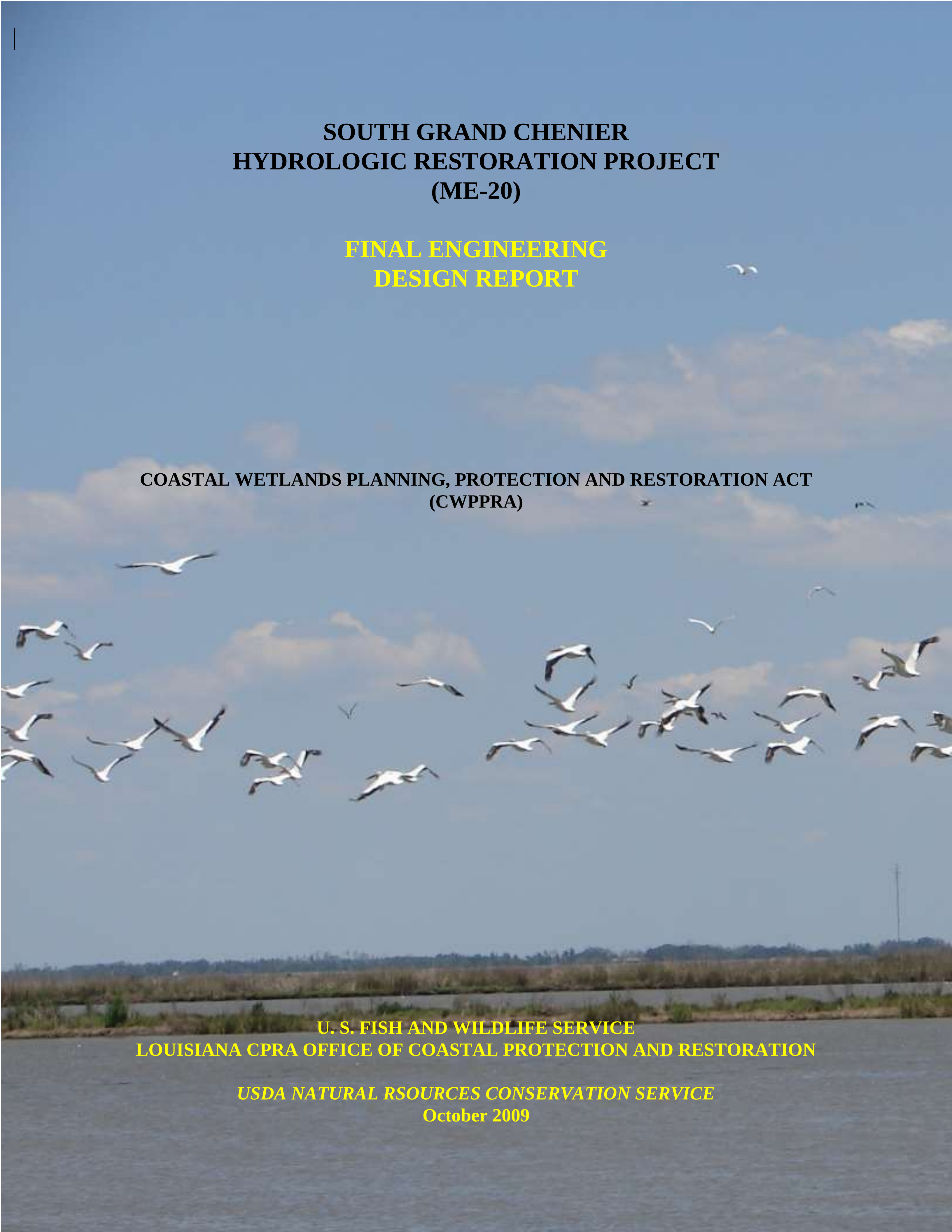

SOUTH GRAND CHENIER
HYDROLOGIC RESTORATION PROJECT
(ME-20)

FINAL ENGINEERING
DESIGN REPORT

COASTAL WETLANDS PLANNING, PROTECTION AND RESTORATION ACT
(CWPPRA)

U. S. FISH AND WILDLIFE SERVICE
LOUISIANA CPRA OFFICE OF COASTAL PROTECTION AND RESTORATION

USDA NATURAL RSOURCES CONSERVATION SERVICE
October 2009

SOUTH GRAND CHENIER HYDROLOGIC RESTORATION PROJECT (ME-20)
FINAL ENGINEERING DESIGN REPORT

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REPORT

SOUTH GRAND CHENIER HYDROLOGIC RESTORATION PROJECT (ME-20)
CAMERON PARISH, LOUISIANA

I. INTRODUCTION:

Final Design Report Contents - According to the Coastal Wetlands Planning Protection and Restoration Act Standard Operation Procedures, the following items should be included in the final design report; 1) a revised cost estimate, 2) revised Wetland Value Assessment, 3) statement of constructability, 4) draft Operation and Maintenance Plan, 5) semi-final plans and specifications, 6) description of differences in Phase I and Phase II project features, 7) response to 30% design review comments, and, 8) other supporting data (geotechnical, survey, wave analysis, modeling and other reports and data) (CWPPRA SOP, Section 6(h), page 19). For purposes of this final report we also incorporate the Preliminary Design Report and its attachments (NRCS and FWS 2009).

Project Background - The South Grand Chenier Hydrologic Restoration project is located south of Grand Chenier, Louisiana, in Cameron Parish, between Louisiana Highway 82 and Hog Bayou in the Hog Bayou Watershed. The major environmental problem in the Hog Bayou Watershed is land loss caused by failed agricultural impoundments and pump-offs. Other problems include saltwater intrusion from the Mermentau Ship Channel construction and a Gulf shoreline erosion rate of 40 feet per year. Over a period of 60 years, 9,230 acres (38% of the original marsh) was lost, with the greatest amount of land loss occurring between 1956 and 1974. The major contributors to land loss in the watershed are subsidence, compaction, and the oxidization of marsh soils in the former pump-offs, and leveed agricultural areas between Hog Bayou and Highway 82. Large areas of marsh south of Highway 82 were "forced drained" during the 1960s, 1970s, and 1980s. Many of these same areas now consist of open water with very little wetland vegetation. The largest area of current loss is in a failed impoundment in the southern part of the project area (Louisiana Coastal Wetlands and Restoration Task Force and Wetland Conservation and Restoration Authority 1999).

The South Grand Chenier project was approved by the LA Coastal Wetlands Conservation and Restoration Task Force on Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) Priority Project List 11. The United States Fish and Wildlife Service (USFWS) is the Federal sponsor and the Louisiana Office of Coastal Protection and Restoration (OCPR) is the local sponsor. The Department of Agriculture, Natural Resources Conservation Service is responsible for assistance with engineering, design and construction.

The project's goals are to, 1) nourish or enhance emergent marsh with freshwater, nutrients, and some sediment south of Highway 82 via fresher water from the Mermentau River, and 2) restore marsh via dedicated dredging from the Gulf of Mexico.

The conceptual project (Phase I) consisted of freshwater introduction from the Mermentau River at two locations (BP Plant and the Dr. Miller Canal) to brackish marshes south of Hwy 82 and marsh creation using dredged material from the Gulf. That conceptual plan proposed to restore approximately 400 acres from dredged material placement and nourish or enhance an additional 4,000 acres of emergent marsh through freshwater introduction.

The proposed 95% design is based on the geotechnical investigation/analysis, hydrodynamic modeling report, and historical knowledge of existing similar projects.

II. RECOMMENDED PROJECT FEATURES:

The project features include maintaining the Dr. Miller Canal to flow low salinity Mermentau River water from Upper Mud Lake across Hwy 82 via culverts under that highway. The project also includes the restoration of 452 acres of marsh in two cells via dedicated dredging in the Gulf of Mexico 4 miles south of the project area (Table 1). The existing Dr. Miller Canal freshwater introduction channel will have a 40 foot-wide bottom width, 2:1 side slopes, with the bottom elevation at - 3.0 feet NAVD 88 and be fully contained by levees east and west of the channel (Table 1). Corrugated aluminum culverts will be installed at 13 natural drainage areas along the canal to provide drainage from the adjacent marsh to the freshwater introduction channel. The hydrodynamic modeling report concluded that a Dr. Miller channel bottom elevation of - 3.0 feet NAVD 88 would flow sufficient freshwater southward to reduce salinities in target marshes. The - 3.0 foot elevation was also chosen because the top of the Bridgeline Holdings pipeline crosses that channel at an elevation of - 5.0 feet NAVD 88, and a minimum of 2 feet of cover must be maintained over this pipeline.

Table 1: South Grand Chenier Hydrologic Restoration Project Features.

<u>Channel Improvements</u>

- Widen, deepen, levee, and install 1-way flapgated drainage culverts in the Dr. Miller Canal (20 feet X 4 feet deep; - 3 feet NAVD) and install 4, 42 inch-diameter culverts under the Grand Chenier ridge and Hwy 82.

<u>Structures</u>

- Install/replace a 3 barreled, 48-inch diameter control structure with flapgates at the Dr. Miller Canal and Upper Mud Lake to flow water north and south.
- Install plugs and 2, 48 inch-diameter culverts in the east-west waterway at its intersection with the Dr. Miller Canal and maintenance dredge that canal to its terminus.
- Install levees and 1-way flapgated 36-inch-diameter drainage culverts (at 9 natural drainage areas) on each side of the Dr. Miller Canal.
- Extend the Dr. Miller Canal 50 to 150 feet southeastward to enable culverts to be installed southward without bends in the pipe.
- Install 4, 42-inch diameter culverts with 1-way south flowing flapgates under Grand Chenier and Hwy 82.
- Place 48 inch-diameter culverts or openings in board roads in Area B, and

flapgated culverts in the Miller-McCall levee for freshwater flow to Areas B and C south of Hwy 82.

Marsh Restoration

- Restore 170 acres of marsh in southeast Area C and 282 acres of marsh east of Second Lake from Gulf dredged material.

To convey freshwater through the Dr. Miller Canal channel to the marshes south of Hwy 82, one option in the original conceptual plan (Phase I) was to enlarge a 4,000 linear foot drainage ditch east of the Dr. Miller Canal and construct a 1,200 foot-long open channel from that drainage ditch southward to Hwy 82 at Canic's Pond. Another option was to construct a 1,275 linear foot channel from the Dr. Miller Canal southward to Hwy 82. The open channel was abandoned due to landowners' objections. To satisfy this objection, 4, 42 inch-diameter 1,275 foot-long culverts were chosen to provide the same volume of freshwater as a channel for this system to function properly. Extending the Dr. Miller Canal up to 150 feet eastward to eliminate the need for a 120 degree angle in the 4 culverts would reducing the long-term maintenance problem of debris collecting in the elbow.

