planted be cypress and 30% of the canopy species planted be tupelo and other non-cypress species may be altered in situations where several native trees remain after eradicating invasive/nuisance species. For example, if the remaining native trees are almost all cypress, then a greater proportion of the planted trees may consist of non-cypress species. Similarly, the composition of the species planted might also be altered to be more representative of the species composition present in nearby healthy swamp habitats.

1.3 SWAMP WVA MODEL – TARGET YEARS FOR MODELS

Typically use the target years specified below when analyzing swamp restoration polygons built in existing open water features and for any other swamp restoration polygons that require deposition of fill material as part of the construction process:

TY	Year	
0	2021	Baseline conditions (assume construction starts in 2021 even though anticipated start is late 2021)
1	2022	Initial construction activities begin and are completed. No plants installed. V1 = Class 1; V3 = permanent duration.
2	2023	Restoration feature settles to desired target grade. Any associated perimeter containment dikes are degraded or gapped. Plants installed. V1 = Class 1; V2 = 538 trees/ac.; V3 = seasonal duration.
3	2024	V1 = Class 2; V2 = 269 trees/ac.; V3 = seasonal duration.
4	2025	V1 = Class 2; V2 = 258 trees/ac.; V3 = seasonal duration.
15	2036	V1 = Class 6; V2 = 215 trees/ac.; V3 = seasonal duration.
35	2056	V1 = Class 6; V2 = 161 trees/ac.; V3 = seasonal or semi-permanent duration.
50	2071	End of project life for a HSDRRS mitigation feature. V2 = 161 trees/ac.; V3 = semi-permanent or permanent duration.

Typically use the target years specified below when analyzing swamp restoration polygons that do not require deposition of fill material as part of the construction process, and when analyzing BLH enhancement polygons:

TY	Year	
0	2021	Baseline conditions (assume construction starts in 2021 even though anticipated start is late 2021)
1	2022	Initial construction activities begin and are completed. Initial eradication of invasive & nuisance plant species is started and completed.

		Plants are installed (either in March or in December depending on construction activities. Appropriate planting season extends from November through February). V1 = Class 1; V2 = 538 trees/ac.; V3 = seasonal duration.
2	2023	V1 = Class 2; V2 = 269 trees/ac.; V3 = seasonal duration.
3	2024	V1 = Class 2; V2 = 258 trees/ac.; V3 = seasonal duration.
15	2036	V1 = Class 6; V2 = 215 trees/ac.; V3 = seasonal duration.
35	2056	V1 = Class 6; V2 = 161 trees/ac.; V3 = seasonal or semi-permanent duration.
50	2071	End of project life for a HSDRRS mitigation feature (adjusted end to be consistent with final TY used in impact WVAs). V2 = 161 trees/ac.; V3 = semi-permanent or permanent duration.

The user of these guidelines is cautioned that the construction schedule for proposed mitigation features may not follow the construction schedule assumed in the preceding sections. If this is the case, the model target years and their associated model assumptions may have to be adjusted accordingly.

1.4 BRACKISH MARSH MODEL – GENERAL ASSUMPTIONS

V1 – Percent of Wetland Area Covered by Emergent Vegetation

Marsh restore, FWP scenario:

Calendar Year	TY	Planted Marsh Platform (credit)	50% planting rate (credit)	Unplanted Marsh Platform (credit)
2021	0 (baseline)			
2022	1 (supratidal)	10%	5%	0%
2024	3 (supratidal)	25%	17.5%	15%
2026	5 (intertidal)	100%	50%	50%
2027	6 (intertidal)	100%	100%	100%

Note: Assume 7-ft center planting densities.

FWOP scenario:
2021 land rolled forward by applying 3 years of loss.

General Notes:

1. Typically, no existing project benefits are considered under FWOP. Project sites were typically selected to avoid overlap with existing non-diversion projects. In the case of existing diversions, either the effect of the diversion is assumed to be captured in the historic loss rate or the diversion would have to substantially fill in the project site FWOP to affect the net changes under V1 and V4, plus marsh creation gets optimal credit on its own if or until accretion does not keep pace with RSLR. Doing marsh creation in diversion areas may be more sustainable. However, not capturing that potential higher sustainability effect within the WVA would be more conservative for compensatory purposes (i.e., would generate less AAHUs and require more acres), but would not allow differentiation between sites with or without existing diversion influence where that influence is not captured in the historic loss rate.

