Appendix A

TERREBONNE NON FEDERAL LEVEE MITIGATION:
WETLAND VALUE ASSESSMENT (WVA) MODEL ASSUMPTIONS AND RELATED GUIDANCE
(Revised/Updated: 14 September 2018)

PREFACE

Several of the assumptions set forth in this document were based on mitigation implementation schedules. Many sections included specified WVA model target years (TYs) and calendar years applicable to assumptions, and a few sections outlined anticipated mitigation construction (i.e. mitigation implementation) schedules. It was 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 was 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 would 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.

Monitoring reports from 2013 and 2017 were used to determine the Future with Project Conditions (FWP) for many of the variables, especially, V1, V2 and V6. In addition, aerial imagery on Google Earth and from other sources was used to determine site conditions and to project future conditions. These sources were used extensively in determining values for variables V1, V2, and V3. The project baseline conditions occurred in 2010 (TY0) and Target Year 1 (TY1) is 2011. Mitigation area configuration and acreage did not match those in the planning documents, thus the constructed mitigation areas were smaller than originally planned.

3.1 FRESH MARSH MODEL – GENERAL ASSUMPTIONS

V1 – Percent of Wetland Area Covered by Emergent Vegetation

Marsh restore, FWP scenario:

TY	Year	Assumption
0	2013	Baseline conditions.
1	2014	10% credit.
3	2016	50% credit.
5	2018	100% credit.
6	2019	100% credit.

Note: Assumed the created elevation would settle to target grade by TY3. After TY5, cover of the land acres after land loss applied would remain optimal until conditions in the mitigation polygon shift to open water (based on Marsh Mitigation and Impact Spreadsheet calculations).

FWOP scenario:
2010 land rolled forward by applying 3 years of loss.

General Notes:
1. Because the project area was open water, no existing project benefits were considered under FWOP.
2. USGS loss rates derived from a linear regression were applied using a linear loss rate.
3. No containment dikes were included in the marsh acreage as they were assumed to be below the marsh target elevation (surveys were apparently not taken).
4. For the FWP scenario, we subtracted the acreage of any marsh that was below the target elevation. A percentage of the area was above the target range but was included in the marsh acreage.
5. For the FWP scenario, only those portions of earthen retention dikes that fall within the intertidal range were included in the marsh restoration feature acreage. Portions of such dikes that were not degraded such that their crest elevation was equal to the final marsh target elevation were not counted in the acreage of the marsh feature, nor were portions of the dikes that would remain underwater. .
6. The areas were allowed to naturally revegetate.

7. For the FWP scenario, land loss were assumed to begin once the restored marsh feature had settled to the desired target grade. This occured 1 year after the initial construction (dike construction, placement of fill as slurry) has occurred.
8. Impacts from all-terrain vehicle (ATV) usage at the site were mentioned in the monitoring reports and were determined from previously mentioned aerial photography. Only those areas that were within the marsh elevation target range were removed from the acreage used in this variable.
9. Average percent vegetation was calculated using the mid-point of the mean vegetation percentages in the monitoring reports.

V2 – Percent Open Water Area Covered by Submerged Aquatic Vegetation

Marsh restore, FWP scenario:

TY	Year	Assumption
0	2010	Baseline conditions (existing conditions).
1	2011	0%
2	2012	80% Class 1 and 20% Class 3
3	2013	0%
4	2014	80% Class 1 and 20% Class 3
6	2016	80% Class 1 and 20% Class 3
25	2025	60% Class 2 and 40% Class 4
50	2050	25% Class 2 and 75% Class 4

Marsh restore, FWOP scenario:
TY50 (2063) = 30% of baseline

Note:
Submerged aquatic vegetation (SAV) cover estimates were based on the estimated average cover during the peak of the growing season. SAVs do not include floating aquatics (but do include floating-leaf aquatics). Monitoring reports and previously mentioned

General Notes:
Fresh and intermediate marshes often support diverse communities of floating-leaved and submerged aquatic plants that provide important food and cover to a wide variety of fish and wildlife species. A fresh/intermediate open water area with no aquatics is assumed to have low suitability (SI=0.1). Optimal conditions (SI=1.0) are assumed to occur when 100 percent of the open water is dominated by aquatic vegetation. Habitat suitability may be assumed to decrease with aquatic plant coverage approaching 100 percent due to the potential for mats of aquatic vegetation to hinder fish and wildlife utilization; to adversely affect water quality by reducing photosynthesis by phytoplankton and other plant forms due to shading; and contribute to oxygen depletion spurred by warm-season decay of large quantities of aquatic vegetation. These effects are highly dependent on the dominant aquatic plant species, their growth forms, and their arrangement in the water column; thus, it is possible to have 100 percent cover of a variety of floating and submerged aquatic plants without the above-mentioned problems due to differences in plant growth form and stratification of plants through the water column.

