E C O L O G I C A L   R E V I E W

South Grand Chenier Hydrologic Restoration
CWPPRA Priority Project List 11
State No. ME-20

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This document reflects the project design as of the 95% Design Review meeting, incorporates all comments and recommendations received following the meeting, and is current as of November 17, 2009.

ECOLOGICAL REVIEW
South Grand Chenier Hydrologic Restoration

In August 2000, the Louisiana Department of Natural Resources (LDNR) initiated the Ecological Review to improve the likelihood of restoration project success. This is a process whereby each restoration project's biotic benefits, goals, and strategies are evaluated prior to granting construction authorization. This evaluation utilizes monitoring and engineering information, as well as applicable scientific literature, to assess whether or not, and to what degree, the proposed project features will cause the desired ecological response.

I. Introduction

The South Grand Chenier Hydrologic Restoration (ME-20) project is located in the Mermentau Basin approximately 6 miles southeast of the town of Grand Chenier between Highway 82 and the Gulf of Mexico (Figure 1). Marshes in this area historically received freshwater when it backed up into Hog Bayou from the Mermentau River during flooding events (Ensminger and Simon 1993). This inflow decreased after the construction of the Catfish Point Control Structure in 1951 reduced freshwater flow down the lower Mermentau River (Louisiana Coastal Wetlands Conservation and Restoration Task Force 2002). The area's hydrology was altered further by the construction of the Mermentau River to Gulf of Mexico Navigation Channel in 1971, which created a conduit that routed freshwater directly to the Gulf and allowed saltwater intrusion into interior marshes (Ensminger and Simon 1993). As a result of these hydrologic changes and several failed agricultural impoundments, the project area has lost a considerable amount of marsh and now comprises 3,292 acres of open water and 2,029 acres of predominantly brackish and saline marsh (U.S. Fish and Wildlife Service 2009).

The goal of the ME-20 project is to nourish and enhance marsh 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. The created marsh will be strategically located to impede the movement of high-salinity water coming from Hog Bayou and Beach Prong into the eastern project area (Figure 1). These strategies are consistent with the *Coast 2050* plan, which recommended the dedicated dredging of sediment for wetland creation and the movement of water from north to south across Highway 82 as Region 4 ecosystem strategies to restore and sustain wetlands (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1999). The project is also consistent with Louisiana's Comprehensive Master Plan for a Sustainable Coast (Coastal Protection and Restoration Authority of Louisiana 2007).

II. Project Features (from: Natural Resources Conservation Service [NRCS] and U.S. Fish and Wildlife Service [USFWS] 2009)

<u>Freshwater Introduction</u>

- A water control structure consisting of three, 48-inch diameter culverts with flap-gates will be installed at the intersection of Dr. Miller Canal and Upper Mud Lake. This structure will be operated to divert water from the Mermentau River (maximum flow capacity = 125 cubic feet per second) when there is sufficient head differential and when salinities are below 5 parts per thousand (ppt).