   In limited cases, some existing project benefits are indeed considered under FWOP. Coordinate directly with CEMVN to determine whether any benefits from existing projects should be considered under the FWOP scenario.
2. Under the FWP scenario, begin applying land loss once the marsh fill has settled to the desired target grade (i.e. in TY2, one year after completion of initial fill placement). The USGS loss rates derived from a linear regression will be applied using a linear loss rate.
3. For the FWP scenario, one must subtract the acreage of interior borrow areas (borrow used to build dikes) from the total acreage of marsh land to derive the percentage of the total feature acreage that will count as marsh land. These borrow areas will have a greater settlement rate than will other portions of the mitigation feature. Seek engineering input as to what percentage of the borrow area footprint will settle to an elevation whereby the area would be considered as shallow open water rather than marsh land.

4. For the FWP scenario, one must also subtract the acreage of any trenasses initially constructed from the total acreage of marsh land to derive the acreage that will count as marsh land. These trenasses will count as shallow open water areas (assuming they are not excavated over 1.5 feet deep in relation to the marsh surface elevation).
5. For the FWP scenario, only those portions of earthen retention dikes that fall within the intertidal range can be included in the marsh restoration feature acreage. Portions of such dikes that are not degraded such that their crest elevation is equal to the final marsh target elevation cannot be counted in the acreage of the marsh feature, nor can portions of the dikes that will remain underwater. Similarly, the footprints occupied by proposed foreshore dikes (rock dikes) cannot be counted in the acreage of the marsh feature.
6. It is assumed that proposed marsh restoration features will not be planted. Instead, it is assumed that suitable vegetative cover will develop rapidly via natural recruitment and colonization of the feature.
7. For the FWP scenario, land loss will be assumed to begin once the restored marsh feature has settled to the desired target grade. This will occur 1 year after the initial construction (dike construction, placement of fill as slurry) has occurred.

V2 – Percent Open Water Area Covered by Submerged Aquatic Vegetation

Marsh restore, FWP scenario:

TY	Year	Assumption
0	2021	Baseline conditions (existing conditions).
1	2022	0%
3	2024	0%
5	2026	Same as baseline conditions.
6	2027	Increase baseline by 10%, then maintain this through TY25 (i.e. SI value plateaus).
25	2046	See guidance for TY6.
50	2071	25% of baseline conditions.

Marsh restore, FWOP scenario:
TY50 (2071) = 15% of baseline

Note:
Base the SAV cover estimates on the average cover during the peak of the growing season. SAVs do not include floating aquatics (but do include floating-leaf aquatics).

General Notes:
Brackish marshes also have the potential to support aquatic plants that serve as important sources of food and cover for several species of fish and wildlife. Although brackish marshes generally do not support the amounts and kinds of aquatic plants that occur in fresh/intermediate marshes, certain species, such as widgeon-grass, and coontail and milfoil in lower salinity brackish marshes, can occur abundantly under certain conditions. Those species, particularly widgeon-grass, provide important food and cover for many species of fish and wildlife. Therefore, the V_2 Suitability Index graph in the brackish marsh model is identical to that in the fresh/intermediate model.

V3 – Marsh Edge and Interspersion

Marsh restore, FWP scenario:

TY	Year	Assumption
0	2021	Baseline conditions (existing conditions).
1	2022	100% Class 5
3	2024	100% Class 3
5	2026	50% Class 3 and 50% Class 1
6	2027	100% Class 1

Notes:

When assigning SI values to variable V3, the percent marsh values (variable V1) should also be considered and interspersion classes developed accordingly. This could result in assumptions that differ from those indicated above.
Between TY6 and TY50, one must use best professional judgment coupled with land loss projections to determine appropriate SI values for variable V3.

