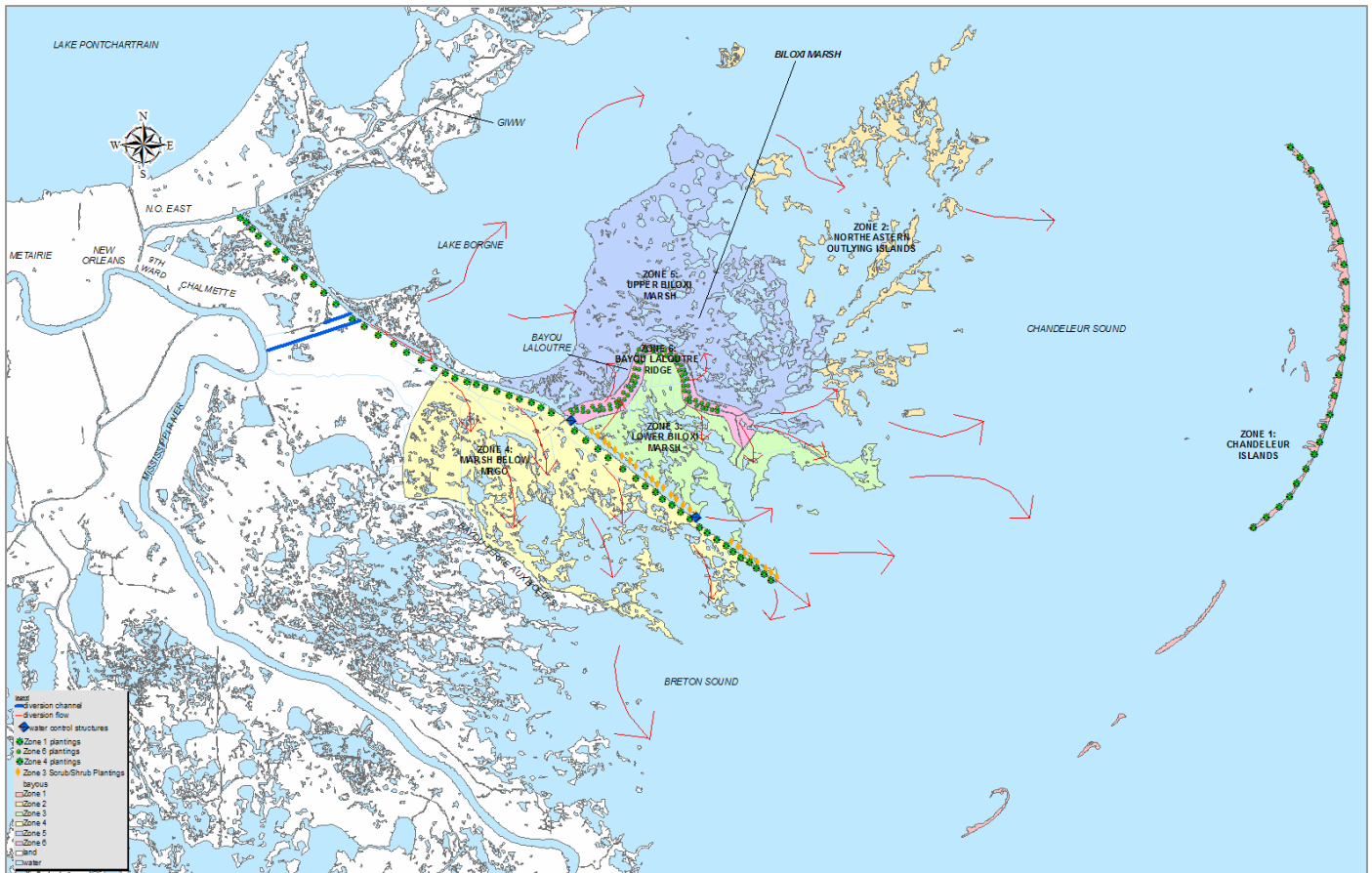


# THE BILOXI MARSH STABILIZATION AND RESTORATION PLAN

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Prepared for:

**THE BILOXI MARSH LANDS CORPORATION**

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## EXECUTIVE SUMMARY

- The Biloxi Marsh estuary is a 210,000 acre network of coastal wetlands located approximately 30 miles southeast of the City of New Orleans between Chandeleur Sound and Lake Borgne (see attached map).
- This estuary serves as a primary wave and storm surge barrier protecting the City of New Orleans and the surrounding parishes. It is also a unique and productive ecosystem that provides day-to-day benefits for the human and natural environment, including mineral exploration.
- This critical real estate has suffered significant degradation from the unintended effects of two major engineering projects: the Mississippi River levees, which prevented annual over bank flooding, and the Mississippi River Gulf Outlet (MRGO).
- Despite these negative impacts, the Biloxi Marsh estuary is geologically stable compared to other delta complexes, and therefore, restoration efforts focused in this region would have a positive impact over a longer period of time.
- The cornerstone of this plan revolves around construction of a massive freshwater diversion project aimed at restoring historic hydrology and the natural flora that affords additional protection to the area (see attached map).
- The ultimate goal of this plan is to reverse the role of the root causes that changed the hydrology of this valuable ecosystem by transforming these root causes into restoration projects that will restore protection and ecological function to six (6) specific Zones within the Biloxi Marsh estuary (see attached map):
  - Restoration Zone 1 – Chandeleur Islands
  - Restoration Zone 2 – Northeastern Outlying Islands
  - Restoration Zone 3 – Lower Biloxi Marsh below Bayou LaLoutre Ridge
  - Restoration Zone 4 – Marsh located below the MRGO
  - Restoration Zone 5 – Upper Biloxi Marsh above Bayou LaLoutre Ridge
  - Restoration Zone 6 – Bayou LaLoutre Ridge
- To accomplish this goal, this plan employs a regional approach to sustainability by incorporating synergistic projects that will achieve six specific goals:
  - Enhance the hurricane buffer for populated areas
  - Reduce land loss
  - Enhance existing habitats
  - Restore deteriorated wetlands and habitats
  - Create a sustainable ecosystem
  - Rebuild the natural, functioning ecosystem to conditions as they existed prior to construction of the manmade engineering projects which caused their degradation.

Unlike past coastal restoration projects, this plan will not employ a piecemeal approach in its search for a solution. Individual restoration techniques such as shoreline protection, vegetative plantings, water control structures, marsh terraces, and marsh creation as well as construction costs will be addressed within the plan. Completion and maintenance of these projects is expected to rebuild a sustainable ecosystem

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similar to that which existed prior to the construction of levees and the MRGO as well as provide protection to New Orleans and surrounding parishes.

This plan was created through a collaborative effort by the following participants and funded solely by the Biloxi Marsh Lands Corporation and Lake Eugenie Land and Development, Inc.; owners of approximately 150,000 acres of the Biloxi Marsh.

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## INTRODUCTION

The Biloxi Marsh complex is located approximately 30 miles southeast and seaward of the City of New Orleans. It is a primary wave and storm surge barrier protecting the City of New Orleans and the surrounding parishes, as well as the predominant feature of the Lower Pontchartrain Sub-basin. In an effort to ensure the Biloxi Marsh is restored and stabilized, this Plan was created by examining all the regional issues leading to the degradation of the Biloxi Marsh and outlines the necessary steps to rectify the various root causes of that degradation. As historically predominant with past coastal restoration projects, a piecemeal approach will not be employed. This Plan assembles a group of synergistic projects which utilizes and restores existing topography in an attempt to rebuild a sustainable regional ecosystem which includes the Biloxi Marsh as its predominant feature. One major component of the Plan transforms the Mississippi River Gulf Outlet (MRGO) into a beneficial conduit of fresh water and sediment to restore and stabilize the coastline. The area's unique geology and low subsidence rates makes its potential for sustainability higher than other areas within the coastal Zone of Louisiana.