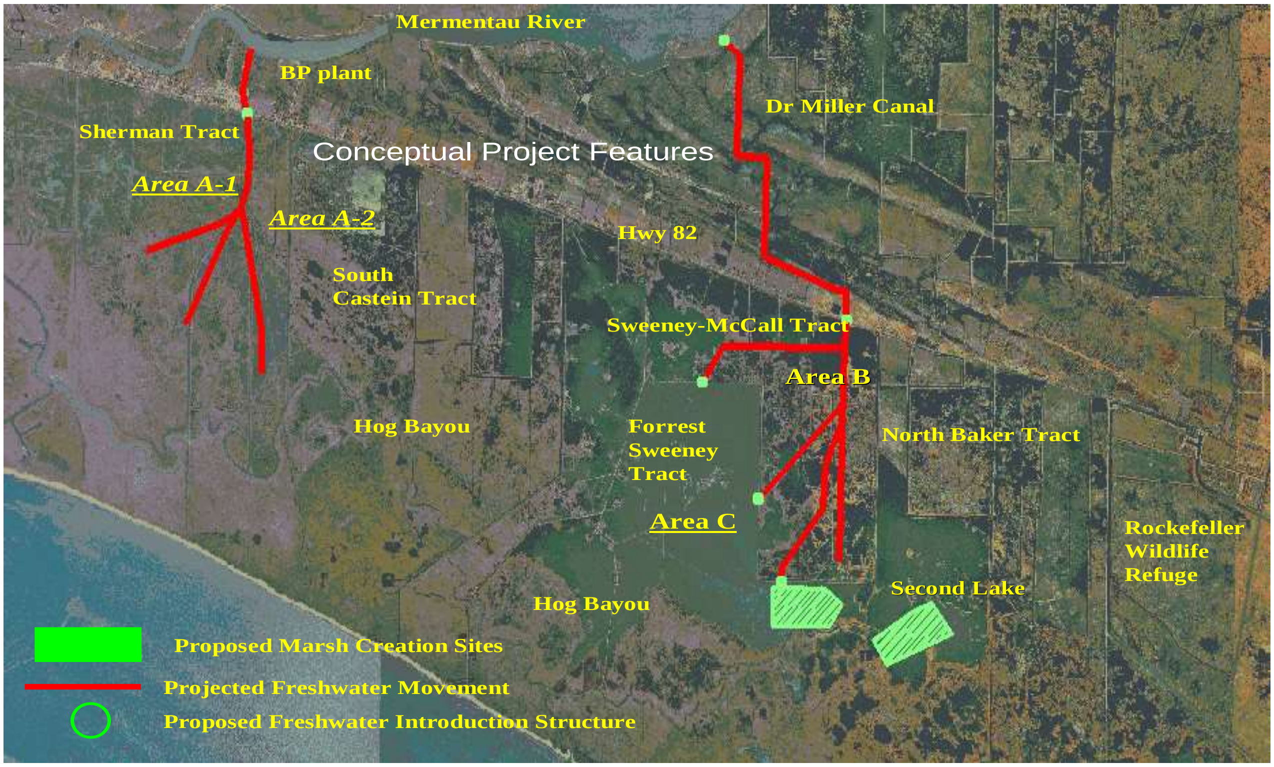
The original conceptual plan, supported by the modeling report, recommended jacking 3, 60 foot-long 48 inch-diameter culverts under Hwy 82. To maintain the required capacity for this system, 4, 1,275 foot-long 42 inch-diameter culverts will be installed under Grand Chenier ridge and Hwy 82. Three culvert design alternatives were considered; 1) a 36 inch-diameter reinforced concrete culvert ($190 per linear foot), 2) a 42 inch-diameter steel culvert ($320 per linear foot), and 3) a 42 inch-diameter High Density Polyethylene (HDPE) culvert ($200 per linear foot).

Four, 42 inch-diameter HDPE culverts will be installed to pass freshwater under Hwy 82 to the brackish emergent marshes south of that highway. HDPE pipe was chosen because a solid weld without joints can be obtained that will not deteriorate from exposure to salt water. The State Department of Transportation and Development (DOTD) requires that jacking pipe under a State highway in this part of the State be solid (no jointed pipe) from right-of-way to right-of-way. The HDPE pipe can be fusion welded to eliminate joints. The bottom invert elevation for the 42 inch-diameter HDPE pipe is - 4.0 feet NAVD 88 due to the need to maintain a minimum of one foot clearance between the Tennessee Gas pipeline and the top of the HDPE pipe.

Jacking and boring pipe and open cut pipe installation were methods considered to install the pipes under Hwy 82. A by-pass road would have to be constructed to keep Hwy 82 open to traffic with the open cut construction method. Jacking and boring was selected as the preferred alternative because it is less expensive and less impacting to traffic flow than the open cut method.

It is recommended that approximately 452 acres of marsh be restored in shallow open water by placement of dredged material in two containment areas north and south of Hog Bayou as indicated on the project map (see Figure 1).

Figure 1: South Grand Chenier Hydrologic Restoration Project Conceptual Features.



South Grand Chenier Control Structure Operation Schedule

- Freshwater Introduction - Open the Dr. Miller Canal-Upper Mud Lake structure to flow water southward when Mermentau River salinities are less than or equal to 5 parts per thousand (ppt), rainfall/storm conditions permitted, and water levels are at or below marsh level in marshes adjacent to the channel. (Gage No. 3 2002-2003 salinity data from the modeling study indicated that salinities were at or below 5 parts per thousand (ppt) 75% of the time.)

- Freshwater Introduction Stopped - Southward freshwater flow at the Upper Mud Lake-Dr. Miller Canal structure would be stopped and flow northward to Upper Mud Lake and southward across Hwy 82 permitted when Mermentau River salinities are greater than 5 ppt, or when the area is threatened with heavy rainfall/storm events.

- Miller Management - Structures in Miller-McCall levee bordering Area C south of Hwy 82 will be closed to prevent freshwater inflow during marsh management drawdown events from March through June every third year.

Marsh Management Plans – Area C is currently managed by the Miller-Yentzen management plan. That plan included refurbishment of the levees between Areas B and C and the levee north of Hog Bayou that forms Area C's southern boundary, and the installation of 3, 48 inch-diameter flapgated culverts with variable crest weirs located in the southern Hog Bayou levee to control

Area C water levels. The Baker Tract management plan includes the maintenance of levees between Area B and the Baker Tract and along the southern and eastern border of the Baker Tract in addition to the installation of 4, 24 inch-diameter flapgated culverts with variable crest weirs in the southern levee north of Second Lake. Safety provisions include, 1) a 12 part per thousand (ppt) salinity target level, 2) a water level target of + 4 inches above marsh level, and, 3) a storm safety provision that permits all flapgates to be raised and stoplogs removed prior to the approach of storms (Table 2).

Monitoring and Operation - Structure monitoring and operation will be performed through the State Coastal Protection and Restoration Authority, Office of Coastal Protection and Restoration, if the project is approved for construction. Monitoring for structure operations will consist of continuous salinity and water level recorders placed at the Dr. Miller Canal-Upper Mud Lake intake structures, the Dr. Miller Canal, and continuous water level recorders placed in the marshes adjacent to Dr. Miller Canal. Data from the monitoring recorders will be transmitted to a common website for access by project managers, the parish engineer, and local drainage district.

Table 2: Miller Yentzen and Baker Tract Marsh Management Plan Operation Schedules

Dates	**Structure Configuration**	**Management Objective**
Non-Drawdown Year (2 of 3 years)		
February 1 - October 31st	Flapgates locked open and stoplogs removed	Maintain water exchange
November 1 – January 31st	Flapgates locked open; stoplogs set no higher than average marsh elevation (1.2 feet NAVD); stoplogs on one culvert removed completely (Baker Tract).	Maintain water level from 0 to – 0.5 feet marsh level.
Drawdown year (every 3rd year)		
February 1 – May 31st	Flapgates operating and stoplogs removed	Maintain water level between 12 and 16 inches below marsh level.
June 1 – October 31st	Flapgates locked open and stoplogs removed	Maintain water exchange
November 1 – January 31st	Flapgates locked open; stoplogs set no higher than average marsh level; stoplogs on one culvert removed completely (Baker Tract).	Maintain water level from marsh level to – 0.5 feet marsh level.

Drainage Concerns Addressed - The following project features were designed to reduce drainage concerns for the areas east and west of the Dr. Miller Canal expressed by the Cameron Parish Gravity Drainage District for the Grand Chenier area (Table 3).

Table 3: List of Features that Address Drainage Concerns.

- Project will add 4, 42 inch-diameter culverts at Hwy 82 to provide additional drainage southward across Hwy.
- The levee on each side of canal will prevent Mermentau River water from entering adjacent marshes north of Hwy 82.
- Culverts with 1-way flap gates will maintain normal drainage of areas adjacent to Dr. Miller Canal, but not drain marshes.
- Drainage Northward – Drainage northward will also occur, if head differential exists, during storm/heavy rainfall events by closing southward flow at the Dr. Miller Canal and Mermentau River at Upper Mud Lake.
- Modeled Dr. Miller canal water levels were + 1.0 to + 2.0 feet NAVD, or + 0.8 to + 0.5 feet above marsh (marsh level = + 1.2 feet to + 1.5 feet. NAVD)

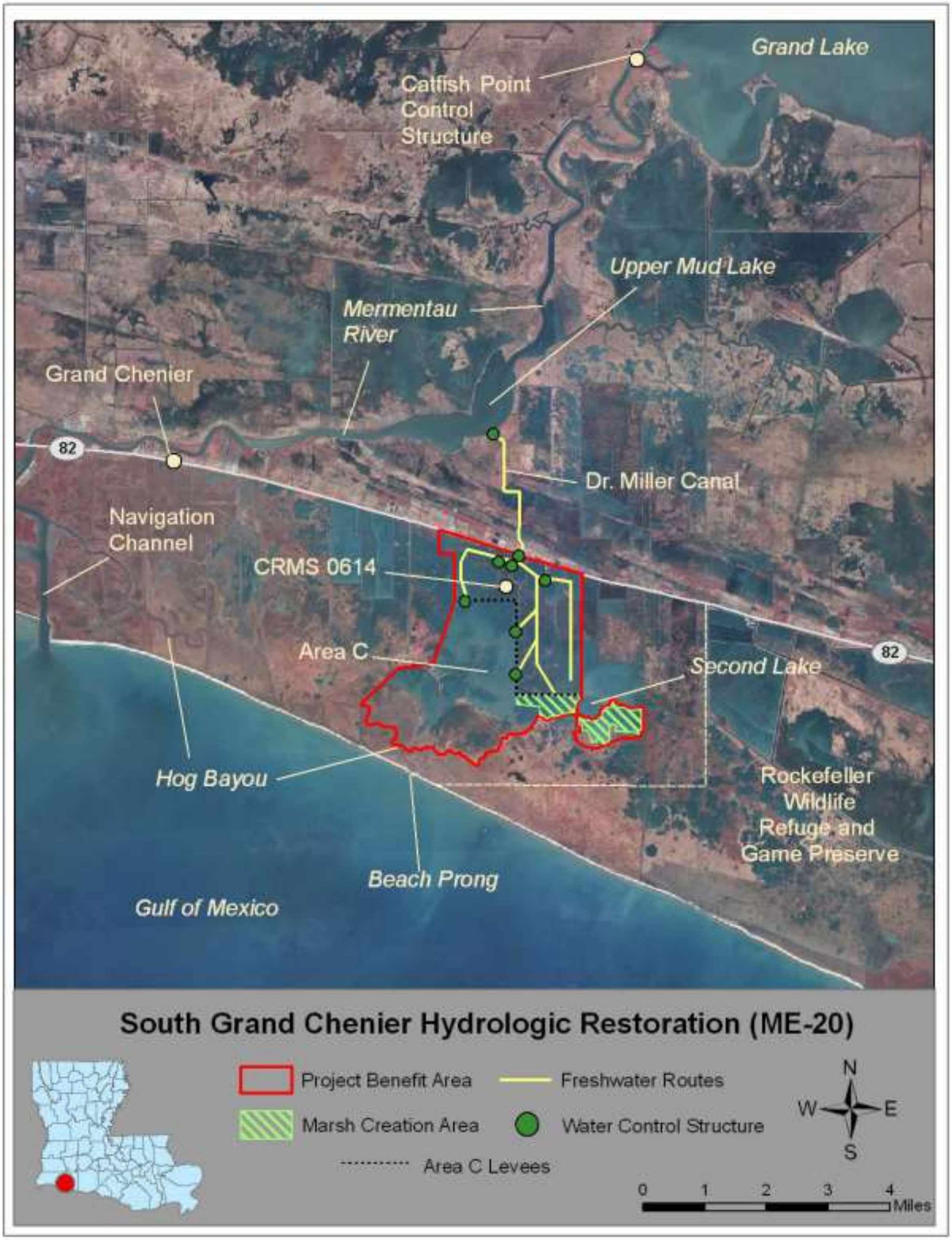
III. DISCRIPTION OF CHANGE FROM PHASE I APPROVAL:

The major feature change from the approved conceptual project (Phase I) is the removal of the Area A (BP Plant) freshwater introduction area. According to the Hydrodynamic Modeling Report (Attachment G), the Area A “BP Canal” project component showed no salinity reduction benefits to target area marshes. In some instances, that feature increased area salinities. Therefore it was eliminated by the Project Management Team (Table 1, Figure 2).

