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

East/West Grand Terre Islands Restoration
CWPPRA Priority Project List 9
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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 December 14, 2005.

95% Ecological Review
East/West Grand Terre Islands 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 East/West Grand Terre Islands Restoration (BA-30) project is located in Jefferson and Plaquemines Parish, Louisiana. East and West Grand Terre combined with Grand Isle comprise the westernmost stretch of the Plaquemines barrier island chain spanning from Caminada Pass to Quatre Bayou Pass. The islands are currently separated by Pass Abel and are bordered by Barataria Bay to the north, the Gulf of Mexico to the south, Barataria Pass to the west, and Quatre Bayou Pass to the east. Tropical storms, subsidence, and absence of a replenishing sand source caused Grand Terre Island to separate into the two currently existing islands (Figure 1).

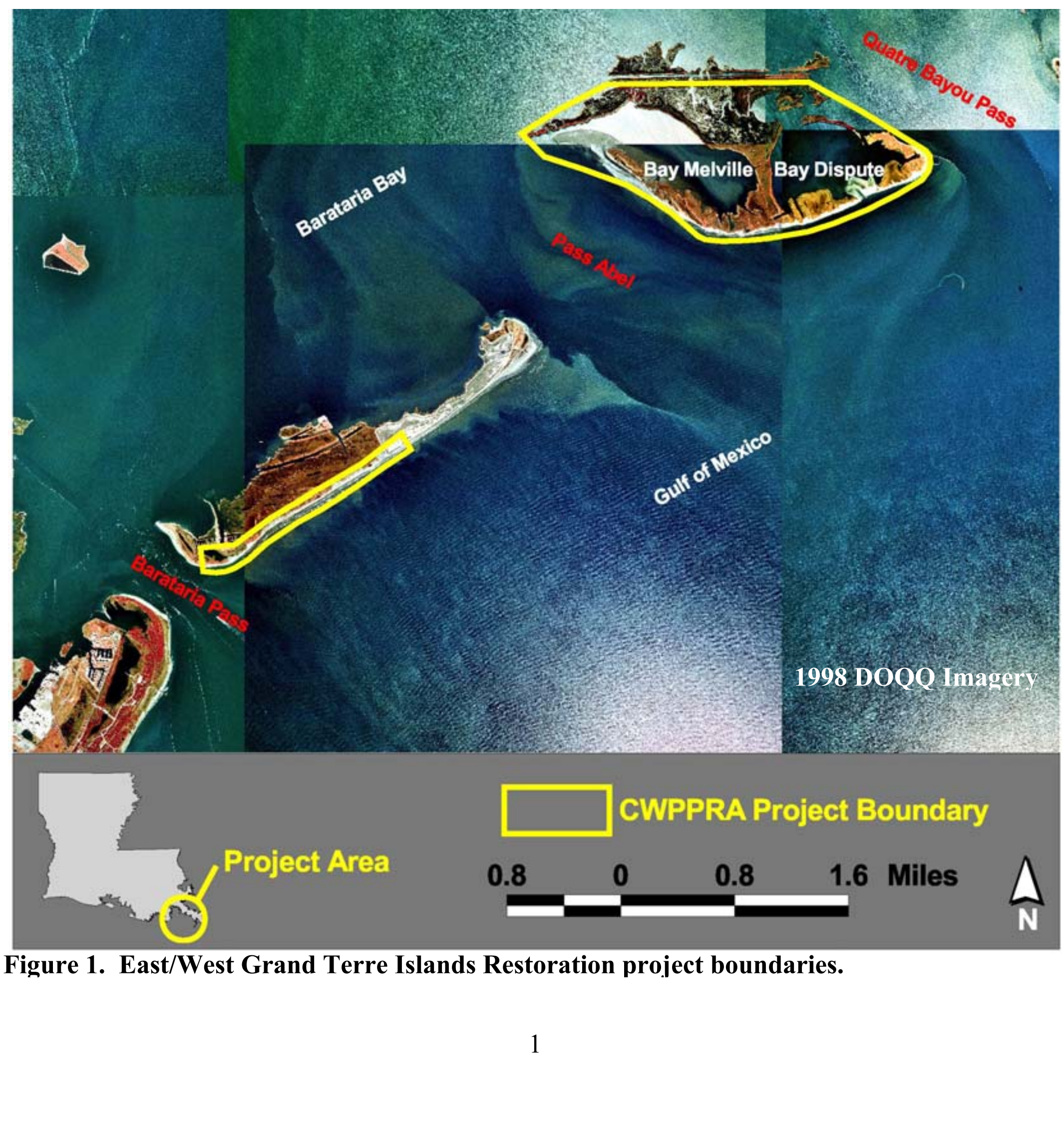

Figure 1. East/West Grand Terre Islands Restoration project boundaries.