V4 – Percent of the Open Water Area ≤ 1.5 Feet Deep (in relation to marsh surface)

Marsh restore, FWP scenario:

TY	Year	Assumption
0	2021	Baseline conditions (existing conditions).
1	2022	Any marsh lost becomes shallow open water.
3	2024	Any marsh lost becomes shallow open water.
5	2026	Any marsh lost becomes shallow open water.
6	2027	Any marsh lost becomes shallow open water.
50	2071	1/6th of the shallow open water becomes deep based on 0.5 feet of subsidence.

Marsh restore, FWOP scenario:

- Marsh lost between TY1 & TY50 becomes shallow open water.
- At TY50, 1/3 of existing shallow water becomes deep (based on subsidence rate used in determining SLR adjustment).

V5 – Salinity

Assume salinity scores will be the same for FWP and FWOP scenarios.

Assume salinity values will not change enough over time to force a shift from the fresh marsh model to the brackish marsh model.

Data Source --
CRMS site http://www.lacoast.gov/crms2/Home.aspx - Click on Basic Viewer under the Mapping link. Click on the nearest data station and then select the Water tab to get the salinities. The data are approximately average annual and most appropriate for the Brackish Marsh and Saline Marsh models if the period of record doesn't have an anomalous event (e.g., drought, unusual FW diversion operation). Average annual salinity may be accepted on a case-specific basis for the Fresh Marsh/Intermediate Marsh model as well.

V6 – Aquatic Organism Access (% wetland accessible & type of access)

Marsh restore, FWP scenario:

TY	Year	Assumption
0	2021	Baseline conditions (existing conditions).
1	2021	0.0001 (supratidal; retention dikes not gapped or degraded)
3	2024	0.0001 (supratidal; retention dikes have been gapped or degraded)
5	2026	1.0 (intertidal)
6	2027	1.0 (intertidal)
50	2071	1.0 (intertidal)

Note:
Suggested minimum standard for “gapping” containment dikes or similar dikes is no less than one 25-foot wide gap (bottom width) every 1,000 feet, with the “gap” excavated to the desired average marsh elevation. The preferred standard is one 25-foot wide gap (bottom width) every 500 feet, with the “gap” excavated to the pre-project elevation (i.e. the water bottom). If the project design does not provide the minimum gapping, then the

organism access values indicated above will need to be adjusted accordingly (re the maximum score attained as of TY5).

Marsh restore, FWOP scenario:
The structure rating is based on site specific, existing conditions and how those may change over time with land loss.

1.5 ADDITIONAL GUIDANCE FOR MARSH RESTORATION FEATURES PROPOSED IN AREAS WHERE THERE IS NO SIGNIFICANT LAND LOSS OVER TIME

The guidance provided herein is only applicable to proposed marsh restoration (marsh creation) features located in areas where data indicate no land loss will occur over the life of the mitigation project. For proposed marsh restoration features located in areas where there will be land loss, the general assumptions previously provided for use in running WVA marsh models will remain applicable.

V1 - % of Wetland Area Covered by Emergent Vegetation

Guidance for determining how much of the restored marsh feature will be land and how much will be shallow open water:

- Assume 1% of the total feature acreage will be open water in TY1 and 99% of the total acreage will be land.
- After TY1, increase the open water area by 0.075% each year using the total feature acreage to determine the acreage increase. Decrease the total acreage of land accordingly.

Example Calculation:
Assume the proposed marsh restoration feature encompasses 100 acres that can all be counted as marsh land.
At TY1, the land area will be 99% of the 100 acres while the open water area will be 1% of the 100 acres.
The increase in the open water area per year after TY1 and the decrease in the land area per year after TY1 will be: 0.075% X 100 acres = 0.075 acre per year.