The conceptual project consisted of installing 24-inch diameter culverts every 500 feet in the Dr. Miller Canal levees (spoil banks) to provide drainage of adjacent marshes and Chenier. The revised project features consist of installing 9, 36 inch-diameter culverts placed in natural drains or low areas to provide adequate drainage. The planned two to four 48 inch-diameter culverts through Grand Chenier ridge and under Hwy 82 were replaced with four 42 inch-diameter culverts due to the need to maintain sufficient cover between the culverts and the highway.

The original conceptual drainage ditch improvement route from the Dr. Miller Canal terminus 4,000 feet eastward to Canic’s Pond then southward across Hwy 82 has been removed. Instead, a more direct southerly route has been chosen consisting of extending the Dr. Miller Canal 50 to 150 feet southeastward and installing 4, 42 inch-diameter culverts southward from its terminus across Hwy 82. A Gulf of Mexico borrow area was chosen vs. an Upper Mud Lake borrow because of less distance, less landowners, and not having to cross Hwy 82 (Table 1).

Figure 2: South Grand Chenier Hydrologic Restoration Project Revised Features (Lindquist 2009).



V. SEMI-FINAL DRAWINGS:

The 95% Design drawings and specifications are included in Attachment C.

VI. PIPELINE INVESTIGATION:

Three gas distribution pipelines are shown in the semi-final drawings (Attachment C). Two of the pipelines cross the project area roughly parallel to each other on the Grand Chenier ridge and run in an east-west direction. These pipelines are owned by Tennessee Gas Pipeline Company and Gulf South Pipeline Company. The third pipeline is owned by Bridgeline Holdings and crosses the southern portion of the Dr. Miller Canal in an east-west direction. Pipeline information has been provided by each company and has been surveyed by NRCS accompanied by representatives from each pipeline company who assisted in locating their respective pipelines. Preliminary designs have been provided to each company and the company representatives have agreed to the plans. Pipeline Right-of-Way Agreements will be executed with each company in the future.

Additionally, a pipeline owned by Dynegy Pipeline runs roughly in an east/west direction located approximately 1,000 feet south of the Gulf of Mexico borrow area. This pipeline should not affect the project area due to this distance.

VII. GEOTECHNICAL INVESTIGATION AND ANALYSES:

A geotechnical investigation and analysis has been performed by Eustis Engineering (Attachment D). Additional geotechnical analyses were performed by the Corps of Engineers' Engineer Research Development Center (ERDC) to determine borrow area behavioral characteristics (Attachment E). These analyses were used to more accurately determine the in situ borrow volume to slurry fill volume and self weight consolidation of the slurry material for the marsh restoration areas.

The parameters for the earthen containment dikes and the dikes along Dr. Miller Canal were determined from the Eustis Engineering and ERDC geotechnical analyses. The foundation properties of the placement areas were evaluated for settlement and the borrow area was evaluated for dredge slurry characteristics. The reports consist of analyses of settlement, parameters for the marsh creation containment dike, pile supports for the corrugated aluminum pipe installation, stable slopes for the freshwater introduction channel and the settlement/consolidation of the marsh creation areas.

Due to favorable soil properties in the project area, the marsh creation containment dikes will be constructed with in-situ material will have a minimum of + 6.0 foot (NAVD 88) top elevation, a minimum 5 foot top width with side slopes as required. The containment dike volume will be added to the volume of dredged material needed for marsh creation. The water conveyance channel (Dr. Miller Canal) dikes will have a + 5.0 foot (NAVD 88) top elevation, a minimum 4 foot top width with a minimum 3H:1V side slopes, and 15 feet berm width. The culvert placement in board roads and Miller-McCall levee for water flow to Areas B and C will have a minimum 15 foot top width, a minimum top elevation of + 5.0 feet (NAVD 88), and a minimum 3H:1V side slopes.

Corps' Engineering Research Development Center (ERDC) Geotechnical Report Recommendations

The marsh creation areas consist of two units: the east (Second Lake) and the west (Area C). ERDC performed settling analyses for each marsh creation unit using a column settling test to evaluate settlement in each unit [Engineering Manuel 1110-2-5027 (USACE 1987)]. From the test data, the SETTLE model was used to develop settling curves, both turbidity and total suspended solids were measured to develop a flocculent settling curve.

East Marsh Creation Unit (Second Lake) - Two 80 foot-deep soil borings were taken by Eustis Engineering and provided to ERDC to perform the column settling test for the 282-acre east unit (Second Lake). The top 6 feet of soil consisted of organic clay, from 6 feet-deep to 30 feet-deep, the material was gray clay (CH), and from 30 feet-deep to 80 feet-deep the soil consisted of clay with shell fragments. A depth of 30 feet was used as the compressible foundation; half of the consolidation was in the upper 4 feet. From the column settling test and target marsh elevation of + 1.3 feet (NAVD 88), it was determined that 707,200 cubic yards of in situ borrow material would be required with a total fill volume of 2,091,499 cubic yards. From the settling curve, the marsh elevation is predicted to be + 0.92 feet NAVD 88 at TY 20 (Attachment E).

West Marsh Creation Unit (Area C) - Two 80 foot-deep soil borings were taken by Eustis Engineering and provided to ERDC to perform column settling test for the 170-acre west unit (Area C). The top 6 feet of soil consisted of organic clay, from 6 feet-deep to 33 feet-deep, the material was gray clay (CH) and from 33 feet-deep to 80 feet-deep, the soil consisted of clay with shell fragments. A depth of 30 feet was used as the compressible foundation; half of the consolidation was in the upper 4 feet. From the column settling test and target marsh elevation of + 1.3 feet (NAVD 88), it was determined that 355,000 cubic yards of in situ borrow material would be required with a total fill volume of 1,124,491 cubic yards. From the settling curve, the marsh elevation is predicted to be + 0.96 feet NAVD 88 at TY 20 (Attachment E).

This modeling exercise allowed the estimation of dredge material volume and initial dike height at 3-year and 5-year post placement intervals (Tables 4 and 5). In general, the foundation sediment showed low permeability resulting in little consolidation. Analyses of the dredged material displayed slow settling characteristics which would require relative high retention dikes.

VIII. MARSH CREATION DESIGN:

The desired marsh creation target height at 3 years post construction was determined to be + 1.3 feet NAVD 88 by project team members comprised of NRCS, USFWS and OCPR based on NRCS field surveys. Recent project area field surveys established marsh elevations at + 1.2 feet NAVD 88. Fenstermaker and Associates recorded marsh elevations of + 1.5 feet NAVD 88 in their modeling report (Attachment G).

The ERDC marsh creation analyses will be used to more accurately determine the in situ borrow volume to slurry fill volume ratio and self weight consolidation of the slurry fill. The marsh settlement curves as shown in the geotechnical report were used to establish the marsh creation dredged material fill height.

The initial fill height is established at + 4.5 feet NAVD 88 for the East (Second Lake) marsh creation area, and + 4.3 feet NAVD 88 for the West (Area C) marsh creation area to achieve the desired 3 year marsh elevation as determined in the ERDC marsh creation report (Tables 4 and 5). The containment dike alignment was developed as to fully contain the dredge fill material. We plan to add at least 30% dredged material losses to those quantities estimated in Tables 4 and 5, totaling 919,360 cubic yards (707,200 cubic yards + 30%) and 461,500 cubic yards (355,000 cubic yards + 30%) for the East and West areas respectively.

See the semi-final drawings (Attachment C) and geotechnical reports (Attachments D and E) for more detailed information.

Table 4. PSDDF Model Runs – East (Second Lake) Placement Area

In Situ Volume yd³	As Placed Estimated Time to Complete Dredging days	Predicted Effluent Conc.[1] mg/l	Volume Sand yd³	Volume Fines yd³	Volume Total yd³	Void Ratio Fines	Average[2] Sediment Thicknes s ft	Fill Elevation ft	Required Dike[3] Elevation ft	Elevation At 5 years ft	At 3 years ft
700,000	44.2	25.24	8528	2,063,788	2,072,316	9.8748	4.55	4.40	6.40	1.196	1.272
705,000	44.5	25.24	8589	2,077,051	2,085,640	9.8671	4.58	4.43	6.43	1.205	1.281
707,000	44.6	25.24	8614	2,082,353	2,090,966	9.8640	4.60	4.45	6.45	1.208	1.286
707,200	**44.7**	**25.24**	**8616**	**2,082,883**	**2,091,499**	**9.8637**	**4.60**	**4.45**	**6.45**	**1.2088**	**1.3022**
707,500	44.7	25.24	8620	2,083,678	2,092,298	9.8632	4.60	4.45	6.45	1.209	1.323
708,000	44.7	25.24	8626	2,085,004	2,093,629	9.8624	4.60	4.45	6.45	1.293	1.370
709,000	44.8	25.24	8638	2,087,654	2,096,292	9.8609	4.61	4.46	6.46	1.295	1.372
710,000	44.8	25.24	8650	2,090,304	2,098,954	9.8594	4.61	4.46	6.46	1.297	1.374
725,000	45.8	25.24	8833	2,130,007	2,138,840	9.8367	4.70	4.55	6.55	1.325	1.403
715,000	45.1	25.24	8711	2,103,547	2,112,258	9.8518	4.64	4.49	6.49	1.306	1.384
800,000	50.5	25.24	9747	2,327,329	2,337,076	9.7305	5.14	4.99	6.99	1.464	1.550
820,000	**51.8**	**25.24**	**9990**	**2,379,629**	**2,389,620**	**9.7041**	**5.25**	**5.10**	**7.10**	**1.5001**	**1.5886**
825,000	52.1	25.24	10051	2,392,684	2,402,735	9.6976	5.28	5.13	7.13	1.509	1.598
850,000	53.7	25.24	10356	2,457,842	2,468,197	9.6657	5.43	5.28	7.28	1.611	1.703

[1] Assuming a withdrawal depth of 1 ft.
[2] Average sediment thickness is the average, based on the average existing elevation of -0.15 ft.
[3] Assuming 1 ft freeboard and 1 ft ponded depth required.