Coast 2050 identified the restoration and maintenance of barrier islands in Region 2 as an ecosystem strategy essential for returning the "island chains to a condition suitable for maintaining the integrity of the estuarine system" (Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands conservation Restoration Authority 1999). All of Louisiana's barrier islands are experiencing island narrowing and land loss as a consequence of a complex interaction among global sea level rise, subsidence, wave and storm processes, inadequate sediment supply, and intense human disturbance (Penland *et al.* 1988; McBride *et al.* 1989; Williams *et al.* 1992). In some locations, shoreline erosion of Louisiana barrier islands exceeds 65 feet per year (Penland and Boyd 1981). These processes have resulted in the loss of natural terrestrial and aquatic barrier island habitats (National Marine Fisheries Service [NMFS]/LDNR 1999).

The original purpose of this project was to restore marsh habitat and close shoreline breaches on East Grand Terre Island and to increase the overall elevation and seaward extent of East and West Grand Terre Island's shorelines thus protecting existing infrastructure on West Grand Terre. However, the scope of this project has been reduced to only include East Grand Terre. Restoration efforts for West Grand Terre were eliminated after cost projections of alternatives designed to restore both islands were exceeded during modeling efforts to test the feasibility of restoration. The cost to construct either of two beach alternatives for West Grand Terre in combination with alternatives for East Grand Terre (approximately $33 million - $62 million depending on the alternative grouping) far exceeded the original Phase I (engineering and design) total construction budget of $18 million. East Grand Terre was suggested to be the more critical of the two islands due to the excessive amount of overwash and numerous breaches along the island shoreline; conversely, West Grand Terre was thought to be the more stable of the two islands and does not require immediate attention. Additionally, West Grand Terre Island has exhibited slight progradation near a rock revetment installed around Fort Livingston on the western end of the island near the revetment (Personal Observation, Agaha Brass). Therefore, except for potential beneficial use of dredged material from future maintenance dredging of Barataria Pass by the United States Army Corps of Engineers (USACE), there are no plans to restore the island at this time.

East Grand Terre consists of 359 acres of saline marsh, 59 acres of upland scrub/shrub, 36 acres of shore/flat, 27 acres of barren uplands (likely dunes), and 892 acres of open water based on the 1988/1990 habitat data. These acreages indicate a 70% total land area loss since 1884 (Penland et al. 1999). Increases in land area and water acreages were recorded in 1993 as an effect of Hurricane Andrew in 1992 (NMFS/LDNR 1999). A comparison of a 1993 - 2001 habitat analysis to the 1988/90 habitat data revealed that the elevation of the island decreased over time as evidenced by the loss of scrub/shrub acres and increase in saline marsh acres (United States Geological Survey – Johnson Controls 2005).

Construction of marsh, beach, and dune platforms potentially would increase island longevity, protect estuarine systems, and return the island to a more historical alignment. An array of design alternatives has been evaluated through the use of hydrodynamic models to determine which is the most suitable for nourishing and rebuilding East Grand Terre Island. The alternatives vary primarily in seaward extent with respect to existing island features and the width of the marsh platform.

II. Goals Statement

East Grand Terre

1. Adequately restore island/shoreline to prevent breaching through target year (TY) 20
2. Maintain a total of 572 acres (marsh and island) at TY20 representing a net island increase of 341 acres over future without project
3. Ensure marsh platform maintains an elevation between Mean High Water (+1.6 feet NAVD 88) and Mean Low Water (+0.55 feet NAVD 88) from TY3 to TY20
4. Ensure coverage of vegetation on marsh platform is ≥ 80% beginning in TY3 and continuing to TY20
5. Optimize tidal linkage to created marsh platform
6. Achieve the following supratidal acreages (area above +2.0 feet NAVD 88)
   - 334 acres in TY1 (260 existing and 74 created)
   - 130 acres in TY20
7. Maintain the TY6 shoreline seaward of the pre-construction shoreline
8. Maintain an average post-storm dune platform elevation of +4.0 feet NAVD 88
9. Achieve the following intertidal acreages (area between 0.0 and +2.0 feet NAVD 88 elevation)
   - 432 acres in TY1 (226 existing and 206 created)
   - 339 acres in TY20

III. Strategy Statement

East Grand Terre

- Construct 71 acres of dune platform to +6.0 feet NAVD 88, 82 acres of beach, and 432 acres of back barrier marsh on East Grand Terre.
- Place marsh creation material at an elevation of +2.3 feet NAVD 88 and allow it to settle and dewater down to the intertidal range (see goal number 9 above).
- Utilize effective planting schemes and sand fencing to maximize vegetative coverage and survival along with providing increased dune stabilization.
- Create tidal ponds and creeks and ensure tidal exchange by degrading retention dikes that do not naturally degrade.

IV. Strategy-Goal Relationship

Project goals will be achieved by mining and transporting offshore sand and marsh material to restore East Grand Terre Island. The material will be used to create a dune to prevent shoreline breaching and abate wave surges from storms. A marsh platform will also be created that, once settled and dewatered, would create intertidal marsh habitat and act as an overwash plateau. The placed material will be shaped to obtain design elevations, widths, and slopes of the design template predicted to best achieve the stated goals (dictated by numerical modeling of alternatives). Tidal creeks and ponds will be incorporated into the marsh to increase tidal exchange. Vegetation plantings will be incorporated into marsh and dune construction to increase their stability and provide nesting bird habitat.