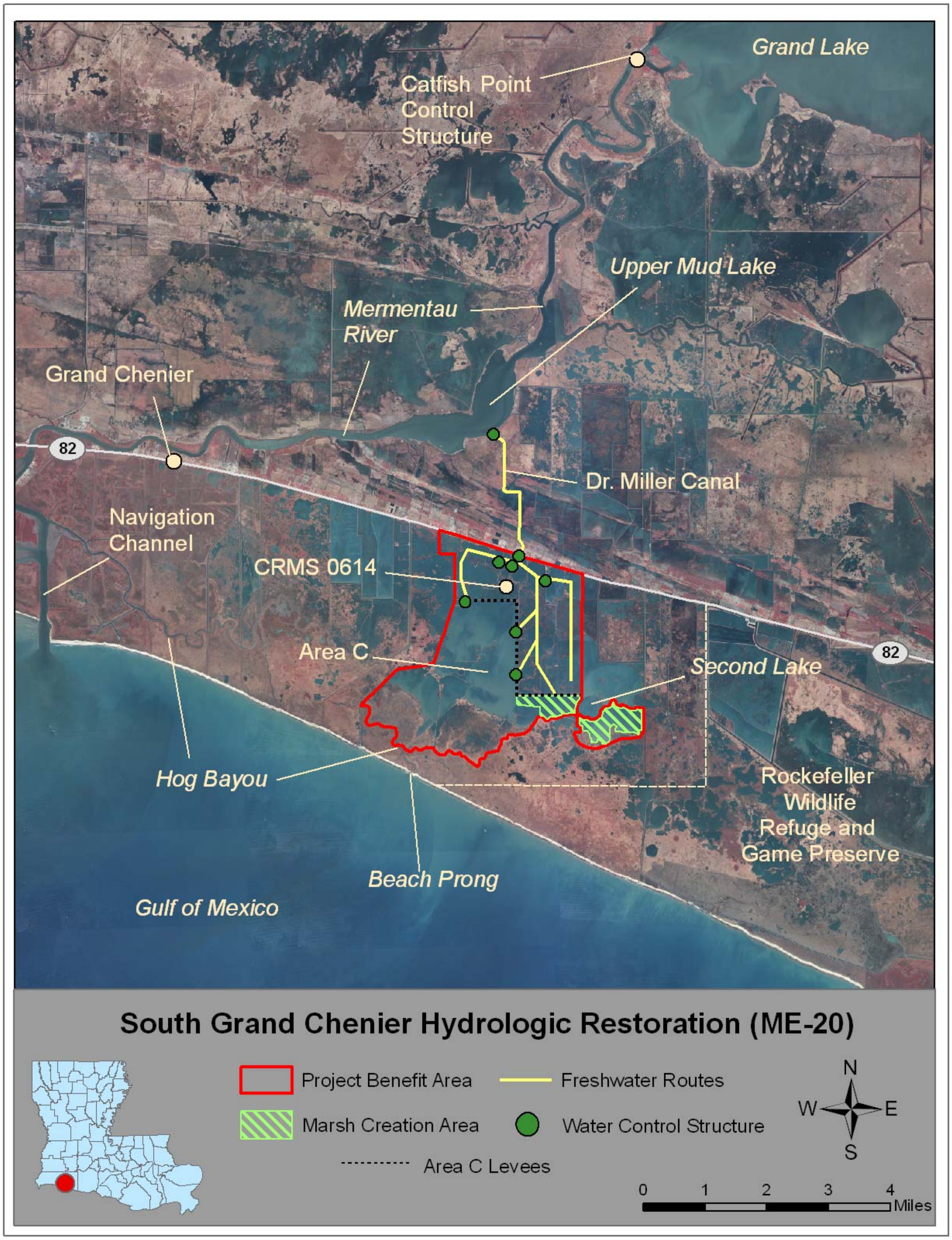

Figure 1. The South Grand Chenier Hydrologic Restoration (ME-20) project area and features.

- The diverted water will be conducted south by the Dr. Miller Canal, which will be enlarged and extended from Upper Mud Lake to Highway 82. Levees surrounding the canal will have flap-gated culverts installed at appropriate elevations to allow water to drain from the adjacent marshes into the canal.
- Four culverts will be buried from the southern terminus of Dr. Miller Canal south to Highway 82, where they will connect to pipes installed underneath the highway.
- Culverts or breaches will be installed in the levees and board roads south of Highway 82 to convey water throughout the project area. The culverts in the levees bordering Area C will be closed for four months every three years to accommodate drawdown events in the managed southern portion of the project area. Otherwise, the culverts will be locked open to maintain water exchange.

Marsh Creation

- Sediment dredged from the Gulf of Mexico will be transported via pipeline to two marsh creation cells located near Second Lake (Figure 1). The western cell will be 170 acres in size and will be pumped to an elevation of +4.3 feet NAVD 88, whereas the eastern cell will be 282 acres and will be pumped to +4.5 feet NAVD 88. The created marshes are projected to reach an elevation of +1.3 feet NAVD 88 three years post-construction.
- Containment dikes will be degraded one year after construction and trenasses will be constructed to return natural hydrology to the created marshes.
- The created marshes will be planted with *Spartina alterniflora* (Darryl Clark, USFWS, Personal Communication, June 25, 2009).

III. Assessment of Goal Attainability

Freshwater Introduction

The goal of the ME-20 project is to nourish and enhance marsh through the introduction of Mermentau River water. Freshwater introductions from the Mississippi River have proven to be an effective strategy for maintaining Louisiana's deltaic marshes. Plant productivity and vertical accretion have been enhanced primarily by the high concentrations of nutrients and sediments in Mississippi River water (DeLaune et al. 2003, Twilley and Nyman 2005, Lane et al. 2006). In addition, marsh vegetation benefits from the input of freshwater, which reduces the deleterious effects of high salinities and sulfide concentrations on plant growth (Bradley and Morris 1990, Pezeshki and DeLaune 1993). Similar benefits may be derived from the introduction of water from the upper Mermentau Basin, considering that nutrient and suspended sediment concentrations are high due to the intensive agriculture production in the watershed (Skrobialowski et al. 2004). Despite this, there are currently only two freshwater introduction projects in the basin, i.e., Pecan Island Freshwater Introduction (ME-01) and Freshwater Introduction South of Highway 82 (ME-16), which convey water from Grand or White Lake to marshes in the lower Mermentau Basin. Preliminary monitoring results indicate that salinities have been reduced in both project areas, and vegetation cover and quality have improved in the ME-16 project area (Miller 2000, Mouledous and Billodeau *in press*). However, it is unclear whether these results are due to the project features, climactic variability, or natural recovery following storm events. Additional data are needed to fully assess the effectiveness of these projects.