Determination of land area and open water area:

TY	Land Acres	Open Water Acres	Open Water Calculation	Land Calculation
1	99.00	1.00	100 ac.*0.01	100 ac.*0.99
3	98.85	1.15	(1.0 ac. at TY1) + (2 yrs * 0.075 ac./yr.) = A	(99.0 ac. at TY1) - A
5	98.70	1.30	(1.0 ac. at TY1) + (4 yrs * 0.075 ac./yr.) = B	(99.0 ac. at TY1) - B
6	98.625	1.375	(1.0 ac. at TY1) + (5 yrs * 0.075 ac./yr.) = C	(99.0 ac. at TY1) - C
21	97.50	2.50	(1.0 ac. at TY1) + (20 yrs * 0.075 ac./yr.) = D	(99.0 ac. at TY1) - D
25	97.20	2.80	(1.0 ac. at TY1) + (24 yrs * 0.075 ac./yr.) = E	(99.0 ac. at TY1) - E
50	95.325	4.675	(1.0 ac. at TY1) + (49 yrs * 0.075 ac./yr.) = F	(99.0 ac. at TY1) - F

Determination of land area covered by emergent vegetation (marsh area):

TY	Land Acres	Marsh Acres	Marsh Area Calculation
1	99.00	9.9	99.0 ac. land * 0.10 (i.e. 10% of land covered by emergent vegetation)
3	98.85	49.425	98.85 ac. land * 0.50 (i.e. 50% of land covered by emergent vegetation)
5	98.70	98.70	98.70 ac. land * 1.00 (i.e. 100% of land covered by emergent vegetation)
6	98.625	98.625	98.70 ac. land * 1.00 (i.e. 100% of land covered by emergent vegetation)
21	97.50	97.50	97.50 ac. land * 1.00 (i.e. 100% of land covered by emergent vegetation)
25	97.20	97.20	97.20 ac. land * 1.00 (i.e. 100% of land covered by emergent vegetation)
50	95.325	95.325	95.325 ac. land * 1.00 (i.e. 100% of land covered by emergent vegetation)

Notes:

1. Values for TY0 will be based on existing conditions within the marsh restoration features.
2. The general assumptions applicable to determining the percentage of the marsh feature acreage (e.g. land acreage) that is covered by emergent vegetation remain the same as those set forth in the original fresh marsh WVA model guidance. These assumptions are: TY1 = 10%; TY3 = 50%; TY5 = 100%; TY6 = 100%.
3. Refer to the notes under the variable V1 assumptions for fresh marsh models concerning how features such as dikes, interior borrow areas, and constructed trenasses must be handled as regards the acreage of marsh land.

V4 – Percent of the Open Water Area ≤1.5 Feet Deep (relative to marsh surface)

Assume all of the open water areas that develop within the marsh feature (see variable V1 guidance) will be less than or equal to 1.5 feet deep. This assumption is applicable to target years 1 through 50.

3.5 PROJECT CONSTRUCTION NOTES FOR RESTORED MARSHES

The typical anticipated schedule for initial construction associated with the proposed marsh restoration features is as follows:

- June 2021 – Begin construction
- Feb. 2021 – Complete construction
- Feb. 2022 – Initial marsh grade settles to target grade (1 year after end of construction). Degrade containment dikes, and/or install “fish gaps”, and or establish gaps in other dikes.
- 2022 – Install plants (intermediate marsh and brackish marsh features only).

Note that none of the proposed fresh marsh restoration features will be planted. It was assumed that these areas would be sufficiently vegetated via natural recruitment and colonization. Planting would only occur if sufficient vegetative cover (herbaceous) does not develop through natural processes.

Remember that it is very important to review the most detailed design plans available (e.g. initial 35% design plans (drawings), or 65%+ design plans), and the project description narrative associated with these plans. These descriptions and drawings contain important information for specific mitigation features/sites that will affect assumptions used in the WVA models.

3.6 MARSH MODELS – MODEL TARGET YEARS

Typically use the target years specified below when analyzing marsh restoration polygons built in existing open water features:

TY	Year	
0	2021	Baseline conditions (assume construction starts in 2021 even though anticipated start is late 2021)
1	2023	Initial construction activities begin and are completed. No plants installed. V1 = 10% credit (but see calcs for areas where there is no land loss). V2 = 0%. V3 = 100% Class 5. V4 = lost land becomes shallow water. V6 = 0.0001.
3	2024	Restoration feature settles to desired target grade. Any associated perimeter containment dikes are degraded or gapped. Plants installed in intermediate and brackish marsh features (no planting in fresh marsh features since none required). V1 = 50% credit (but see calcs for areas where there is no land loss). V2 = 0%. V3 = 100% Class 3. V4 = lost land becomes shallow water. V6 = 0.0001.
5	2026	V1 = 100% credit (but see calcs for areas where there is no land loss). V2 = baseline SAV cover. V3 = 50% Class 3 and 50% Class 5. V4 = lost land becomes shallow water. V6 = 1.0
6	2027	V1 = 50% credit (but see calcs for areas where there is no land loss). V2 = increase baseline SAV cover by 15%. V4 = lost land becomes shallow water. V6 = 1.0
25	2046	V2 = increase baseline SAV cover by 15%.
50	2071	End project life. V2 = 50% of baseline SAV (FWP). V3 = 100% Class 3. V4 = 1/6th of shallow open water becomes deep (FWP); but if no land loss, all open water remains shallow. V6 = 1.0

The user of these guidelines is cautioned that the construction schedule for proposed mitigation features may not follow the construction schedule assumed in the preceding sections. If this is the case, the model target years and their associated model assumptions may have to be adjusted accordingly.

4.1 RELATED TOPICS – LAND LOSS AND ACCRETION

LAND LOSS RATES

To remain consistent with the WVAs run for the levees (including those for the 57-year period of analysis), the linear loss rates must be calculated in the linear loss spreadsheet. This requires 1984 to 2010 mitigation analysis/land change data from USGS within which a particular time period is chosen depending on water levels taken at that time with efforts to pick years that allow for the greatest time during this range. Data selection is subject to interagency approval. The rate should be calculated in acres/year for integration with below methods on SLR and accretion.

The land loss rate applied to restored marshes will be 50% of the background (FWOP) loss rate. However, land loss rates will revert back to baseline rates after 10 inches of soil have formed/accreted above the initially created marsh platform. Based on input from Dr. Andy Nyman and other academics, plant roots extend downward a maximum of approximately 10 inches below the marsh surface. Consequently, when the plant roots are no longer in contact with the created platform, loss rates revert back to those of the adjoining marshes (i.e., background loss rate).

Derivation and Application of Land Loss Rates

A linear regression is applied to USGS' hyper-year (hyper temporal) data of the extended boundary. The slope of the regression line provides the acres of marsh lost for the extended boundary during the years of USGS analysis. By dividing the slope (marsh lost in acres) by the acreage at the beginning of the USGS evaluation period (e.g. 1984), the percent loss rate is determined for the extended boundary. (Note: USGS provides a percent loss rate by dividing the marsh lost in acres by the total acres of the extended polygon, which is why the percent loss rates are different.)

The project area FWOP loss rate (in acres/year) is determined by applying the extended boundary percent loss rate to the marsh acres in the project area at the beginning of the USGS period of analysis (e.g. 1984 in this case) under FWOP. The project area FWP loss rate is determined by multiplying the acres of the marsh creation area by the percent loss rate and dividing by 2 to apply the 50% reduction in loss for marsh creation.

ACCRETION

Utilize the following accretion rates when running WVA models:

- Fresh Marsh and Intermediate Marsh = 7.2 mm/year.
- Brackish Marsh = 7.7 mm/year.

Accretion is incorporated into determining when the background loss rate resumes within a created marsh area. Normally, the loss of mechanically created or nourished marsh is considered to be half of background loss rate. In the year when post-construction accretion exceeds 10 inches, the loss rate returns to the background loss rate. However, when created marshes are higher than natural marshes, there could be a delay in the loss rate change. Depending on the mechanically created marsh elevation post-construction, cumulative accretion assumes a 3-year settling period (marsh creation sites are assumed to achieve full functionality and vegetation coverage 3 years after construction).

Marsh collapse is a 10-year period that begins when the calculated cumulative accretion deficit reaches limits determined by staff working on the modeling for the 2012 Coastal Master Plan (see below). Typically, the collapse criteria are reached only during the High SLR scenario, however this generalization may not hold true in all cases.

Collapse Threshold Ranges Used in Master Plan Work

- Intermediate Marsh (cm): Low = 30.7; High = 38.0; Median = 34.4
- Brackish Marsh (cm): Low = 20.0; High = 25.8; Median = 22.9.
- Saline Marsh (cm): Low = 16.0; High = 25.0; Median = 20.5.