V. Project Feature Evaluation

Coastal Planning and Engineering, Inc. (CPE), was tasked with generating and modeling design alternatives to restore both the East and West Grand Terre Islands. Their work utilized and completed work initiated by Weston Solutions, Inc. in 2003. CPE chose to develop three each of beach and marsh alternatives plus a no action alternative and to model seven initial alternative restoration designs for East and West Grand Terre. An additional dune and marsh alternative was later modeled (based on their island restoration experience) to minimize cost and potentially maximize restoration effectiveness. All of their designed beach alternatives contain a "design fill" and an "advanced fill" section. The design fill section is the fill volume required at TY20 to meet the project goals and the advanced fill section is the sacrificial portion of the fill that will erode over the 20-year project life.

Alternative Discussion

Initially, two beach and marsh alternatives were modeled for East Grand Terre Island (EGT). A decision was made to model an additional beach and marsh alternative in an attempt to minimize restoration costs. The beach alternatives consisted of constructing a seaward beach and dune platform along the entire island shoreline while the marsh alternatives consisted of both partially or completely filling Bays Melville and Dispute to create and/or renourish either 432 or 741 acres of marsh. The alternatives varied in the volume of material that would be placed along the shoreline as design and advanced fill and also in the amount and elevation of material placed in the marsh creation cells (Table 1). It was hoped that by reducing the dune crest width, lowering the marsh elevation, modifying the design and advanced fill volumes, and utilizing a different borrow area of the three alternatives that the costs to construct the project would be lowered. In addition, CPE was instructed to evaluate the smaller marsh because the larger marsh component contained inflated costs associated with oyster lease impacts.

Table 1. Comparison of the three beach and marsh alternatives modeled by CPE.

	Beach Alternative 1	Beach Alternative 2	Beach Alternative 3	Marsh Alternative 1	Marsh Alternative 2	Marsh Alternative 3
Advanced Fill (cy)	342,400	1,127,600	572,000	-	-	-
Design Fill (cy)	978,600	927,000	883,700	-	-	-
Dune Elevation (Feet NAVD 88)	+6.0	+6.0	+6.0	-	-	-
Dune Crest Width	90	90	70	-	-	-
Marsh Fill (cy)	-	-	-	1,908,000	5,550,00	1,732,000
Marsh Elevation (Feet NAVD 88)	-	-	-	+2.5	+3.5	+2.3
Marsh Material	-	-	-	Silty Sand	Silty Clay	Silty Sand
Marsh Acres	-	-	-	432	741	432

After the model and settlement analysis of the third alternative was conducted, it was determined that some of the methods used to realize a cost savings could be applied to alternative one and also reduce its price. Thus, the height of marsh alternative 1 was lowered to +2.3 feet NAVD 88 from +2.5 feet NAVD 88. The review of the analyses revealed that doing so would potentially increase the duration that the marsh platform would be intertidal. It is also pertinent to mention that the materials used in marsh alternatives 1 and 3 differ from those used to construct marsh alternative 2. Marsh alternative 2 required additional fill volumes due to its larger design. To compensate for the additional volume needs and reduce costs, a silty clay material was used instead of the silty sand material used for marsh alternatives 1 and 3. The poorer quality material used in alternative 2 was placed at a higher initial elevation and settled faster than the material used in alternatives 1 and 3.

Model Discussion

Two models were used to determine the impacts of a natural event on the design alternatives. Cross-shore storm impacts were evaluated using the Storm Induced Beach Change Model (SBEACH). SBEACH simulates beach profile changes that result from varying storm waves and water levels (CPE 2004). CPE modeled 5, 10, and 20-year return period storms at TY0 and TY20 to determine the impacts to dune elevation. Of those storm scenarios, a 20-year event at TY0 and a 10-year event at TY20 were shown to be the most damaging and thus drove the design. The shorter return period storm results indicated those storms do not produce surges significant enough to overtop and lower the dune elevation but do displace and cause material to be lost offshore. This information was the driving factor in selecting the dune elevation and crest width parameters that would meet the goal of maintaining a +4.0 foot dune elevation at TY20.

Shoreline performance was modeled using the Generalized Model for Simulating Shoreline Change (GENESIS) software. The model determined shoreline changes relative to a fixed baseline based on the wave-driven longshore sediment transport (CPE 2004). The results of this analysis showed that nearly all of the advanced fill placed for the alternatives would be lost or displaced from the original alignment. In most scenarios, the design fill was also eroded to the extent that no placed fill was available at TY20 and the baseline profile was once again subjected to losses.