Table 5. PSDDF Model Runs – West (Area C) Placement Area

In Situ Volume yd^3	As Placed: Estimated Time to Complete Dredging: days	Predicted Effluent Conc.[1] mg/l	Volume Sand yd^3	Volume Fines yd^3	Volume Total yd^3	Void Ratio Fines	Sediment Thickness ft	Fill Elevation ft	Required Dike Elevation[3] ft	Elevation: At 5 Years ft	At 3 Years ft
250,000	15.8	42.33	3,046	817,002	820,047	11.0542	2.99	3.14	5.14	0.875	0.920
275,000	17.4	42.33	3,350	890,177	893,527	10.9398	3.26	3.41	5.41	0.905	0.955
290,000	18.3	42.33	3,533	933,760	937,293	10.8766	3.42	3.57	5.57	0.975	1.027
300,000	18.9	42.33	3,655	962,689	966,344	10.8364	3.52	3.67	5.67	1.014	1.068
350,000	22.1	42.33	4,264	1,105,957	1,110,221	10.6553	4.05	4.20	6.20	1.226	1.288
355,000	**22.4**	**42.33**	**4,325**	**1,120,166**	**1,124,491**	**10.6388**	**4.10**	**4.25**	**6.25**	**1.2402**	**1.3038**
360,000	22.7	42.33	4,386	1,134,355	1,138,741	10.6225	4.15	4.30	6.30	1.255	1.319
400,000	25.3	42.33	4,873	1,247,185	1,252,058	10.5007	4.57	4.72	6.72	1.431	1.502
420,000	26.5	42.33	5,117	1,303,170	1,308,287	10.4447	4.77	4.92	6.92	1.490	1.565
423,000	26.7	42.33	5,153	1,311,545	1,316,698	10.4366	4.80	4.95	6.95	1.499	1.575
423,500	**26.7**	**42.33**	**5,160**	**1,312,940**	**1,318,100**	**10.4352**	**4.81**	**4.96**	**6.96**	**1.5003**	**1.5761**
424,000	26.8	42.33	5,166	1,314,335	1,319,501	10.4339	4.81	4.96	6.96	1.502	1.578
425,000	26.8	42.33	5,178	1,317,125	1,322,303	10.4312	4.82	4.97	6.97	1.505	1.581

[1] Assuming a withdrawal depth of 1 ft.
[2] Average sediment thickness is the average, based on the average existing elevation of +0.15 ft.
[3] Assuming 1 ft freeboard and 1 ft ponded depth required.

IX. BORROW AREA FOR MARSH CREATION FILL MATERIAL:

The marsh creation borrow area is located approximately 4 miles south of the Area C and Second Lake marsh creation areas, in the Gulf of Mexico, south of Grand Chenier, Louisiana.

Magnetometer surveys were performed in the borrow area by T. Baker Smith for Burk Kleinpeter, Inc. The magnetometer survey is included in the Burk-Kleinpeter, Inc. survey report (Attachment B). This survey showed six possible flow lines and/or other obstructions within the proposed borrow area. Each anomaly was investigated individually and found to be insignificant marine debris. Each possible line was re-examined by gradiometer and visually inspected to make a reasonable professional opinion that the anomalies were not major obstructions or pipelines. However caution should be used when dredging around these anomalies.

Borrow Area Wave Refraction Analyses have been completed (Attachment F). Three alternative borrow areas were evaluated in the wave analysis report. Alternative 1 was a 3,000-foot by 3,000-foot area placed seaward of the Dynegy Pipeline and approximately 5 miles south of the marsh creation areas. Based on the wave height and direction the impact on the shoreline would be negligible under average conditions. However 1 and 20 year storms are expected to have a significant impact on the sediment transport. Alternative 1 would involve pumping the fill material a greater distance than Alternative 2 which would increase costs.

Alternative 2 is a trapezoidal shaped 6,000-foot by 1,500-foot area located approximately 4 miles south of the marsh creation areas. This borrow area would have a minor impact on the shoreline, but the wave flux would be smaller than Alternative 1. Alternative 2, because it is closer to the marsh creation areas, would have reduced pumping costs compared to the other alternatives.

Alternative 3 is rectangular shaped 3,850-foot by 1,500 foot area placed seaward of the Dynegy Pipeline and approximately 5 miles south of the marsh creation areas. This borrow site would have the least impact on the shoreline. However to get the required volume of in situ borrow material, an additional 5 feet of cut depth would be required. Alternative 3 would also involve pumping the fill material a greater distance than for Alternative 2, which would increase costs.

Alternative 2 was chosen for the borrow area because its effects on wave height and direction would have a minor impact on the Gulf shoreline south of Grand Chenier. Because the borrow area is one mile closer to the fill areas than the other alternatives, it would have reduced pumping costs. Project benefits would outweigh any borrow site impacts to near shore sediment transport compared to the other sites.

The material required for the two marsh creation areas will be obtained from the borrow site shown on the semi-final drawings (Attachment C). The average depth of cut below the existing Gulf bottom in this area is approximately 15.0 feet which equals to an elevation of -35 feet NAVD 88. The total available in situ volume of material in the borrow area is estimated to be 6,660,000 million cubic yards. The material required for marsh creation is estimated to be 1,380,860 cubic yards (including adding 30%). A safety factor ratio of 4.82:1.0 (6,660,000 CY/1,380,860 CY = 4.82) is generous enough to compensate for any losses that may occur during dredging operations. See ERDC's geotechnical and modeling reports for further information (Attachment E).

X. HYDRODYNAMIC MODELING REPORT:

The hydrodynamic modeling report's goal was to evaluate the various project alternatives' effectiveness of introducing freshwater from the Mermentau River to brackish marshes south of Hwy 82 to reduce salinities and salinity spikes. It also included a combined analysis of the South Grand Chenier Hydrologic Restoration (ME-20) and Little Pecan Bayou Hydrologic Restoration Projects (ME-17) (C. H. Fenstermaker and Associates 2005).

A coupled one and two-dimensional (MIKE FLOOD: MIKE 11 and MIKE 21) numerical computer model was established then initially calibrated and validated for existing project area hydrologic conditions. Direct comparisons of "Base Run" (Existing conditions) and "Conceptual Design Run" (proposed project features) were made including various added scenarios or "runs" (Table 6). The model predicted salinity and water level fluctuations, velocities, and discharges in the project area under various conditions. Salinity transport was computed through an Advection Dispersion (AD) module dynamically coupled with the hydrodynamic model. Seven recording gages collected continuous salinity and water level data from July 2002 to April 2003. The gages were located in the Mermentau River, mouth of the Mermentau Ship Channel, Hog Bayou at

Second Lake, Little Pecan Bayou, and the southern portion of Grand Lake (C. H. Fenstermaker and Associates 2005).

The report evaluated the performance of the proposed freshwater introduction project features, the Dr. Miller Canal and the BP Canal, to convey sufficient freshwater from the Mermentau River to brackish marshes south of Hwy 82 within the South Grand Chenier Hydrologic Restoration Project area (ME-20). The model runs included, 1) the conceptual project, 2) the addition of a weir at the S-shaped Canal in Area A, 3) 22,000 gallon-per-minute (GPM) pumps at the BP Plant and Dr. Miller Canal at Hwy 82, and 4) increasing the number of 48 inch-diameter culverts under Hwy 82 from 2 to 4 (Table 6).

Table 6: South Grand Chenier Project Hydrodynamic Model Runs.

- <u>Conceptual Run</u> – Conceptual project features included.
- Run No. 1 - <u>S-Shaped Canal Weir</u>. - Weir with a sill elevation at 1 foot below marsh level across the S-shaped canal at Hog Bayou.
- Run No. 2 - <u>Model Run with Pumps</u>. - Run No. 1 with 48 inch-diameter pumps (approximately 22,000 GPM) at the BP Plant and Dr. Miller canals and Hwy 82 intersection.
- Run No. 3 - <u>More Hwy 82 Culverts.</u> - Increase Hwy 82 structure capacity from 2, 48 inch-diameter to 4, 48 inch-diameter culverts.

The model concluded that the Dr. Miller Canal freshwater introduction project component was beneficial in reducing salinities in the target area by an average of 60% [from 5 parts per thousand (ppt) to 2 ppt] (Table 7). The model predicted that the BP Canal freshwater introduction project component would not significantly lower salinities in the target marshes; therefore this component was removed from the project. The BP feature did not reduce salinities south of Hwy 82 because salinities in that part of the lower Mermentau River were almost equal to those in Hog Bayou south of the BP target marshes (Table 7) (C. H. Fenstermaker and Associates 2005).

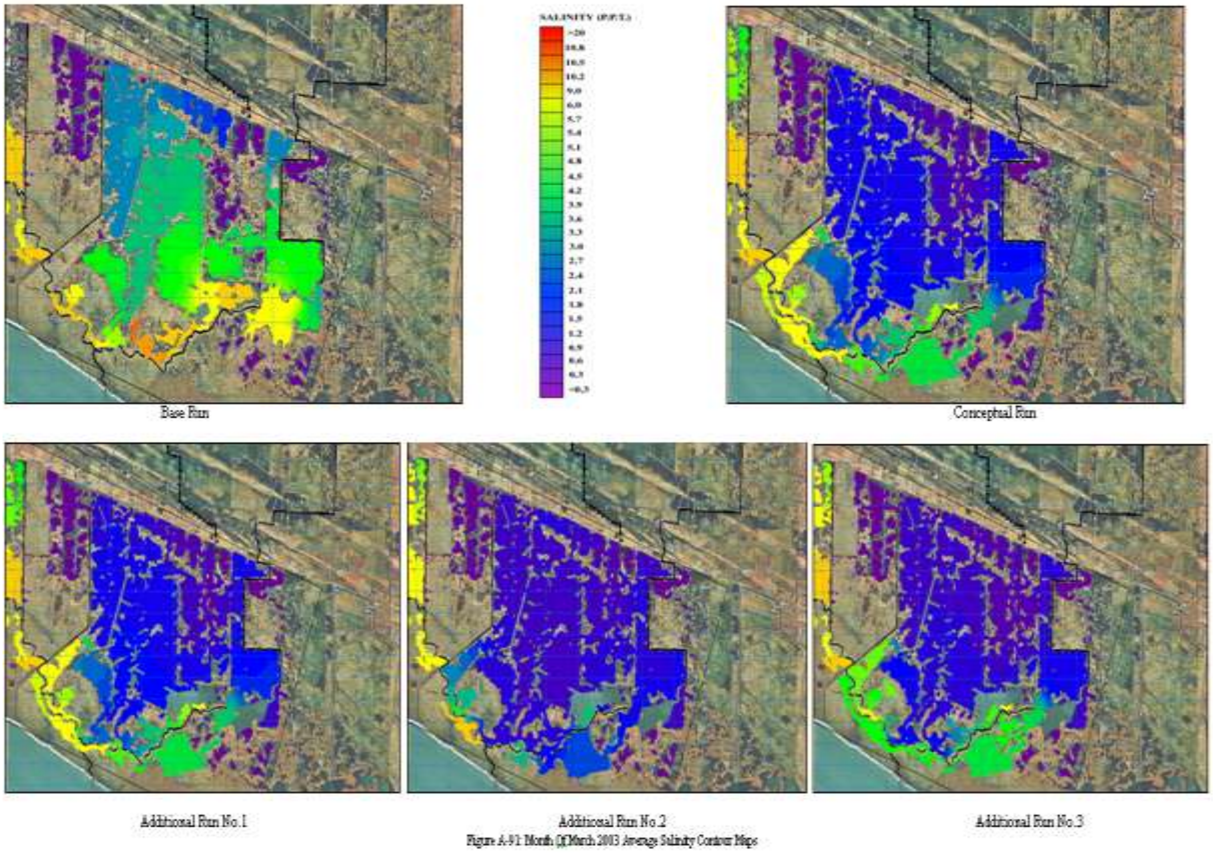
Table 7: Hydrodynamic Model Results of South Grand Chenier Project Alternatives.