The start of the degradation process was the building of levees along the banks of the Mississippi River. The construction of these levees prevented routine over bank flooding events negatively impacting the Biloxi Marsh, particularly the Bayou LaLoutre Ridge, which if restored and replanted acts as a significant wave and storm surge barrier for New Orleans and the surrounding parishes. The lack of sediment has also affected the sustainability of the Chandeleur Islands. The Chandeleur Islands act as the primary line of defense for protecting southeastern Louisiana from hurricane waves and storm surge and provides day to day protection of the Biloxi Marsh complex from prevailing southeasterly winds.

The second major engineering project that exacerbated and accelerated the degradation of the Biloxi Marsh was the construction of the 76 mile long Mississippi River Gulf Outlet (MRGO) ship channel. This deep draft navigation channel, originally

intended to be an economic boom to the area has, in reality, been an underutilized and poorly maintained environmental disaster. The original servitude obtained from land owners limited the channel's width to 500 feet. Due to ongoing dredging of the channel to depths of 40 feet and the lack of bank stabilization, the MRGO now far exceeds the width of its servitude, with widths exceeding 2,700 feet in some areas. This deep channel combined with its ongoing widening causes two significant problems: 1) it allows saltwater to move inland, altering the regional ecosystem as well as the ecosystems within the Biloxi Marsh, killing oak trees along the Bayou LaLoutre Ridge, and causing saltwater intrusion as far north as the Lake Maurepas Swamp; 2) more importantly, at its current width and depth it acts as a major conduit for storm surges headed inshore toward New Orleans and the surrounding parishes.

This plan will address six specific goals for stabilizing and restoring the Biloxi Marsh through synergistic planning:

1. Enhance the hurricane buffer for populated areas
2. Reduce land loss
3. Enhance existing habitats
4. Restore deteriorated wetlands and habitats
5. Create a sustainable ecosystem
6. Rebuild the natural, functioning ecosystem to conditions as they existed prior to construction of the manmade engineering projects which caused their degradation

In an effort to organize the plan and make it synergistic, the region was broken into six geographic Zones. To accomplish project goals, restoration and protection techniques were applied to each Zone. The six Zones are as follows:

1. Restoration Zone 1: Chandeleur Islands
2. Restoration Zone 2: Northeastern Outlying Islands
3. Restoration Zone 3: Lower Biloxi Marsh
4. Restoration Zone 4: Marshes below MRGO
5. Restoration Zone 5: Upper Biloxi Marsh

## 6. Restoration Zone 6: Bayou LaLoutre ridge

The initial cornerstone of this Plan will be to rebuild the Chandeleur Islands using natural and manmade wave and storm surge protection barriers designed to recreate the wave breaking effects provided when the island was still one large continuous, elevated and vegetated land mass. The beneficial effects of an island populated by dense vegetation cannot be underestimated as a wave and storm surge barrier for the Biloxi Marsh, but more importantly for New Orleans and the surrounding parishes.

The next cornerstone of the plan and predominant concept is the use of the MRGO as a conduit for fresh water and sediment. The Plan proposes two alternative means of introducing fresh water and sediment into MRGO. The first is the deepening and straightening of the existing Violet Canal. Alternately and preferably, the Plan will propose digging a new canal just below the existing Violet Canal. The building of water control structures at the junction of the Violet Canal or the alternative Canal and the Mississippi River, and on the MRGO immediately below Bayou LaLoutre will also be proposed. Additionally, the MRGO should be narrowed to its original legal servitude width of 500 feet with the banks stabilized. During periods of high water on the Mississippi River these projects, acting in combination, should allow water velocities necessary to move much needed fresh water and sediments to the Biloxi Marsh as well as to regions beyond, such as the Mississippi Sound. If utilized in this way, the MRGO would be transformed from an ecological catastrophe into a useful and advantageous tool for rebuilding the coastline. All dredging deeper than that needed to provide sufficient water velocity to move fresh water and sediment while accommodating economically viable marine traffic should be stopped. These strategies will be discussed in greater detail in the body of this report, including design plans and costs.