Because much of the ME-20 project area has been impounded, there should be a noticeable increase in plant productivity in response to the freshwater introduction. Numerous studies have found that the levees surrounding impounded marshes restrict the influx of material, resulting in reduced sedimentation and nutrient accumulation (Boumans and Day 1994, Bryant and Chabreck 1998). Consequently, productivity of these marshes is likely nutrient limited. Impounded marshes in nearby Rockefeller Wildlife Refuge and Game Preserve had significantly lower interstitial ammonium and phosphorus concentrations as compared to tidally-influenced marshes (Foret 2001). Experimental fertilization of the impounded marshes significantly increased plant productivity (Foret 2001). In contrast, fertilization of tidally-influenced marshes did not significantly increase productivity. Tidally-influenced marshes may be more limited by high porewater salinity and sulfide concentrations, both of which inhibit nutrient uptake and gas exchange (Bradley and Morris 1990, Pezeshki and DeLaune 1993).

The ability of the ME-20 project to reduce salinity levels in the project area was assessed using the MIKE FLOOD hydrodynamic model (C.H. Fenstermaker and Associates, Inc. [Fenstermaker] 2005). The model was calibrated and validated using hydrologic data collected from November 2002 to April 2003. Using this data set, the model showed that salinities were reduced by an average of 3 ppt (from 5 ppt to 2 ppt). The model, however, does not show whether the salinity reduction persists through the remainder of the year (May to October), when low head conditions and/or high salinities in the Mermentau River may limit freshwater introduction south of the highway (Louisiana Coastal Wetlands Conservation and Restoration Task Force 2002). Likewise, it is unknown how much the freshwater input would reduce salinities of higher magnitudes (i.e., >10 ppt), which have recently been observed in the project area (Figure 2). In either case, the marsh creation cells should help moderate salinities in the project area by reinforcing the degraded banks of Hog Bayou and Second Lake and thus reducing the amount of saltwater intrusion. This was observed during model runs even during a simulated 40-day period when the culverts were closed due to high (>5 ppt) river salinities.

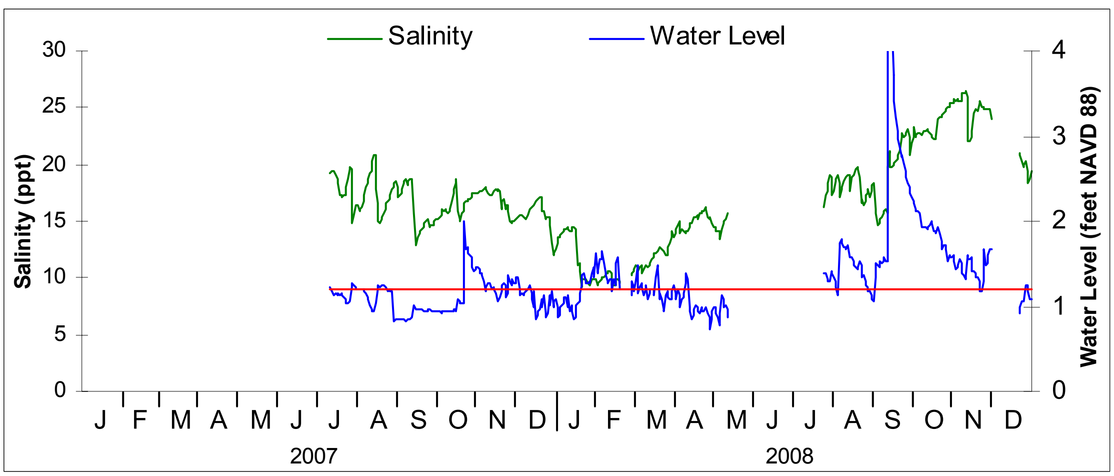

Figure 2. Salinity and water level data from CRMS 0614 in the ME-20 project area. The red line depicts the elevation of marsh (+1.2 feet NAVD 88) surveyed in the project area.

Marshes in the project area are dominated by *Distichlis spicata* and *Spartina patens*, two species that have low flooding tolerance and are more productive in irregularly-inundated, higher elevation habitats (Webb et al. 1995). Consequently, increases to water levels caused by the ME-20 project may be detrimental to local plant productivity. The hydrodynamic model developed by Fenstermaker (2005) found that water levels increased 0.2 feet when the diversion was operating. Fenstermaker (2005) also performed an analysis to determine how the water level increase would affect marsh inundation rates; however, the analysis used a marsh surface elevation of +1.5 feet NAVD 88, which is at the upper limit of marsh elevations in the area and thus would be least inundated. Therefore, another analysis was performed based on the more conservative +1.2 feet elevation surveyed recently (NRCS and USFWS 2009). Using this elevation and the water level data shown in Figure 2 (data after August 2008 were excluded because of the impacts from Hurricane Ike), the baseline marsh inundation rate was estimated to be a suitable 25% with relatively short-duration flooding events occurring between November and April. With a water level increase of 0.2 feet, the marshes would have been inundated 60% of the time, primarily as a result of flooding events lasting 55 and 80 days. This amount of flooding would significantly decrease growth and productivity, and possibly cause mortality (Webb et al. 1995, Lessmann et al. 1997). Consequently, water levels in the project area should be monitored and the diversion regulated so as to prevent long-duration flooding events.