SAV coverage is site specific and should be considered on a case-by-case basis. However, in an attempt to provide some general assumptions, the following project specific conditions should be considered when assessing SAV coverage for FWP and FWOP:

- Water depth
- Project area location: inland/protected vs. open to lake or bay processes
- Salinity levels
- Nutrient input (e.g. within diversion outfall area)
- Rate of land loss and relative sea level rise (RSLR)

Restoring marsh within open water areas will reduce wave fetch, increase shallow open water and buffer inland areas increasing tidal lag. Generally, SAV coverage should increase as a result. In some cases existing conditions are already optimal for SAV coverage and, therefore, under FWP conditions percent cover should be maintained.

Consideration of the rate of land loss and RSLR for the project life should also be factored in. For FWOP, an area supporting SAV coverage will likely continue to experience subsidence and marsh loss resulting in reduced SAV coverage, and potentially reaching a point of habitat collapse where SAV is not supported. While under FWP conditions the area will continue to experience subsidence and marsh loss, it is assumed that the rate of loss has been reduced as a result of bringing in external sediment.

Average percent SAV was calculated using the mid-point of the mean SAV percentages in the monitoring reports.

V3 – Marsh Edge and Interspersion

Marsh restore, FWP scenario:

TY	Year	Assumption
0	2010	100% Class 5.
1	2011	50% Class 3 and 50% Class 4
2	2012	80% Class 1 and 20% Class 3
3	2013	80% Class 1 and 20% Class 3
4	2014	80% Class 1 and 20% Class 3
6	2016	80% Class 1 and 20% Class 3
25	2025	60% Class 2 and 40% Class 4
50	2050	25% Class 2 and 75% Class 4

Notes:
When assigning SI values to Variable V3, the percent marsh values (Variable V1) was considered and interspersion classes developed accordingly. The previously mentioned aerial photographs and monitoring reports were used to develop the classes.
Between TY6 and TY50, professional judgment coupled with land loss projections were used to determine appropriate SI values.

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

Marsh restore, FWP scenario:

TY	Year	Assumption
0	2010	Baseline conditions (existing conditions).
1	2011	Any marsh lost becomes shallow open water.
2	2012	Any marsh lost becomes shallow open water.
3	2013	Any marsh lost becomes shallow open water.
4	2014	Any marsh lost becomes shallow open water.
6	2016	Any marsh lost becomes shallow open water.
25	2025	Any marsh lost becomes shallow open water.
50	2050	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	2010	Baseline conditions (existing conditions).
1	2011	0.0001 (supratidal; retention dikes not gapped or degraded)
2	2012	0.0001 (supratidal; retention dikes have been gapped or degraded)
3	2013	0.0001 (supratidal; retention dikes have been gapped or degraded)
4	2014	0.0001 (supratidal; retention dikes have been gapped or degraded)
6	2016	1.0 (intertidal)
25	2025	1.0 (intertidal)
50	2050	1.0 (intertidal)

Note: Gapping was based on actual gapping operations.

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

3.3 BRACKISH MARSH MODEL – GENERAL ASSUMPTIONS AS THEY DIFFER FROM FRESH MARSH MODEL 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)
2010	0 (baseline)			
2011	1 (supratidal)	10%	5%	0%
2013	3 (supratidal)	25%	17.5%	15%
2015	5 (intertidal)	100%	50%	50%
2016	6 (intertidal)	100%	100%	100%

Note: Assume 7-ft center planting densities.

V2 – Percent Open Water Area Covered by Submerged Aquatic Vegetation

Marsh restore, FWP scenario:

TY	Year	Assumption
0	2010	Baseline conditions (existing conditions).
1	2011	0%
3	2013	0%
5	2015	Same as baseline conditions.
6	2016	Increase baseline by 10%, then maintain this through TY25 (i.e. SI value plateaus).
25	2025	See guidance for TY6.
50	2050	25% of baseline conditions.

Marsh restore, FWOP scenario:
TY50 (2063) = 15% of baseline conditions.

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.

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.

3.6 MARSH MODELS – MODEL TARGET YEARS

Future With Project Condition (FWP)

TY	Year	
0	2010	Baseline conditions
1	2011	Initial construction activities begin and are completed. No plants installed. V1 = 10% credit V2 = 65% aquatic vegetation V3 = 100% Class 5. V4 = 100% shallow open water V6 = 0.0001
2	2012	Brackish marsh feature settles to desired target grade. Any associated perimeter containment dikes are degraded or gapped. Plants installed in brackish marsh features V1 = 19.5% credit. V2 = 65% aquatic vegetation V3 = 50% Class 3 and 50% Class 4. V4 = 100% shallow open water. V6 = 0.0001
3	2013	V1 = 67.5% credit V2 = 82.5% aquatic vegetation V3 = 80% Class 1 and 20% Class 3. V4 = 95% shallow open water. V6 = 0.0001
4	2014	V1 = 70.02% credit. V2 = 82.5% aquatic vegetation V3 = 80% Class 1 and 20% Class 3. V4 = 95% shallow open water. V6 = 0.0001
6	2016	V1 = 87.2% credit V2 = 82.5% aquatic vegetation V3 = 80% Class 1 and 20% Class 3. V4 = 85% shallow open water. V6 = 1.0
25	2025	V1 = 68.5% credit V2 = 35% aquatic vegetation V3 = 60% Class 2 and 40% Class 4.