- The BP Plant Alternative was not effective in lowering salinities in Area A (Figure 6).
- A weir at the S-shaped canal-Hog Bayou intersection was not beneficial in lowering salinities in Area A (Figure 4).
- Dr. Miller Canal freshwater introduction feature reduced salinities in target marshes an average of 60% (3 ppt) (from 5 ppt to 2 ppt) (Figures 4 and 5).
- Dr. Miller Canal modeled water levels were + 1.0 to + 2.0 feet NAVD 88 (marsh level = + 1.2 feet to + 1.5 feet NAVD 88)
- Pumps delivered water faster with more control, increased water levels more but overall salinity reduction was equal to gravity drainage structures (Figures 4 and 5).
- Increasing the capacity of Hwy 82 structures (from 2 to 4, 48 inch-diameter culverts) reduced salinities slightly more than conceptual run (< 1 ppt; ~ 20%) (Figures 4 and 5).
- The average water level head difference was 0.2 feet.
- The average flow rates through 4, 48 inch-diameter culverts under Hwy 82 were 96 cfs.

<u>Combined Project Conclusions (South Grand Chenier and Little Pecan Bayou)</u>

- Combined project features produced greater salinity reductions beyond original individual project boundaries.
- Running both projects together reduced the head differential and caused less water to flow from north to south especially during highest head periods.

Figure 3: Salinity Contour Maps for the Various South Grand Chenier Project Modeled Alternatives.



Legend: Conceptual run = Preferred alternative with 2, 48-inch culverts at Hwy 82; Run No. 1 = Weir at S-shaped Canal; Run No. 2 = Pumps at Hwy 82; and Run No. 3 = 4, 48-inch culverts at Hwy 82.

Figure 4: Salinities at Second Lake for Various South Grand Chenier Project Model Runs.

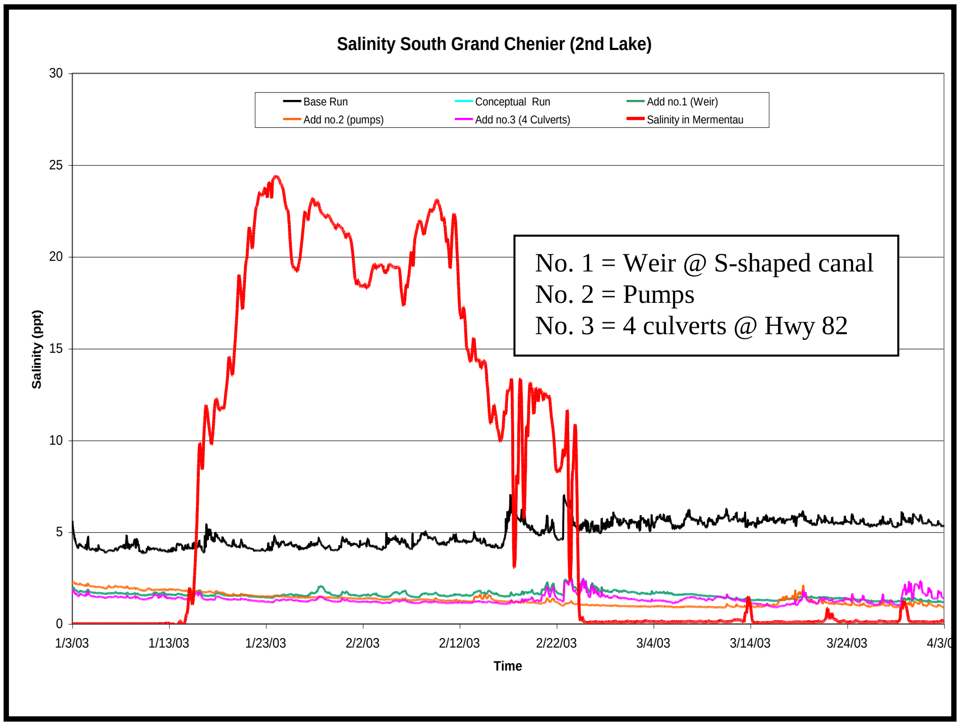
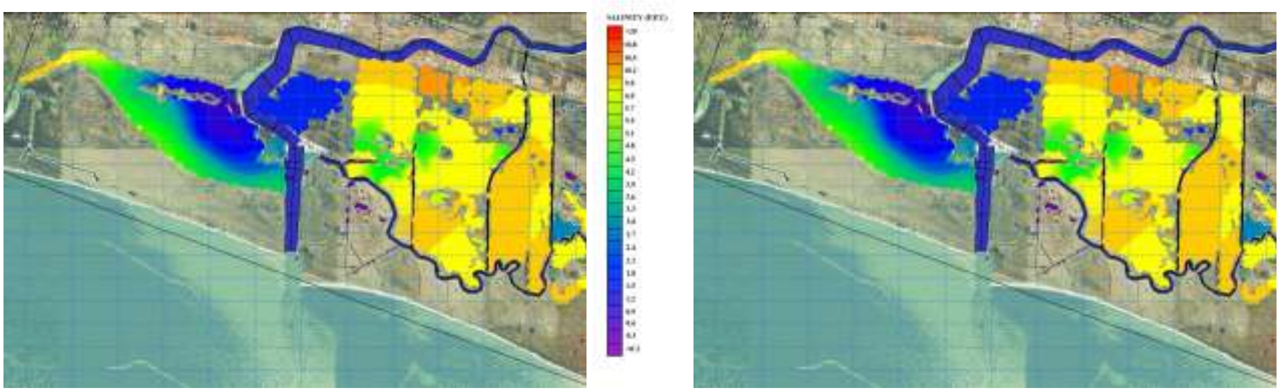
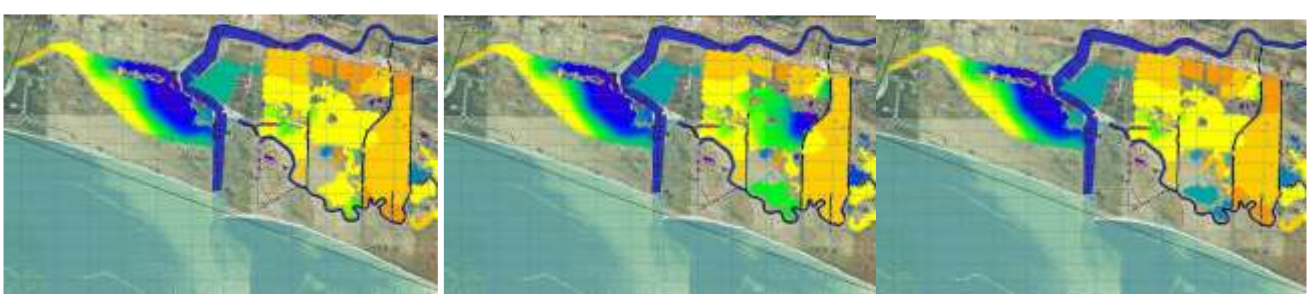


Figure 5: Area A (BP Plant) Salinity Contour Map for March 2003 Modeled Runs.



Base Run Conceptual Plan



Run No. 1 - Weir at S Canal Run No. 2 - Pumps Run No. 3 - 4 Culverts at Hwy 82

XI. ECOLOGICAL REVIEW:

Recommendations

Based on the evaluation of available ecological, geological, and engineering information, and a review of scientific literature and similar restoration projects, the proposed strategies of the South Grand Chenier Hydrologic Restoration (ME-20) project will likely achieve the desired ecological goals. At this time, it is recommended that this project be considered for Phase 2 authorization. However, the following recommendations should improve project success:

- The project's operational plan should be coordinated with the management plan for Area C.

- Plans should be made to further degrade containment dikes and/or reopen trenasses, if needed, to maintain hydrologic exchange to the created marshes (Lindquist 2009).

See the Attachments for the Semi-Final South Grand Chenier Ecological Review report submitted by OCPR (Lindquist 2009).

XII. REVISED WETLAND VALUE ASSESSMENT

The initial Wetland Value Assessment (WVA) completed in 2001 yielded 440 net acres and 322 Aveage Annual Habitat Units (AAHUs). The Phase II revised project scope changed from the original project by removing the BP Plant fresh water introduction component and adjacent project influence area and adding 53 acres of marsh restoration in the at the in the Second Lake site. The revised WVA yielded 352 net acres and 162 AAHUs.

Table 8: Comparison of Original and Revised Wetland Value Assessments

Project Phase	Net Acres	Average Annual Habitat Units (AAHUs)
Candidate Project	440	322
Phase II Revised Project	352	162
Difference	-88	-160

XIII. LAND OWNERSHIP INVESTIGATION:

The State of Louisiana, through its Coastal Protection and Restoration Authority, Office of Coastal Protection and Restoration (CPRA/OCPR) Lands Section provided a landrights report. That report consisted of colored-ownership tract maps and lists of names, addresses and phone numbers of more than 100 landowners in the South Grand Chenier Project (ME-20) area.

Landowner meetings were subsequently held at Rockefeller State Refuge (2003), New Orleans (2003), and the Cameron Prairie National Wildlife Refuge (2006) to present the proposed project features and access routes, and to discuss the hydrodynamic modeling results. The U. S. Fish and Wildlife Service secured letter agreements from all but one of the affected landowners for surveying and geotechnical preliminary field work completed in 2007 and 2008. The OCPR Lands Section obtained a servitude agreement from one undivided landowner for field reconnaissance, surveying, cultural resources and geotechnical investigations (preliminary field work) in the project area.

XIV. SEMI-FINAL DESIGN CONSTRUCTION COST ESTIMATE:

The semi-final construction cost estimate with 25% contingency is **$22,599,900** (Table 9). The total fully funded cost is **$27,936,726.** See Attachments for the detailed fully funded cost estimate developed by the Economic Work Group.

Table 9: Revised South Grand Chenier Project Construction Cost Estimate.