Collapse threshold selected as the median range for type of marsh indicated. First year of collapse is the year when the Cumulative Accretion Deficit (inundation) is equal to or greater than the median range.

Accelerated Sea Level Rise

The land loss rates determined as described above, are for the constant historic or low SLR scenario (1.7 mm/yr). Based on water level gages and known historic SLR rates, the Corps has identified RSLR rates under the historic SLR scenario, and under the intermediate and high SLR scenarios. The intermediate and high SLR scenarios would result in gradually accelerating SLR rates and it is assumed that those scenarios would result in accelerating land loss rates. Using Corps-predicted water level rise, RSLR rates can be determined. RSLR rates are then converted into an annual adjustment factor that increases wetland loss rates in proportion to the magnitude of the RSLR rate. The annual wetland loss rate adjustment factors are based on a positive relationship observed between wetland loss rates and RSLR rates from coastwide non-fresh marshes. In this relationship, RSLR was calculated as the sum of subsidence per statewide subsidence zones (see Figure 1) plus a eustatic SLR rate of 1.7 mm/yr. Recent land loss rates in percent per year were plotted against RSLR determined for those subsidence zones.

Although this is approaching the limits of rigor for WVA, each of the above methods carry substantial averaging and compounding uncertainty. Users should be aware of the general limits of accuracy and avoid adding more complexity unless deemed necessary and reasonable.

4.2 RELATED TOPICS - GENERAL SHORELINE PROTECTION ISSUES

Hard structures (foreshore dikes, rock dikes, breakwaters) get credit for preventing 100% of loss from shoreline erosion as long as the structure is maintained. If it is not maintained, then a linear decrease in effectiveness must be assumed beginning after the end of the maintenance period. For example, if a rock dike is assumed to need a lift every 14 years but the last lift was at year 14 (TY14), then beginning TY28 (for the rock) it would have a linear decrease in effectiveness to the point of not reducing shoreline erosion at all by TY42.

Vegetative plantings get credit for reducing shoreline erosion by 50% until TY20. After TY20, the area would revert to 100% of the shoreline erosion rate.