		V4 = 40% shallow open water. V6 = 1.0
50	2050	End period of analysis. V1 = 39.95% credit V2 = 35% aquatic vegetation V3 = 25% Class 2 and 75% Class 4. V4 = 30% shallow open water. 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.

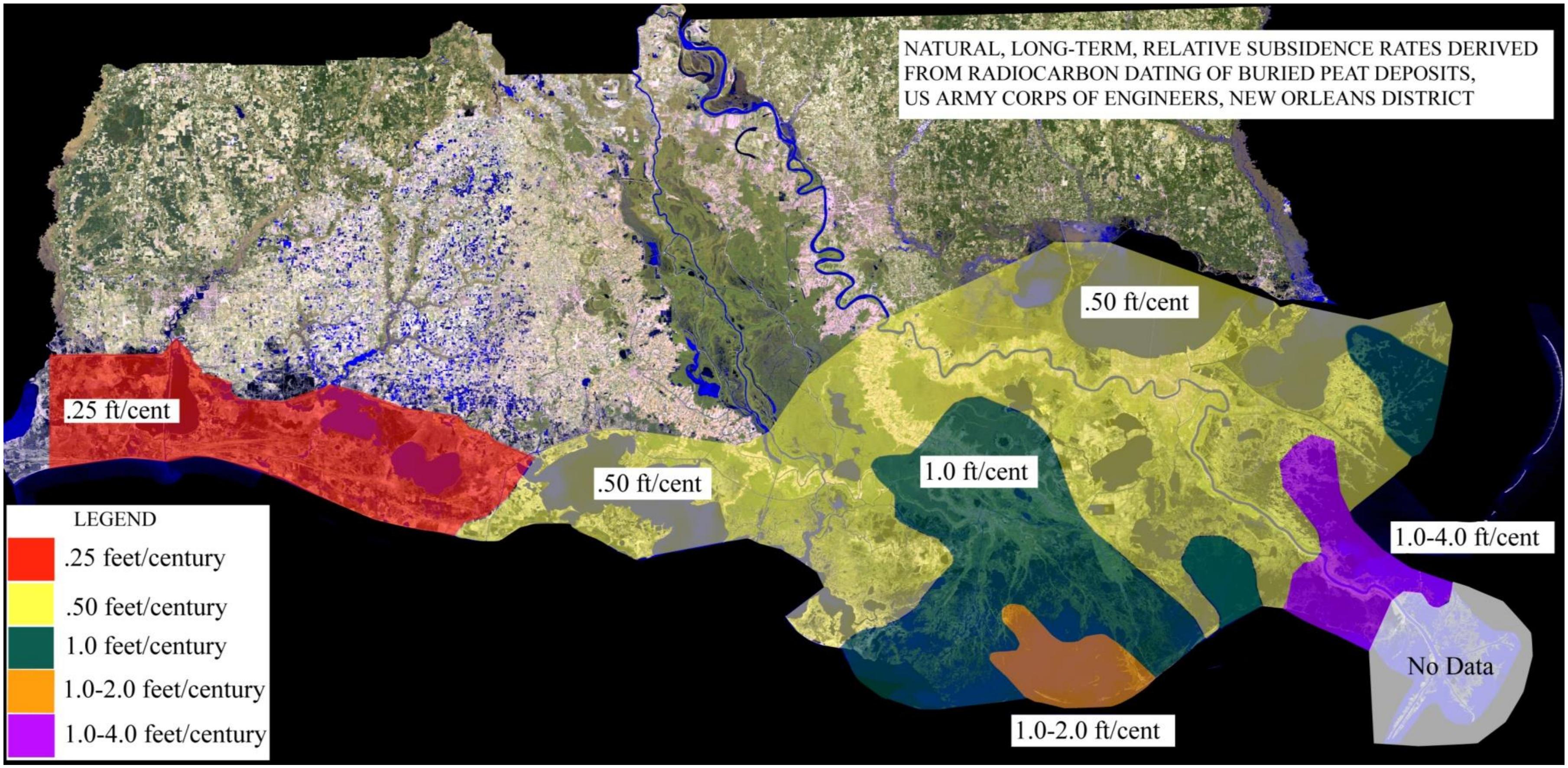

Figure 1. Long-term relative subsidence rates.