Project:	**South Grand Chenier Hydrologic Restoration (ME-20)**	**Date: 2-Sep-09**		**Revised:**	**25-Sep-09**
Computed by:	**Darryl Clark, Charles Slocum, Darrell Pontiff**	Project Priority List 11			*(ver.080509)*
Item No.	**Work or Material**	**Quantity**	**Unit**	**Unit Cost**	**Amount**
1	Structure Removal	1	LS	10,000	$10,000
2	Pollution Control	1	LS	60,000	$60,000
3	Vegetation Seeding	1	LS	12,000	$12,000
4	Construction Surveys	1	LS	250,000	$250,000
5	Mobilization/Demobilization	1	LS	$2,100,000	$2,100,000
6	Traffic Control	1	LS	$20,000.00	$20,000
7	Pile, 12" Diameter	168	Each	$1,500.00	$252,000
8	Pressure Grouting	1	LS	$100,000.00	$100,000
9	Excavation, Common	15,773	CY	$5.00	$78,865
***10**	Excavation, Marsh Creation Dredging w/ 30% added	1,555,860	CY	$7.00	$10,891,020
11	Earthfill, Containment Dikes Open Marsh Area	209,600 CY (34,298 LF)	CY (LF)	$6.55/CY ($40/LF)	$1,371,920
12	Earthfill	15,773	CY	$5.00	$78,865
13	42" Diameter, HDPE Culvert, SDR 21, Jacking & Boring under Hwy 82	400	Linear Foot	$1,300.00	$520,000
14	42" Diameter, HDPE Culvert, SDR 21	4,160	Linear Foot	$200.00	$832,000
15	48" Diameter, CAP Culvert	600	Linear Foot	$200.00	$120,000
16	36" Diameter, CAP Culvert	840	Linear Foot	$160.00	$134,400
17	Rock Riprap	500	Ton	$75.00	$37,500
18	48" Diameter, Flap Gate	16	Each	$11,000.00	$176,000
19	42" Diameter, Flap Gate	4	Each	$10,000.00	$40,000
20	36" Diameter, Flap Gate	9	Each	$9,000.00	$81,000
21	Timber Fabrication & Installation	1	LS	$30,000.00	$30,000
22	Identification Markers, Staff Gauge Units	269	Each	$450.00	$121,050
23	Contractor's Quality Control	1	LS	$360,000.00	$360,000
24	Geotextile	600	Square Yard	$8.00	$4,800
25	Channel Excavation, Dr. Miller Canal	77,000	CY	$5.00	$385,000
26	Real Time Engineering Monitoring Stations (sondes)	3	Each	$4,500.00	$13,500
	ESTIMATED CONSTRUCTION COST				**$18,079,920**
	ESTIMATED CONSTRUCTION + 25% CONTINGENCY				**$22,599,900**

XV. CONSTRUCTABILITY

The project management team determined that the South Grand Chenier Hydrologic Restoration project is feasible to construct for the following reasons.

Fresh Water Introduction from Upper Mud Lake – The existing Dr. Miller channel provides a feasible conduit for fresh water to be introduced from Upper Mud Lake southward to marshes south of Hwy 82. The existing canal depths are close to that needed to flow water to the 4, 42 inch-diameter culverts under the Chenier ridge. Dredged material from Dr. Miler Canal enlargement is sufficient to build levees adjacent to that canal to prevent Mermentau River water from entering adjacent marshes and pasture land. Discussions and negotiations with pipeline companies who own the three existing pipelines that cross the fresh water introduction route have been completed and special provisions incorporated in the semi-final plans and specifications. It is feasible to jack-and-bore the 4, 42 inch-diameter culverts under Hwy 82.

The Fenstermaker model predicted that the 4, 48 inch-diameter culverts would have an average flow rate of 96 cfs. This assumed that the fresh water would travel to Hwy 82 via a canal. The revised project was revised to install 4, 42 inch-diameter culverts from the southern end of the Dr. Miller Canal southward under Hwy 82 due to landowner's preference for buried culverts vs. an open canal. Because of the size and length (1,275 feet) of culverts (42 inch vs. 48 inch), the flow rate was reduced to 57 cfs. The elevation of Hwy 82 dictated 42 vs. 48 inch-diameter culverts in order to have sufficient fill material between the culverts and highway.

The fresh water will enter Area B south of Hwy 82, then to Area C. Area C and the Baker Tract east of Area B are currently under management. Thus the annual duration of fresh water flow is estimated to be 75% of the year (274 days) minus 40 days/year due to management, for a total of 235 days a year. We feel that the rate and duration is conservative and is large enough to allow significant project fresh water, nutrient and sediment benefits according to the Boustany Nutrient and Sediment and Salinity Productivity models (Clark 2009).

Marsh Restoration – The borrow area is located in the Gulf of Mexico four miles south of the marsh creation sites. Past CWPPRA and other projects have shown that it is feasible to use Gulf borrow areas for marsh and barrier island restoration at a higher unit cost than inshore dredging. Wave analysis conducted indicated that impacts to the existing Gulf shoreline south of the proposed project would be minimal (Coastal Engineering 2008, NRCS and FWS 2009). The Corps ERDC analysis of borrow and disposal site soils concluded that 707,200 cubic yards and 461,500 cubic yards of dredged material would be sufficient for the east and west marsh creation areas respectively to achieve marsh level of 1.3 feet NAVD by year 3 post construction. The dredge discharge pipe will be routed along the borrow pits for the western levee of Rockefeller Refuge's Price Lake Unit.

Landrights – The State OCPR has succeeded in obtaining a number of landrights agreements for the project. The owners of the main property owner (Dr. M. O. Miller Estate) have indicated that they approve of the project concept. Landrights is an issue until final agreements are signed.

XVI. LITERATURE CITED

Clark, D.R. 2009. Revised South Grand Chenier Hydrologic Restoration project (ME-20) wetland value assessment. U. S. Fish and Wildlife Service, Lafayette, Louisiana. 34 pp. + appendices.

Coastal Engineering Consultants, Inc. 2008. South Grand Chenier Borrow Area Wave Refraction Analysis. Report for USDA, NRCS. 82 pp + Appendix.

Eustis Engineering Services. 2009. Geotechnical Investigation ME-20 South Grand Chenier Cameron Parish, Louisiana. USDA Contract No. AG-7217-C-07-0113. Metairie, LA. 16 pp + Appendices.

Fenstermaker, C. H. and Associates. 2005. Hydrodynamic modeling of the South Grand Chenier Hydrologic Restoration Project (ME-20). C. H. Fenstermaker and Associates, Lafayette, LA. 63 pp. + appendices.

Lindquist, D.C. 2009. Draft Semi-Final South Grand Chenier Hydrologic Restoration Ecological Review. LA Office of Coastal Protection and Restoration. Baton Rouge, LA. 9 pp.

Louisiana Coastal Wetlands and Restoration Task Force and Wetland Conservation and Restoration Authority. 1999. Coast 2050: Towards a Sustainable Coastal Louisiana, The Appendices. Appendix F - Region 4 Supplemental Information - Louisiana Department of Natural Resources. Baton Rouge, Louisiana. 226 pp.

Smith, T. Baker and Son. 2008. South Grand Chenier Magnetometer/Sonar Scan Survey. Cameron Parish, LA. Prepared for Burk Kleinpeter, Inc., New Orleans, LA. 4 pp + Attachments.

U. S. Army Corps of Engineers. 2009. Grand Chenier, LA, Marsh Creation - Analysis of Dredge Fill Volume Requirements. Prepared for USDA contract. Engineer Research and Development Center, Vicksburg, MS. 35 pp + appendices.

U. S. Army Corps of Engineers. 1987. Engineering Manual 1110-2-5027.

USDA Natural Resource Conservation Service and U. S. Fish and Wildlife Service. 2009. South Grand Chenier Hydrologic Restoration Project Preliminary 30% Engineering Design Report. NRCS, Alexandria, LA. USFWS, Lafayette, LA. 22 pp + Attachments.

APPENDIX A

OPERATION, MAINTENANCE, AND REHABILITATION PLAN FOR THE SOUTH GRAND CHENIER HYDROLOGIC RESTORATION PROJECT (ME-20)

The Office of Coastal Protection and Restoration (OCPR) and the United States Fish and Wildlife Service (USFWS) agree to carry out the terms of this Operation, Maintenance, and Rehabilitation Plan (hereinafter referred to as the "Plan") of the accepted, completed project features in accordance with the Cost Sharing Agreement No. CWPPRA-00-02, DNR Agreement No. 2511-01-03 dated July 25, 2000 and Amendment No.1 to the Cost Sharing Agreement dated October 29, 2003. (Attachment I).

The project features covered by this plan are inclusive of and are identified as the South Grand Chenier Hydrologic Restoration Project (ME-20). The intention of the provisions of this plan is to maintain this project in a condition that will generally provide the anticipated benefits that the project was based on. There is no requirement that this project function to any standard beyond the economic life; except that it is not left as a hazard to navigation or a detriment to the environment.

Construction of the South Grand Chenier Hydrologic Restoration Project was authorized by Section 303(a) of Title III Public Law 101-646, the Coastal Wetlands Planning and Restoration Act (CWPPRA) enacted on November 29, 1990 as amended. This project was approved on the eleventh (11^{th}) Priority Project List.

The construction components associated with this project are located on land owned by various individuals and the State of Louisiana.

1. <u>PROJECT DESCRIPTION, PURPOSE, AND LOCATION</u>

The South Grand Chenier Hydrologic Restoration Project consists of approximately 7,496 acres in Cameron parish. The proposed location of the project is located in the Mermentau Basin approximately six (6) miles southeast of the community of Grand Chenier between LA Highway 82 and the Gulf of Mexico. (Attachment II).

The purpose of the project is to improve marsh productivity and reduce marsh loss in the project area by introducing freshwater, nutrients, and some sediment from the Mermentau River. In addition, the project will create 452 acres of marsh by dedicated dredging from the Gulf of Mexico. The created marsh will be strategically located to prevent the movement of high salinity water coming from Hog Bayou into the eastern portion of the project area.

The project has a twenty-year (20 year) economic life, which began in January 2011.

2. CONSTRUCTION COMPLETION

The South Grand Chenier Hydrologic Restoration completion report is included in the Attachment III of this plan and "As Built" drawings are included in Attachment IV. Within this completion report is a summary of information and significant events including: project personnel; final as-built project features and benefited acres; construction cost and CWPPRA project estimates; construction oversight costs; construction activities and change orders; pipeline and utility crossing owner information; and other significant milestone dates and comments.

The project "As-Built" construction drawings are updated with all field changes and modifications that occurred.

3. PROJECT PERMITS

Project permit applications were completed and submitted to appropriate agencies and permits were received prior to construction. These permits and permit applications are included in Attachment V. Provisions for renewal of certain Federal and State Permits may be required.

4. ITEMS REQUIRING MAINTENANCE AND REHABILITATION

The following completed structural components project features jointly accepted by OCPR and USFWS will require operation, maintenance, repair, and /or rehabilitation throughout the twenty (20) year life of the project.

A. **Water Control Structures:** 19 - Water control structures with flaps and lock pins
B. **Conveyance Channel:** Approximately 15,000 linear feet of channel upstream of Hwy 82
C. **Conveyance Piping:** Approximately 5,000 linear feet of 42 inch diameter HDPE piping
D. **Monitoring Equipment:** 3 - monitoring stations for operations

5. OPERATION AND MAINTENANCE BUDGET

The cost associated with the Operations, Maintenance, and Rehabilitation of the features outlined in Section 4 of this plan for the twenty (20) year project life is included and summarized in Attachment VI.

6. OPERATION OF STRUCTURES

Operation of the structure in accordance with permit requirements (should it be required) will be performed by persons under contract with the State of Louisiana. A copy of the Operations Agreement is included in Attachment VII.

7. RESPONSIBILITIES - MAINTENANCE AND REHABILITATION

A: OCPR will:

1. In accordance with the Cost Sharing Agreement outlined in Attachment I, assume all responsibilities for maintenance and rehabilitation of the accepted completed project features identified in Section 4.

2. Conduct joint site inspections with USFWS of the project site at least annually and after major storm events if determined to be necessary by OCPR and/or USFWS. OCPR will submit to USFWS, a report detailing the condition of the project features and recommendations for any corrective action. If OCPR recommends that corrective actions are needed, the report will include the entire estimate cost for engineering and design, supervision and inspection, construction, contingencies, and urgency of such actions.

3. Perform or have performed any corrective actions needed, if such corrective actions have been approved by OCPR and USFWS. USFWS will participate with OCPR, or its appointed representative, in the engineering and design phases of the corrective actions for the project. Oversight of engineering and construction of the corrective actions for the project will be the responsibility of OCPR or its appointed representative. At least thirty (30) calendar days prior to the date of formal request for construction bids, OCPR or its appointed representative shall provide final copies of all corrective action designs and specifications for review and concurrence by USFWS. OCPR shall approve the final design and specifications prior to proceeding with bid solicitations on all project corrective action construction contracts in coordination with USFWS. Any plan and/or specification changes both before and after award of construction contracts shall be approved by OCPR in coordination with USFWS.