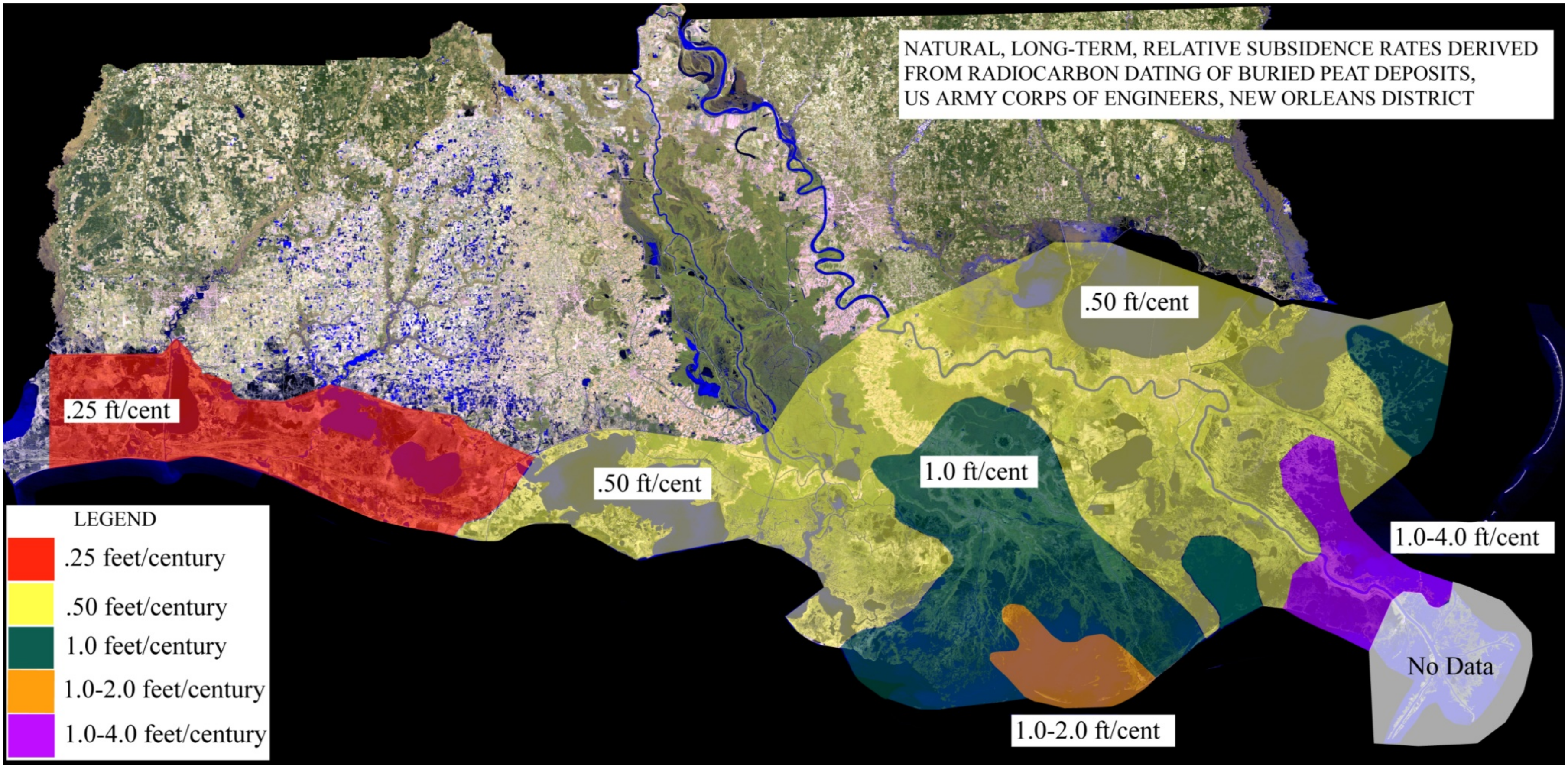

Figure 1. Long-term relative subsidence rates.

APPENDIX 1
Predicting Abrupt Marsh Collapse

(from MRGO Ecosystem Restoration Study methods doc, 3 Feb 2012)
Ronny Paille - USFWS

Research by Nyman et al. (1993) and Nyman et al. (2006) suggests that coastal marshes may undergo rapid degradation and conversion to open water beyond a critical rate of submergence/inundation. Louisiana Coastal Protection and Restoration Authority (CPRA) personnel working to model marsh loss for the 2012 Louisiana Coastal Master Plan have used statewide Coastal Reference Monitoring System data to develop plant productivity vs inundation (i.e., accretion deficit) relationships. From those relationships, they identified inundation ranges at the primary production low-end points (Table 1) to predicting onset of abrupt marsh collapse (Coastal Protection and Restoration Authority of Louisiana 2012). In this study, the median values by habitat type were used to predict onset of abrupt marsh collapse.

Table 1. Cumulative accretion deficits assumed to initiate marsh collapse.

Marsh Type	Range Low Limit (cm)	Range High Limit (cm)	Range Median (cm)
Intermediate	30.7	38.0	34.4
Brackish	20.0	25.6	22.8
Saline	16.0	25.0	20.5

It is assumed that it will take 10 years for the collapsing wetland landscape to completely convert to open water (the 10-year period was assumed to account for wetlands of varying elevations). These values incorporated the average area accretion rate of 7.4 mm per year (Table 2).

Table 2. Study area accretion measurements.

Site	Date	Wetland Type	Method	Accretion rate (cm yr-1)	Source
Breton Sound	1963-1999	Freshwater	^{137}Cs	0.65 ± 0.18	DeLaune and Pezeshki, 2003
Caernarvon diversion	1999	Freshwater	feldspar	1.57 ± 0.05*	Lane et al., 2006
Violet diversion	1999	Saline	feldspar	0.44 ± 0.01*	Lane et al., 2006
Central Wetlands				0.47	U.S. Army Corps *
St. Bernard Parish (Shell Beach)	1963-1992	Saline	^{137}Cs	0.54 ± 0.13	DeLaune et al., 1992
Rigolets	1963-1992	Saline	^{137}Cs	0.77 ± 0.09	DeLaune et al., 1992
Caernarvon	1963-1992	Freshwater	^{137}Cs	0.75 ± 0.12	DeLaune et al., 1992
				Avg. = 0.74	