Marsh Creation

A review of previous marsh creation projects indicates that elevation is one of the most important factors dictating project success. As previously discussed, the elevation of the marsh surface determines its frequency and duration of flooding, which in turn affects vegetation composition and productivity. Marsh platforms built too high may become dominated by upland vegetation; whereas platforms built too low may be excessively-inundated and thus unsuitable for emergent marsh vegetation. Regarding the ME-20 project, the elevation of the marsh platforms is projected to reach +1.3 feet NAVD 88 at year 3 and settle to approximately +1.0 feet NAVD 88 at year 20 (NRCS and USFWS 2009). At these elevations, the platforms would be flooded approximately 20% to 60% of the time, respectively, based on the limited amount of water level data available (Figure 2; data after August 2008 were excluded in the analysis). These inundation rates are generally suitable for many species of emergent vegetation; however, toward the end of the 20-year project life the extent of flooding would be stressful to higher elevation species such as *Distichlis spicata* and *Spartina patens* (Webb et al. 1995).

The proper development and long-term sustainability of the created marsh is also dependent on maintaining natural hydrologic exchange with adjacent water bodies. As previously discussed, artificial barriers such as levees, spoil banks, and dikes prevent the influx of vital sediment and nutrients (Boumans and Day 1994, Bryant and Chabreck 1998). These barriers would also block the influx of plant propagules for colonization of the newly created marsh. The containment dikes constructed for the ME-20 project will be degraded to marsh elevation one year after construction, and they should continue to settle along with the marsh platforms. In addition, trenasses will be constructed in the marsh platforms to further facilitate hydrologic exchange to the inner parts of the created marsh. Future maintenance, though, may be necessary to maintain the exchange if the dikes do not settle as anticipated or if the trenasses become plugged by sediment deposition.

It is important to quickly establish vegetation on created marsh platforms to stabilize the sediment and prevent its loss from erosive processes. The rate at which marsh vegetation naturally colonizes bare sediment is partly dependent on substrate characteristics (Broome et al. 1988). The borrow material that will be used in the ME-20 project is primarily silt and clay, materials that should have adequate nutrient concentrations for rapid, natural plant establishment (Broome et al. 1988). The proposed artificial plantings will greatly accelerate vegetation establishment and development.

Summary/Conclusions

The South Grand Chenier Hydrologic Restoration (ME-20) project should improve marsh productivity by providing much-needed freshwater, nutrients, and sediment. These inputs may be limited to the winter/spring when conditions are most favorable for the diversion of

Mermentau River water to the project area. A seasonal pulse of river water, though, will likely mimic flooding events that occurred in the area prior to hydrologic alterations (Ensminger and Simon 1993, Louisiana Coastal Wetlands Conservation and Restoration Task Force 2002). Such pulses often provide sufficient nutrients to sustain plant production through the year, as well as freshwater and mineral sediment that help moderate the effects of saltwater intrusion during the summer/fall (Day et al. 2003, DeLaune et al. 2003). Improved plant health and productivity should result in greater organic matter accumulation, and subsequently greater vertical accretion rates and marsh stability (Nyman et al. 2006).

Marsh productivity could be impaired by excessive flooding that may result from the diversion. While some flooding is necessary to distribute sediment and nutrients across the marsh surface, long-duration flooding events are detrimental to marsh productivity and sustainability. The proposed water level monitoring and operational plan for the water control structures should ensure that such flooding events do not occur (NRCS and USFWS 2009). The project's operational plan should also be coordinated with the management plan for Area C, and all structures should be operated to both maximize the benefits of the freshwater introduction and ensure proper drainage of the project area marshes, particularly after storm events.

The ME-20 project should also improve local productivity by the successful creation of marsh. This productivity may diminish near the end of the project life as the created marshes decrease in elevation and inundation rates begin to increase to stressful levels. However, it is possible that accretionary processes may be sufficiently developed to compensate for the decreasing elevation (Craft et al. 2002, Edwards and Proffit 2003).

IV. 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 monitoring and operational plan should be coordinated with the existing management plans in the area, and all water control structures should be operated to maximize the benefits of the freshwater introduction.
- Maintenance events should be conducted to further degrade containment dikes and/or reopen trenasses, if necessary, to maintain hydrologic exchange to the created marshes.

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