4. The representatives appointed above shall meet as necessary during the period of construction for corrective actions and shall make such recommendations, as they deem necessary.

5. Provide a total contribution equal to the amount outlined in the Cost Sharing Agreement for the maintenance and rehabilitation cost needed for the twenty (20) year life of the project.

B. USFWS will:

1. Conduct joint site inspections with OCPR of the project site at least annually and after major storm events if determined to be necessary by OCPR or USFWS.

2. Review preliminary design of any operation and maintenance project and provide concurrence prior to formal request for construction bids on any corrective actions for the project.

3. Proved a total contribution equal to the amount outlined in the Cost Sharing Agreement for the maintenance and rehabilitation cost needed for the twenty (20) year life of the project.

The undersigned parties, acting on behalf of their respective agencies, agree to operate, maintain, and rehabilitate the South Grand Chenier Hydrologic Restoration (ME-20) according to this document, referenced Cooperative Agreement, plans, and all applicable permits and laws.

UNITED STATES FISH AND WILDLIFE SERVICE

By: ____ Date: ____________________

Title: ____

OFFICE OF COASTAL PROTECTION AND RESTORATION

By: ____ Date: ____________________

Title: ____

APPENDIX B

Responses to South Grand Chenier Hydrologic Restoration Project (ME-20) 30% Design Review Comments

Responses to Comments Made at the South Grand Chenier Hydrologic Restoration Project (ME-20) 30% Design Review Meeting

After re-reading the modeled conceptual plan, we found that we did indeed model at least part of the Miller-Yentzen Management plan (page 8 of Model). The Miller-McCall levee and 3, 48 inch-diameter culverts installed at 3 locations in the levee were included in the model, but the Miller-Yentzen management structures emptying into Hog Bayou and the closure of the gap at the SE portion of the management plan were not modeled. The gap in the SE part of Area C was effectively closed by the Area C marsh creation cell included in the model. However the existing model run was run without the marsh creation feature blocking salinity at that location. Therefore the future with conceptual model run was run with the management plan without the three 48" diameter culverts located adjacent to Hog Bayou, but with a small opening to that bayou.

The following questions were raised at the 30% Design Review meeting with responses. Rachel Sweeny of NMFS raised most of the following comments.

1. What are the approximate flow rates expected from the Dr. Miller Canal 42 inch-diameter culverts?

   Response - Jason Kroll (NRCS) calculated at the 30% meeting that 100 to 300 cfs could flow through the 3, 48 inch culverts at Upper Mud Lake, but the 42 inch culverts may flow less due to more friction. We recalculated this flow rate based on 4, 42 inch diameter culverts buried 1,200 linear feet below the Chenier using a standard engineering flow rate formula. The 4, 42 inch diameter culverts could flow 57 cfs using a head differential of + 0.20 feet and 1,200 feet long. The Fenstermaker South Grand Chenier Model predicted flow rates of 96 cfs for 4, 48 inch diameter culverts but the culverts were only buried under Hwy 82.

2. How will the freshwater introduction feature be made to be consistent with the Miller and McCall Marsh management plans?

Response - The freshwater would not flow into the Miller area during drawdown periods in the spring to early summer of every 3rd year. Details of the Miller management plan and how the project operation plan may have to be modified to not impact the management plan have been provided.

3. Why are higher slurry heights of 4.3 and 4.5 feet necessary?

Response - The ERDC PSDDF models predicted those heights based on borrow area soils (pages 12 & 13 of Preliminary Design Report).

4. How is the cost of the dredged material to be calculated from the cut or fill?

Response - The cost will be based on the cut plus 30% loss, or a 1 to 1.3 cut to fill ratio.

5. Will the dredged material placement be paid for on the cut or the fill?

Response - Costs will be calculated on the amount of material dredged from the borrow area (or the "cut").

6. How much dredged material would be dredged to fill the two placement areas?

Response - 1,555,000 cubic yards (found in the cost estimate).

7. Would there be levees on both sides of the Dr. Miler Canal and how high?

Response - Yes, they will be 5 feet NAVD to prevent Mermentau River water from entering adjacent fresh marshes.

8. Will there be enough material from maintenance dredging the Dr. Miller Canal to build the levees?

Response - Yes, but this quantity will be recalculated (Charles Slocum, design engineer).

9. Are mob and demob costs sufficient?

Response - These estimates will be reviewed and possibly increased. (These mob and demob costs will be revised.)

10. According to the wave analysis, it may be better to choose Alternatives 1 or 3 than 2 because they are further from the shore and may have less impact to long shore sediment processes.

Response – Rudy Simoneaux stated that the wave analysis predicted that the borrow alternatives would impact long shore transport by increasing sedimentation in the shoreline areas north of the borrow sites. The 15 foot deep borrow site may fill in quickly after dredging. The magnetometer, sonar and geotechnical surveys were all preformed on Alternative 2. That alternative was the preferred borrow area selected by the management team prior to conducting further studies on the borrow site.

11. What does the Contractor's Quality Control include?

Response - It includes all the contractor's monitoring activities (surveys etc.) and daily reports.

12. Will the contractor be doing all of the surveys of the Gulf borrow area?

Response - The contractor will be doing some surveys, but the NRCS will also be conducting surveys.

13. Will there be a full time inspector on site during marsh creation activities?

Response - Yes, NRCS will provide full time construction inspectors.

14. Will the monitoring stations for operation be real time stations?

Response - Yes, we will install real time stations similar to those currently operating for the Hwy 384, Cameron Creole, and the Sabine Structures projects.

Monitoring Stations

2 “Operations Monitoring” stations have been added to the construction and O&M budgets (one in Upper Mud Lake, and one in the Dr. Miller Canal or adjacent marshes). Real time capabilities will be added to the existing CRMS station south of Hwy 82 to provide real time salinity and water level information for structure operations.

Response to EPA’s South Grand Chenier Hydrologic Restoration Project (ME-20) 30% Design Review Comments

> EPA Comment - 1. Finalization O&M procedures will be a critical component of the overall success of the project given the number of control structures associated with the project, particularly given the other wetland management activities identified in the project area. O&M should address maintenance of the guide-levees in addition to the control structures proposed."

Response - The Operation Plan states that fresher water will be allowed to flow southward from Upper Mud Lake through the Dr. Miller Canal when three conditions exist; 1) salinities are at or below 5 parts per thousand (ppt), 2) water levels in the adjacent marshes are at or below marsh elevation (so as not to interfere with area drainage), and 3) storms (tropical storms or hurricanes) are not threatening the area. Fresh water will be stopped from entering the Miller-Yentzen management area south of Hwy 82 once every third year, from March to early summer, when the management area is under drawdown (see attached detailed Operation Plan and Yentzen permit application). The Upper Mud Lake-Miller Canal structures will need to be operated most frequently. The Miller-Yentzen levee structures will only be operated once every 3 years.

The O&M budget has been revised to include maintenance of the Miller Canal levees, and the O&M Plan will include that maintenance.

> EPA Comment - 2. EPA supports the use of an offshore borrow area in place of the previous area identified in Mud Lake. EPA continues to recommend limiting maximum dredging depths, particularly for onshore and coastal borrow areas, to avoid creating areas that may lead to anoxic conditions."

Response - The current borrow area depth plan is to dredge to 15 feet below the Gulf bottom at the borrow site. We expect the Gulf borrow site to fill with new sediment from wave action within a few years. We plan to conduct a borrow area bathymetric survey within 5 years of dredging to determine the rate of refilling.

> EPA Comment - 3. Is any prep work required, such as a bedding material, prior to the installation of the 48”culverts in the conveyance channel?"

Response - The 42 inch-diameter culverts from the end of the Dr. Miller Canal through Hwy 82 will be bedded in a sandy bed material if needed. The design engineer (Charles Slocum) estimates that no bedding material may be needed on the Grand Chenier ridge due to the presence of sandy soils. Sandy bed material may be needed to support the buried culverts south of Hwy 82 to the plunge pool. All other culverts (36 inch-diameter, 48 inch-diameter) will be placed on the ground with pilings for support.

> EPA Comment - 4. It is acknowledged that the current design sheets reflect a 30% draft, but confirm the final drawings include correct pages references for the typical cross-sections identified."

Response - The page references will be corrected in the revised 95% designs.

Response to the Corps of Engineers' South Grand Chenier Hydrologic Restoration Project (ME-20) 30% Design Review Comments

ECOLOGICAL REVIEW

- Corps' Comment - Pg 3, last para – much of the marsh was once impounded – many of the levees seem to have gaps in them now.

Response - The problem may be the interpretation of the word “impoundment”. In our opinion impoundment does not necessarily mean a marsh that is completely walled off from the surrounding marsh, but rather an area where the hydrologic connection with surrounding waters is *restricted* by levees, dikes, structures, etc. The Area B portion of the ME-20 project area is clearly constrained by levees on the western and southern sides with the repair of the breaks by the Miller Management Plan. Area B still has openings to the east and southeast into the area north of Second Lake. However, we will reword the sentence to read: "Because marsh in the ME-20 project area *has been more or less* impounded…".

- Corps' Comment - Pg 4, 1st para – It is a significant deficiency that the April-Oct low water-high salinity period has not been modeled. It is not clear how the marsh creation cells impede saltwater from Hog Bayou. They may stop some water from going south, but not from moving north and west. The last sentence about the flooding caused by the proposed diversion causing significantly decreased productivity is of great concern. The first recommendation on page 6 should become part of the plan.

Response – It is true that the model run period was January to March 2003, a lower salinity period. Continuous salinity and water level data was taken from August 2002 through March 2003. The fall 2002 data was used for model calibration and validation and the winter-early spring 2003 data used for the model runs as is the usual modeling procedure. The model was costly to run and we needed to end the field data collection effort to begin the model calculations in a timely and cost efficient manner.

We do not consider this a significant deficiency to using the model to predict, 1) if the project can flow fresh water southward, and 2) the project's effects on salinities and water levels. Even though the period of model runs was during lower salinities, the model was able to show that, 1) project features were able to flow water across Hwy 82, and 2) those features were able to reduce salinities in the target areas from 5 parts per thousand (ppt) to 2 ppt, a significant 3 ppt, 60% reduction (except for Area A).

Much of the second comment (i.e., the water level impacts and limitations of the modeling effort) was addressed in the 30% Design Review Report and at the August 6, 2009, 30% meeting. The operation plan includes "real time" monitoring of salinities and water levels south of Hwy 82 to alert us to change operations if excessive impoundment becomes a problem.

As for the ability of the marsh creation areas to impede saltwater intrusion, we reference the modeling report results that show that higher salinity water does not traverse the area where the marsh creation cells are placed. In addition, it seems logical that marsh would be better able to impede (i.e., slow or obstruct but not completely block) saltwater intrusion better than the open water that currently exists in the area.

The first Ecological Review recommendation (ER page 6), is part of the project's operation plan as stated in the Preliminary Design Report (pages 3 and 4). The freshwater diversion's effects on the target marshes south of Hwy 82 will be monitored with real time salinity and water level recorders that transmit data to a satellite [i.e., Sabine Structures (CS-23) and Cameron Creole Maintenance projects (CS-04)]. If the diversion causes water levels to rise above marsh level for a significant amount of time, the diversion will be stopped until those levels recede to marsh level or below.