Settlement Analysis

The accepted measure of a slope's stability is its "safety factor" or minimum factor of safety (FSmin), which is the ratio of soil strength to soil and surcharge weights plus seepage (Soil Testing Engineers, Inc. 2004). The higher the safety factor, the less likely slope failure will occur. FSmin is 3.14 for the dunes and ranges from 0.9 – 1.7 for the marsh containment. The settlement analysis for a marsh platform constructed to +2.5 feet NAVD 88 using silty sand (as in marsh alternatives 1 and 3) would settle below mean high water (+1.6 feet NAVD 88) at TY8 and remain above mean low water (+0.55 feet NAVD 88) until the end of the 20-year project life (Figure 3). A marsh platform constructed at an elevation of +3.5 feet NAVD 88 using silty clay (as in marsh alternative 2) would settle below MHW around TY5 and stay intertidal through TY20 (Figure 4). It can be extrapolated from Figure 3 that a platform constructed to +2.3 feet NAVD 88 using the silty sand material would settle below MHW at TY6 and remain intertidal until TY20, thus extending the time the platform remains intertidal.

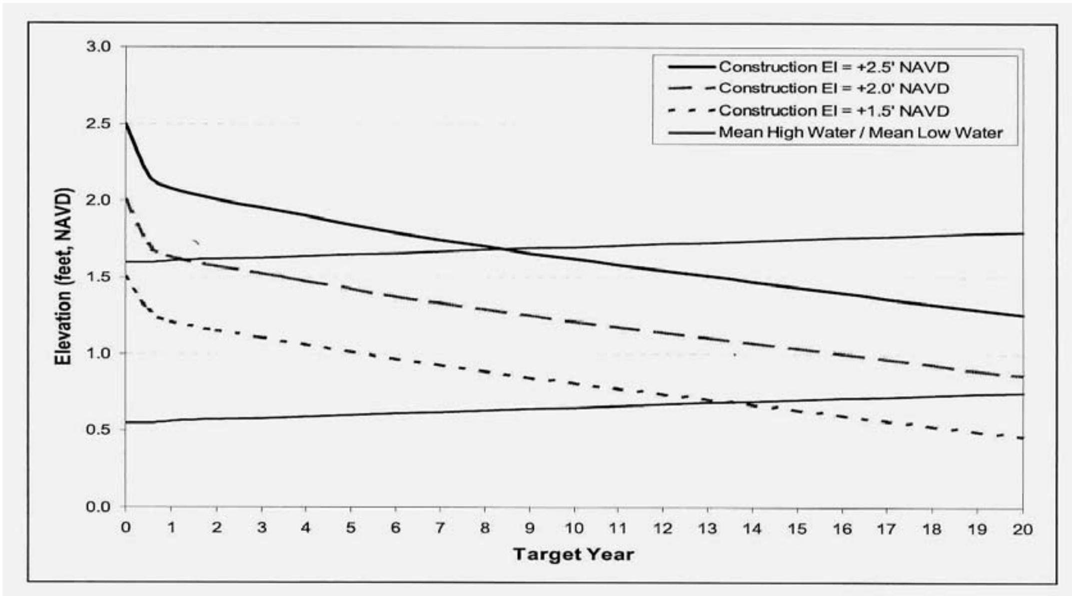

Figure 3. Settlement rates of silty sand material used for marsh creation placed at or below elevation +2.5 feet NAVD 88 (CPE 2004).

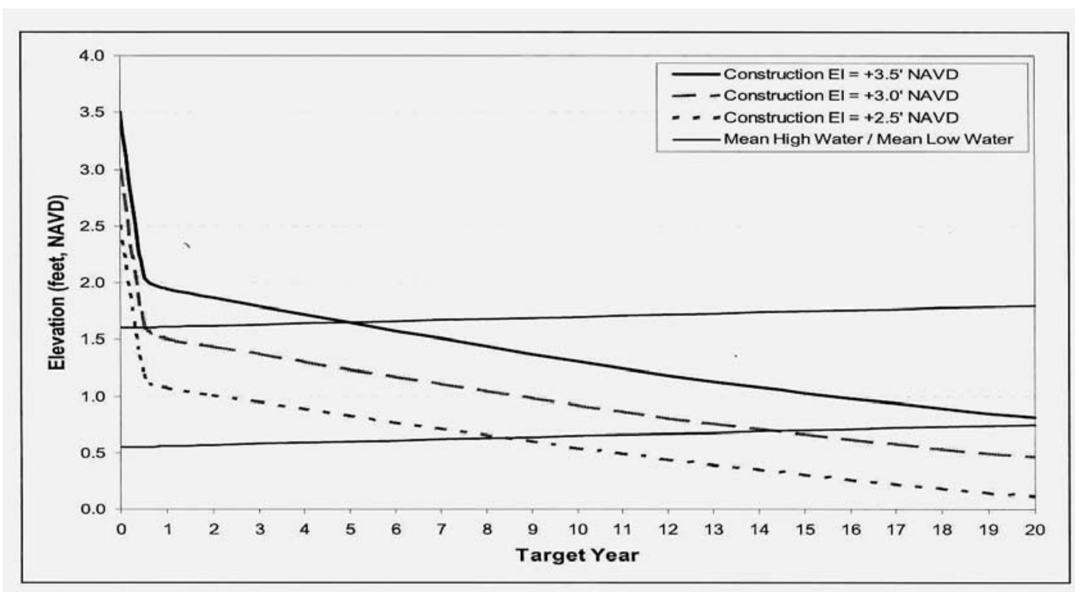

Figure 4. Settlement rates of silty clay material used for marsh creation placed at or below elevation +3.5 feet NAVD 88 (CPE 2004).