** personal communication, Mr. Del Britsch, New Orleans District, U.S. Army Corps of Engineers*

Using this average accretion rate and the water level increases associated with sea level rise (post the SLR baseline year of 2011, see Figure 1), the cumulative accretion and cumulative water level rise were calculated for each year within the project life. The accretion deficit may then be calculated as the difference between the cumulative water level rise and the cumulative accretion. Based on those calculations, the collapse criteria were determined (Table 3).

Figure 1. Shell Beach predicted relative sea level rise estimates.

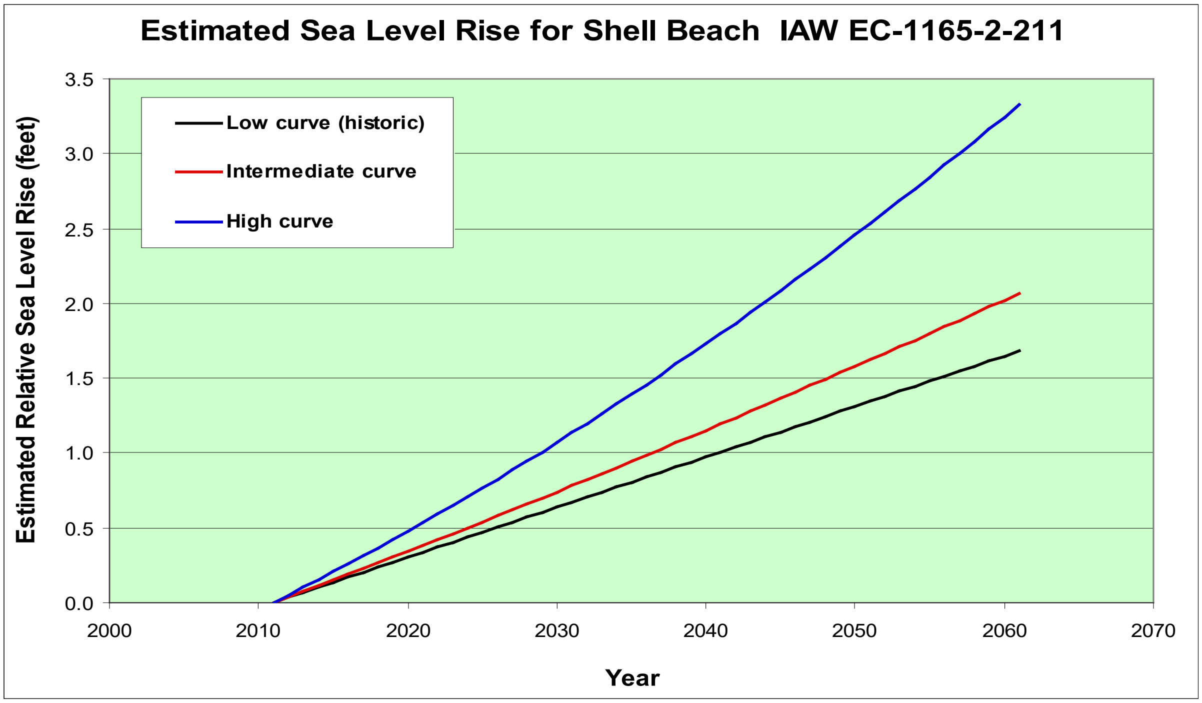

Table 3 Years when marsh collapse is predicted to begin.

SLR Scenario	Year Marsh Collapse Begins		
	INT marsh	BR marsh	SAL marsh
Med SLR	**	2058	2054
High SLR	2044	2035	2033

** *collapse occurs beyond the 50-year project life*

According to this analysis, marsh collapse would begin in 2033 and 2035 for saline and brackish marshes, respectively, under the High RSLR scenario. Under the medium SLR scenario, collapse would begin in 2054 and 2058 for saline and brackish marshes, respectively.

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