- Corps' Comment - Pg 4, Fig. 2 needs a legend.

Response - The legend for Figure 2 is already provided at the top of the figure (green line = salinity, blue line = water level) and the red line is described in the text below the figure itself.

DREDGED FILL VOLUME REQUIREMENTS

Corps' Comment - No comments

PRELIM 30% ENGINEERING DESIGN REPORT

- Corps' Comment - Description of "existing conditions" is sparse.

Response – The existing conditions and need for the project are presented briefly in the Preliminary Design Report (Report). The general purpose of the report was to present preliminary engineering designs and other engineering information (i.e., surveying, modeling, and geotechnical reports). Existing conditions within the Hog Bayou watershed will be treated more extensively in the draft Environmental Assessment.

- Corps' Comment - Pg 1, last sent – is there freshwater introduction now? How deep is the Dr. Miller Canal now?

Response – There are no freshwater diversions across Hwy 82 in the Grand Chenier area at this time. The project's purpose is to initiate diversions in the Mermentau Basin west of Rockefeller Refuge. There are existing diversions across Hwy 82 on the eastern side of Rockefeller Refuge (ME-16) and at Pecan Island (ME-01).

The existing Dr. Miller Canal water depths are from – 1.0 to – 1.5 feet NAVD (88) (with some areas as deep as 2.0 feet), or 2.5 to 3.0 feet below marsh level (using + 1.5 feet NAVD as marsh level north of Hwy 82). The preliminary designs showed two cross sections of the southern end of the Dr. Miller Canal, but the numbers were very small (Sheet 7a). The 95% designs will show more detailed Dr. Miller Canal cross and longitudinal sections.

- Corps' Comment - Pg 5, Table 2, bullet 1 – how many culverts are there now?

Response – There are currently no culverts at Hwy 82. The Dr. Miller Canal is a drainage canal that currently only flows north to Upper Mud Lake. Four, 42 inch-diameter freshwater introduction culverts will be installed from the southern end of the Dr. Miller Canal under Hwy 82 to increase marsh productivity south of that highway.

- Corps' Comment - The description of project features on page 2 is very confusing and Fig. 1 doesn't help much.

Response – The project features consisting of freshwater flow across Hwy 82 at the Dr. Miller Canal and marsh restoration of 452 acres in two cells near Hog Bayou are discussed on Pages 1 and 2 and depicted in Figures 1 and 3 of the Report. If we had more information concerning the specific difficulty you had with that description, we could revise it in the Final Design Report.

We do not understand the difficulty in interpreting Figure 1. That figure presents the project's conceptual features, but not in a detailed manner. It shows two freshwater introduction features, the Dr. Miller Canal (east) and the BP Plant (west) plus the two marsh restoration (creation) cells to the south. Conceptual maps are not meant to show all depths, elevations and structures. The Figure 1 legend refers to its features. The preferred alternative map (Figure 3, page 6) is the official CWPPRA project features map found in the fact sheet (www.lacoast.gov). The Preliminary Drawings contain more project feature details.

- Corps' Comment - Table 1, Structures, bullet 1 – is there a diversion structure in the Miller Canal now?

Response – There are no diversion structures currently located in the Dr. Miller Canal. That canal functions to drain water northward to Upper Mud Lake through two 48 inch-diameter flapgated culverts (flaps operating outward to U. Mud Lake) at its intersection with Upper Mud Lake.

- Corps' Comment - Table 1, Structures, bullet 2 – show east-west canal on a plate and identify

Response – Figure 3 is too small to show this east-west waterway. Details of the east-west waterway are depicted on Sheets 2 and 3 of the Preliminary Drawings. More details will be presented in the 95% drawings.

- Corps' Comment - Table 1, Structures, bullet 6 – identify board roads, Miller-McCall levee and areas B and C on a plate. Show location of the four 1,200 culverts mentioned in the first full paragraph. Are the 1,275 foot long culverts mentioned in the second paragraph the same ones?

Response – Areas B and C are depicted on Figure 1 (page 3) of the Report. Figure 1 also shows the board roads in the McCall Tract and the Miller-McCall levee, but they are not labeled. We will label the board roads and levee in Figure 1 of the final report. The board roads and Miller-McCall levee are depicted on Sheets 4 and 5 of the Preliminary Drawings.

Figures 1 and 3 of the Report show the location of the freshwater diversion structures under Hwy 82 as "proposed freshwater diversion structure" (Figure 1) or "culvert" (Figure 3). Sheets 5, 7, 7a, and 9 of the Preliminary Design Drawings depict the location of the 42 inch-diameter diversion culverts under Hwy 82. The 95% design drawings will more fully show these culverts.

The 1,275 foot long culverts mentioned in the last paragraph of Page 2 are the same referred to as 1,200 foot long culverts in the first full paragraph of Page 1. They both refer to the 42 inch-diameter diversion culverts. The first paragraph will be revised to state that 1,275 foot-long culverts will be installed vs. 1,200 foot-long culverts.

- Corps' Comment - Pg 4, bullet 1 – confusing, flow is always permitted south across Hwy 82 isn't it? "culverts one-way flowing south"

Response – This is correct. Flow across Hwy 82 will always be to the south. Flapgates on the south side of the 42 inch-diameter culverts will prevent higher salinity water from crossing Hwy 82 to fresh marshes north of that highway. Southward flow from Upper Mud Lake will be prevented when salinities are greater than 5 ppt, but flow south from rainfall will always be permitted. If flow from Upper Mud Lake is stopped, drainage to Upper Mud Lake and southward across Hwy 82 will be permitted if sufficient head difference exists.

- Corps' Comment - Pg 4, bullet 2 – identify the managed tract on a plate. How often is it "managed"?

Response – The "managed" tract is Area C or the Forrest-Sweeney Tract depicted on Figure 1. The managed area consists of continuous levees and the installation of 3, 48 inch-diameter flapgated culverts with stoplogs at Hog Bayou to manage water levels. During non-drawdown years (2 of every 3 years), water exchange is maintained from February through October (flapgates locked open, stoplogs removed, allowing total tidal exchange), water levels are maintained from 0.0 to – 0.5 feet average marsh elevation from November through January to maintain sufficient water levels for waterfowl. During drawdown years (once every 3 years), water levels are maintained between 1.0 and 1.3 feet (16 inches) below marsh elevation from February through May (stoplogs removed, flapgates closed), water exchange is maintained from June through October (flapgates locked open, stoplogs removed), and water levels from 0.0 to – 0.5 feet average marsh elevation are maintained from November through January (same as for non-drawdown years) (see attached Yentzen marsh management permit application).

We will include the Miller-Yentzen management plan in the final design report.

- Corps' Comment - Pg 5, Table 2, bullet 5 – very confusing. If Miller Canal water levels were +1.0 to +2.0 ft NAVD how can they be +0.8 to +0.5 feet above marsh level? With marsh level+1.2 to +1.5 feet NAVD, the canal is **below** marsh level when it is at +1.0.

Response – That is correct. Canal water levels of + 1.0 feet are below marsh level. We agree this bullet is confusing because only the 2.0 foot high water level difference between marsh level was presented. 2.0 foot high canal water levels would be + 0.8 to + 0.5 feet above marsh level. One foot water levels should be from - 0.2 feet to - 0.5 feet marsh level (using marsh levels of + 1.2 to 1.5 feet). This will be clarified in the final design report.

- Corps' Comment - Pg 9, last sent – it says "culvert", but seems to describe a levee.

Response – The sentence refers to both culverts and levees. Each will have a minimum 15 foot top width and a top elevation of + 5.0 feet NAVD.

- Corps' Comment - Pg 16, last para – suggest mentioning that the BP project area is totally separate from the Dr. Miller Canal area.

Response – We will stress that the BP Plant freshwater diversion is totally separate from the Dr. Miller Canal diversion. The BP feature was part of the conceptual project that was eliminated because the model predicted it would not reduce salinities in the target marshes.

- Corps' Comment - Pg 19, Table 16 – suggest referring to Figures 9-13 as appropriate.

Response – We will refer to Figures 9 to 13 in Table 6 of the final report.

- Corps' Comment - Bullet 3 – Figure 10 shows much of the project area being brackish, with some fresh and some saline. In average of 5ppt seems very low for such an area. The project makes it nearly all fresh with an average of 2ppt. This seems high for fresh. To put it another way, the base run shows an area that is about 75 % intermediate, brackish and saline. Run #3 makes it 80% fresh. I have trouble seeing how a change from an average of 5 ppt to 2 ppt can freshen it this much, especially using Chabreck's salinity ranges:

Fresh	0-3 ppt
Int	2-5 ppt
Brack	4-15 ppt
Sal	>12 ppt

Response – The fresh, intermediate, brackish, and saline indicators in Figure 10 refer to water salinity levels not marsh types. The figure will be revised to either remove the labels or identify them are referring to water salinity levels not marsh types. Thus the "fresh" indicator means that water salinities are on the fresh side, not that the marsh is fresh. However, if salinities consistently remained below 2 ppt within project marshes, this "fresh" area would convert from brackish and intermediate to fresher marsh types.

The average salinity of 5 ppt is the salinity the model predicted in Area C with future-with-project scenarios predicted from the continuous recorder data measured at the

Second Lake station (Gage No. 2). The modeled period, January through March 2003, was a lower salinity period. The data recorded at the Second Lake station southeast of Area C was in the 3.5 to 8 ppt range. The model used that data to predict baseline FWOP salinities in the 5 ppt range in Areas B and C.

- Corps' Comment - Fig 10 has some purple (fresh) in the far southeastern area – I assume this is due to Little Pecan.

Response – The modeled effects of the South Grand Chenier Project alone, not Little Pecan, are depicted in Figure 10. The area referred to in "purple" is the Baker Tract east of Area B. Area B (Sweeney-McCall tract) has openings in its eastern levee that allows freshwater to freshen the adjacent Baker Tract north of Second Lake.

- Corps' Comment - Fig 12 – can't see numbers in legend.

Response – The numbers in the legend are small but readable. The left "Y axis" depicts salinity change from 0 ppt at the top to – 8 ppt at the bottom. The right "Y axis" depicts salinities in the Mermentau River that ranges, in 5 ppt increments, from 0 ppt at the bottom right to 30 ppt at the top (upper right).

- Corps' Comment - Fig 13, Run 4 – since the BP project area is totally separate from the Dr. Miller area, how can 4 culverts change anything from the base run? It seems to change brackish marsh to saline.

Response – The BP Plant feature was changed from 2, 48 inch to 4, 48 inch-diameter culverts, doubling its diversion capacity, for the 4-culvert model run. That model run also increased the Dr. Miller Canal Hwy 82 culverts from 2 to 4, 48 inch-diameter culverts. Therefore the total diversion capacity was increased 100% at both diversion locations.

You are correct that the model predicts that the BP feature would increase salinity in the target marshes at least for part of the modeled period. This is one reason the BP Plant diversion feature was removed from consideration. The other reason was that the BP feature did not reduce salinities.

- Corps' Comment - Pg 22, para 1 – this is a repeat of information from page 3.

Response – We assume you are referring to Page 20, paragraph 1, Section XI, "Analysis of Alternatives for O&M Cost Reductions." While each section discussed the 42 inch-diameter HDPE culverts among others, the two sections are different. Page 3 describes changes to the conceptual project features and Page 20 describes alternatives to reduce future O&M costs. Both sections are necessary, and the reasons for choosing the HDPE culverts are pertinent to both sections.

Project Managers

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DC 9-04-09