Alternative Performance

Table 2 is a listing of the designed beach alternatives coupled with marsh alternative 1 and how effectively they achieve each stated goal based on the results of the aforementioned models and settlement analysis.

Table 2. Predicted goal achievability for each design alternative.

Goal Summary	No Action	Alternative 1	Alternative 2	Alternative 3
#1 Prevent island breaching through TY20	No	No	**Yes**	**Yes**
#2 Maintain a total of 572 acres (marsh and island) at TY20	No	No	No	No
#3 Maintain marsh elevation between MHW and MLW through TY20	No	No	No	No
#6 Maintain 130 acres of supratidal habitat at TY20	No	**Yes**	**Yes**	**Yes**
#7 Maintain TY6 shoreline seaward of pre-construction shoreline	No	**Yes**	**Yes**	**Yes**
#8 Maintain a post-storm dune elevation of +4.0 feet NAVD 88	No	No	**Yes**	No
#9 Maintain 339 acres of intertidal habitat at TY20	No	No	**Yes**	No

Note: Goals 4 and 5 were beyond the scope of the model

Beach alternative 1 would only meet the goals of achieving the supratidal acreage and maintaining the shoreline position seaward of the existing position until TY6, but would not maintain a +4 foot NAVD 88 elevation at TY20 nor prevent the shoreline from breaching. None of the marsh alternatives will maximize the amount of time the platform is between MHW and MLW. The platforms just do not settle below MHW soon enough to meet that goal. Marsh platforms for alternatives 1 and 3 will settle below MHW at TY6, quicker than marsh alternative 2 (TY8), extending the time they remain intertidal.

The selected alternatives for project completion are beach alternative 1 and marsh alternative 1. These alternatives were selected because the benefits of the least productive alternatives were still more desirable than taking no action and the costs to construct them were more in line with what the original cost to construct both islands would have been. The alignment is a 70 to 90-foot wide dune crest, +6.0 feet NAVD 88 initial dune elevation, a seaward berm slope of 1(V):45(H), a landward berm slope of 1(V):30(H) and a 432-acre marsh platform constructed with an elevation of +2.3 feet NAVD 88. To enable tidal exchange and allow deposition of suspended sediment (carried by tides) within the interior of the marsh platform the project will include tidal creeks and tidal ponds.

<u>Sand-fencing</u>

The Barrier Island Comprehensive Monitoring Program (BICM) recommends installing sand-fencing 4 feet high with 50% porosity (i.e., ratio of area of open space to total projected area) placed shore-parallel along the entire length of the dune to capture wind-blown sand and to help build and stabilize mounds (Lee and Khalil, In Press). Monitoring results of previously constructed projects have shown the effectiveness of sand-fences to stabilize dunes and trap wind-blown sand (Mendelssohn et al. 1991 and LDNR 1998a-d).

<u>Vegetation</u>

The dune will be vegetated with *Spartina patens* (marshhay cordgrass) and *Panicum amarum* (bitter panicum) with a density equivalent of 4-inch trade containers on

10-foot centers. The United States Department of Agriculture (USDA) recommended the use of both *S. patens* and *P. amarum* in dune restoration projects (USDA 1992). These plants should stabilize sand particles when used in conjunction with sand-fencing. However, it should be noted that prior attempts to incorporate vegetative plantings into the construction phase of a project's design have not yielded favorable results. Therefore the LDNR, Coastal Engineering Division has developed a protocol to increase the likelihood of success. This protocol entails implementation of plantings a year after construction to allow adequate dewatering and adjustment of the placed material, a review of past planting plans and specifications, and an evaluation species used in past projects. Revisions made to improve the next project's design (e.g., diversifying plant types, installing dune plants sooner, and using larger/wider marsh platform plantings) will be based on the ability to accurately pinpoint past vegetation planting problems (Kenneth Bahlinger, LDNR, Personal Communication, April 2005).

VI. Assessment of Goal Attainability

The Assessment of Goal Attainability focuses on the likelihood of the proposed project features (i.e., the dune and marsh platform creation, sand fencing, and vegetation plantings) affecting the desired ecological response. This section details the findings from a review of scientific literature and monitoring results of projects similar in scope to the East/West Grand Terre Islands Restoration project.

The selected alternatives for restoring East Grand Terre Island are beach alternative 1 and marsh alternative 1. Table 3 presents the cost/benefit comparison from which the decision to select the chosen alternatives was based upon. A significant difference between the amount of supratidal and dune acreages did not exist to support requesting an additional 3-5 million dollars for construction. The selected alternative does not meet the majority of the goals but does supply an adequate amount of supratidal and dune acres compared with the other two alternatives at TY20. The cost of alternative 1 is still nearly as much as the original Phase 1 approved engineering and design construction estimate.

Table 3. East Grand Terre Beach Fill Alternatives with Marsh Alternative 1 Cost/Benefit Comparison.

	No Action		Alternative 1		Alternative 2		Alternative 3	
	TY1	TY20	TY1	TY20	TY1	TY20	TY1	TY20
Design Fill (cy)	-	-	978,600	193,400	927,000	927,000	883,700	328,100
Advanced Fill (cy)	-	-	342,400	(TY8) 0	1,127,600	52,000	572,000	(TY11) 0
Supratidal Acres	254	113	342	319	388	359	342	319
Dune Acres	-	-	79	22	117	54	79	30
TY1 Total Fill (cy)	-		1,321,000		2,106,000		1,455,700	
Cost (w/ Marsh Alternative 1)	-		$15 Million		$20 Million		$18 Million	

Dune and Marsh Platform Building

Beach nourishment, or fill, generally can be defined as the artificial addition of suitable quality sediment to an island area that has a sediment deficiency in order to rebuild and maintain that area at a width that provides storm protection and a re-creation area (Campbell and Spadone 1982). According to the Louisiana Gulf Shoreline Restoration Report (Campbell and Benedet 2003), the basic design for beach nourishment should place enough sediment in the island system to produce a volumetrically stable and sediment-rich barrier complex. The most important parameter when developing an optimal design is to compensate for the amount of sediment typically lost naturally by the system. An initial increase in volume placed should be incorporated to minimize those losses and reduce impacts to the existing island. The alternatives as designed by CPE have incorporated an advanced fill section in an attempt to protect the design fill section.

The height of constructed dunes has been a controversial subject. Some believe that dune height should mimic the natural surroundings and allow for overwash of the islands. Penland et al. (2003) recommends building dunes at an elevation that mimics natural barrier island conditions (+3.0 to +6.0 feet NAVD 88) to facilitate an increase in biodiversity. Others believe that dune height should be significantly higher than natural dunes to protect infrastructure and prevent overwash during storm events (Campbell and Benedet 2003). Dune height should be a function of specific project goals. If the goal of the project is to prevent overwash, higher dunes should be utilized. If the goal is to prevent breaching the goal could possibly be accomplished with the use of lower, wider dunes.

There are several recently constructed CWPPRA barrier island projects that have included the design and implementation of dune and marsh platforms. However, it is difficult to evaluate these projects due to the fact that environmental monitoring data are limited. In fact, lack of pre- and post-construction monitoring and engineering data has been identified as a significant problem with past attempts to assess the effectiveness of other beach nourishment projects (Davison et al. 1992). For comparison purposes, a list of constructed CWPPRA projects along the Isle Dernieres barrier island chain and their respective design parameters are below.

- Isle Dernieres Restoration East Island (TE-20)
    - Marsh platform constructed to an elevation of +4.0 feet NGVD-29 and 800 feet wide
    - Dune elevation of +8 feet NAVD 88 with a dune width of 300 to 500 feet
    - Construction completed in July 1999

- Isle Dernieres Restoration Trinity Island (TE-24)
    - Marsh platform constructed to an elevation of +4.0 feet NGVD-29 and 800 feet wide
    - Dune elevation of +8.0 feet NAVD 88 with a dune width of 300 feet
    - Construction completed in July 1999

- East Timbalier Island Sediment Restoration - Phase 1 (TE-25)
  - Marsh platform constructed to an elevation of +3.0 feet NGVD-29 and 500 feet wide
  - Dune elevation of +5.0 feet NAVD 88 and dune width of 200 feet
  - Construction was completed in May 2001

- Whiskey Island Restoration (TE-27)
  - Dune and Marsh elevations ranging from +3.0 to +4.0 feet NAVD 88 with a width of 300-500 feet
  - Construction completed in July 1999

- Timbalier Island Dune and Marsh Creation (TE-40)
  - Marsh platform constructed to an elevation of 1.4 feet NAVD 88 and 800 feet wide
  - Dune elevation of +8.0 feet NAVD 88 and a dune width of 400 feet
  - Currently under construction

These projects are just a few examples of projects similar to the East/West Grand Terre Islands project that should provide input to the effectiveness of the restoration techniques using dune, beach, and marsh platforms to restore barrier islands. The varying feature designs should also provide an algorithm to test the effectiveness of each design to meet the specified goals of these and future projects.

Vegetation Plantings and Sand Fencing

Factors that may affect vegetation planting projects include soil characteristics, wave fetch, herbivore threats, and many other site specific conditions (Bahlinger 1995). The following studies support the use of vegetation plantings in barrier island restoration projects, when used in combination with sand fencing:

- Mendelssohn et al. (1991) demonstrated the success of effectively building dunes in low sediment supply systems such as the Bay Joe Wise area, by combining vegetation plantings with sand-fencing to decrease wind velocity along the dune. The three species of plants used in the study were *Panicum amarum* (bitter panicum), *Uniola paniculata* (sea oats), and *Paspalum vaginatum* (seashore paspalum). Mendelssohn et al. also concluded that straight fences with spurs were initially more successful at accumulating sand and promoting dune height than other alignments and that the only way to maintain a healthy, well-vegetated dune on Louisiana's transgressive barrier islands appeared to be through beach nourishment, dune building, and vegetative stabilization.

- In 1992, LDNR performed a restoration study on vegetation plantings which incorporated the use of *Spartina patens* (marshhay cordgrass) planted at Trinity Island, one of the four islands in the Isles Dernieres chain. By 1994, the transplanted *S. patens* along with other native vegetation such as *Salicornia virginica* (salicornia), *Baccharis halimifolia* (baccharis), *Avicennia germinans* (black mangrove), and *Solidago sempervirens* (seaside goldenrod) spread to assist in stabilizing the island (Bahlinger 1995).

Table 3 lists vegetation planting projects that have been constructed on barrier islands and funded through CWPPRA. Results from these projects suggest that the timing and scheduling of the planting is critical. Sand-fences should be installed immediately after construction to minimize immediate losses due to post-construction material adjustment and to provide a protective barrier for the plantings. Based on the best professional judgment of those involved with these projects the deposited material should be allowed to settle and dewater, prior to vegetation establishment, for approximately one complete growing season in order to minimize plant establishment in topographical depressions.

Table 3. Vegetation Plantings Implemented as Part of CWPPRA Barrier Island Restoration Projects.

Project Name	Date Planted	Date Monitored	Species Planted	# of Plants	Planting Plots	Monitoring Results
Vegetative Planting of Dredged Material Disposal on Grand Terre Island (BA-28)	May 2001	2003	*Spartina alterniflora*	35,000 plugs	Dredge Spoil Area	84.57% mean cover at 100% of the bay stations monitored.
			Avicennia germinans	600 tube containers	Dredge Spoil Area	0.1% mean cover at 7% of the dune stations monitored. 4.5% mean cover at 50% of the bay station monitored.
			Spartina patens	3,100 four-inch containers	Dredge Spoil Area	39% mean cover at 43% of the dune stations monitored.
			Panicum amarum	3,100 four-inch containers	Dredge Spoil Area	31% mean cover at 64% of the dune stations monitored.
			Spartina spartinae	3,100 four-inch containers	Dredge Spoil Area	No cover in stations monitored.
Eastern Isles Dernieres, East Island (TE-20)	July 1999	2003	*Panicum amarum*	N/A	Spur Plots	24% mean cover at 64.65% of the spur stations monitored. 18.33% mean cover at 42.86% of the unplanted stations monitored. No cover in bay stations monitored.
			Spartina patens	N/A	Spur Plots	0.55% mean cover at 28.57% of the unplanted stations monitored. No cover in spur stations.
			Spartina alterniflora	N/A	Bay Plots	No cover in bay stations monitored.
Eastern Isles Dernieres, Trinity Island (TE-24)	July 1999	2003	*Panicum amarum*	N/A	Dune and Spur Plots	20% mean cover at 7.69% of the dune stations monitored. 18% mean cover at the 30.77% of the bay stations monitored. 27.50% mean cover at 50% of the spur stations monitored. 11.75% mean cover at 36.36% of the unplanted stations monitored.
			Spartina patens	N/A	Dune Plots	76% mean cover at 7.69% of the dune stations monitored. 27.10% mean cover at 76.92% of the bay stations monitored. 7.5% mean cover at 16.67 of the spur stations monitored. 2% mean cover at 9.09% of the unplanted stations monitored.
			Spartina alterniflora	N/A	Bay Plots	No cover in bay stations monitored.
Whiskey Island Restoration (TE-27)	July 1999	2003	*Panicum amarum*	N/A	Dune and Spur Plots	46.70% mean cover at 25% of the spur stations monitored. 6.55% mean cover at 18.18% of the unplanted stations monitored. No cover in dune stations monitored.
			Spartina patens	N/A	Dune Plots	25% mean cover at 25% of the spur stations monitored. 5.67% mean cover at 27.27% of the unplanted stations monitored. No cover in dune stations monitored.
			Spartina alterniflora	N/A	Bay Plots	32.50% mean cover at 33.33% of the bay stations monitored. 0.10% at 9.09% of the unplanted stations monitored. Was not planted on dune.
Timbalier Island Planting Demonstration (TE-18)	1996	1999	*Spartina patens*	N/A	Dune	22% mean cover at 100% of the bayside stations monitored. 7% mean cover at 100% of the gulfside dune stations monitored.
			Panicum amarum	N/A	Dune	16% mean cover at 100% of the bayside dune stations monitored. 9% cover at 100% of the gulfside dune stations monitored.

*Notes: The percent cover numbers are representative of the amount of each species present during the monitoring event at a percentage of the available monitoring stations. To calculate the mean cover percentages for the entire set of stations multiply the mean cover percent by the percent of stations where the species was present

Tidal Creeks

The sustainability of any created or managed marshes requires that the marsh substrate build vertically at a rate at least equal to local rates of relative sea-level rise. In coastal salt marshes, natural processes of sediment deposition are the dominant means by which this is achieved (Frey and Basan 1985). Studies of marshes where impaired tidal hydrology has been restored show that the recovery of a salt marsh's functionality (e.g., fish utilization) is dependent upon the degree of flooding depth, duration, and frequency (Burdick et al. 1997). While marsh elevation in the tidal frame is the essential control of these hydroperiod parameters, sedimentation rates in newly re-flooded intertidal areas are the critical determinant of elevation as well as being important in the long-term sustainability of the systems (Reed et al. 1999). Haltiner et al. (1997) however, has documented that poor designing of tidal creeks in a marsh created with dredged material, in combination with a low marsh elevation, resulted in erosion rather than sedimentation in parts of the marsh system. Incorporation of tidal creeks in marsh restoration projects is a necessity to return estuarine areas from a declined state back to their natural state, but further research needs to be done and care should be taken to ensure proper design and implementation. The design of the selected marsh alternative platform should be sufficient to maintain the marsh at an intertidal level and thus allow for a functional tidal creek system.

Summary and Conclusions

The purpose of the East/West Grand Terre Islands Restoration project is to rebuild and nourish the islands using sand and marsh materials mined from the offshore borrow areas. Storm impacts, inadequate sediment supply, and relative sea level rise have altered the islands necessitating their restoration and renourishment. East Grand Terre (EGT), due to multiple breaches in its shoreline and extremely low elevation, was deemed more critical than West Grand Terre Island and thus was selected for restoration based on preliminary modeling of design alternatives for both islands exceeding the original Phase I (engineering and design) approved project construction budget.

Coastal Planning and Engineering, Inc. used hydrodynamic models to mimic island hydrology, evaluate designed alternatives, and determine the effects of dredging sand from borrow areas to determine the most cost effective means of restoring EGT. The models predicted that the selected alternatives (beach alternative 1 and marsh alternative 1) will meet only two of the project's goals. The alternatives selected to restore EGT would maintain the island shoreline seaward of the TY6 existing shoreline and create the supratidal acres necessary for increased island stability. The design marsh platform will not maximize the time the marsh remains between MHW and MLW. It will, however, be intertidal for the majority of the project life thus creating a more healthy marsh that will aid in preventing island breaching should the shoreline material be lost. It will also supply the added benefit of overwash catchment.

CPE (2004) reported that approximately 22 acres of created dune and 287 acres of created and restored marsh would remain after the 20-year project life. However, these estimates fall short of acreage approximations documented in the Wetland Value Assessment that should remain at TY20. Therefore, it is unlikely that the goal of maintaining approximately 572 acres of the created and/or restored marsh and island by the end of the 20-year project life will be achieved.

A review of both published and unpublished literature of previously constructed restoration projects similar in nature and design to the East/West Grand Terre Islands Restoration project were used to confirm the effectiveness of dune, marsh, and beaches as barrier island restoration features. Monitoring results for projects of this nature have limited documented data to suggest each feature's effectiveness, but they do provide vegetation and sand fence findings that show fences and vegetation plantings are a major component of successfully stabilizing dunes constructed for the purpose of restoring barrier islands.

The LDNR Restoration Technology Section acknowledges that island restoration may be possible if adequate abatement of impacts due to wave surges created by hurricanes and tropical storms are reduced via dune, marsh, and beach creation. Historically these weather events have been the main causes of land loss in the area. The selected alternatives may not address all of the listed goals but are the most cost efficient means of accomplishing some of the goals of this project. Creating dune, marsh, and beach should at a minimum provide a platform for overwash and transgression to help maintain East Grand Terre Island; however, due to the lack of monitoring information available on most of the constructed island projects, it is difficult to draw a conclusive opinion on the effectiveness of beach restoration projects. This project and constructed projects similar in design provide a prime opportunity to study island restoration techniques and better design future barrier islands projects.

VII. Recommendations

In their preliminary design report, the modeling firm recommended constructing beach alternative 2 and marsh alternative 1 because those alternatives achieved more of the predetermined goals as established by the 1999 WVA. However, the cost for this alternative combination was greater than what was approved for construction. Prior to the 30% Design Review, LDNR and NOAA decided to proceed towards the 95% Design Review and subsequent requesting of funds for the least costly alternatives for East Grand Terre (beach alternative 1 and marsh alternative 1), thus sacrificing attainment of some goals for budgetary constraints.

After the 30% Design Review, the design team revisited the WVA process and recalculated the habitat acreage targets using the new barrier island WVA model and boundary. The barrier island WVA model more accurately calculated the transfer rate of material to other habitat classification that was thought to be lost in the older WVA rendition. The lowering of supratidal acreages results in an increase in intertidal acres. The only change to the project that was necessary was an increase in total volume placed due to negative impacts of Hurricane Katrina which impacted the island in August of 2005, causing the loss of existing supratidal material and increases in the widths of existing breaches.

Based on the current level of design, the proposed strategies of the East/West Grand Terre Islands Restoration project would achieve some ecological benefits and warrants proceeding towards Phase II funding. The LDNR maintains its concurrence with the selection of beach alternative 1 and marsh alternative 1 as an attempt to construct the most cost effective alternatives to restore EGT. The current level of design warrants continued progress towards Phase II funding.

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