## HISTORICAL CONTEXT AND PLAN DEVELOPMENT

The Biloxi Marsh estuary is a 210,000 acre network of coastal wetlands. Biloxi Marsh Lands Corporation (BLMC) and its sister company Lake Eugenie Land & Development, Inc. (LKEU) together own approximately 150,000 acres of the Biloxi Marsh. BLMC and LKEU are currently under the same management with very similar ownership. Each company's ownership of the land and internal bodies of water dates back to the early 1900s. BLMC and LKEU derive the majority of their income from oil and gas exploration and development activities which take place on or near their respective property. Through contractual agreements with the oil and gas companies conducting the exploration and development, each company actively manages its assets through funded oversight and requirements that all mitigation take place on their property. This contractual requirement that all statutory mitigation take place on each company's property has recently resulted in the restoration of several areas.

For the nearly fifty years, BLMC has leased close to 40,000 acres to the State of Louisiana for the establishment and maintenance of the Biloxi-Wildlife Management Area (WMA). The Biloxi-WMA provides a massive area on which the public can hunt, fish and view wildlife. During the early days of the Biloxi-WMA, Biloxi Marsh Lands Corporation in conjunction with the Louisiana Department of Wildlife and Fisheries (LDWF) employed marsh management techniques such as the building of wooden and earthen dams across bayous to trap fresh water in the marsh. Changes in regulatory schemes since the inception of the Biloxi-WMA have prevented the continuation of employing these marsh management techniques.

The *Biloxi Marsh Stabilization and Restoration Plan* was conceived and funded several years prior to Hurricanes Katrina and Rita by Biloxi Marsh Lands Corporation. Its initial scope was to operate within the limitations of the Louisiana Coastal Area Study (LCA) and was limited to the Biloxi Marsh estuary. Hurricanes Katrina and Rita have caused significant damage to the Biloxi Marsh and the region bringing to the forefront the need to preserve and protect the wetlands seaward of the City of New Orleans and the

surrounding parishes. Due to these events Biloxi Marsh Lands Corporation authorized additional funding, added experts to the development team and increased the scope the Plan to make it more regional while adding specificity. The major component which was added is the major fresh water diversion.

## **FRESHWATER DIVERSION**

Formation of the Biloxi Marsh occurred more than 2000 years ago through annual flood cycles within the St. Bernard delta complex of the Mississippi River. Annual river cycles within this marsh complex caused sediment deposition during periods of over-bank flooding. Although the Biloxi Marsh is relatively stable compared to other delta complexes (Calvin 2002), this estuary has suffered degradation from the unintended effects of two major engineering projects: (1) construction of the Mississippi River levees and (2) creation of the MRGO. These projects essentially deprived the area of river sediments and nutrients and ultimately severed the lifeline that nature had created for hundreds of years.

Therefore, a cornerstone of this plan is a massive river diversion designed to reverse this situation – to transform the MRGO from a source of habitat degradation and human exposure into a solution for habitat restoration and human protection. The project will re-introduce freshwater, sediment, and nutrients into the estuary, restoring historic hydrology. A restored hydrology, dominated by river flows, will help to re-establish a natural and diverse habitat gradient, with forested wetlands and fresh marshes on the northern fringes, intermediate and brackish marshes in the middle regions, and saltwater marshes at the edge of the Gulf of Mexico. The major components of the diversion project include a diversion channel, MRGO modifications, and water control structures. These components of the freshwater diversion project are illustrated in Figure 1.

## Freshwater Diversion Planning

The use of freshwater diversions to offset salinity increases and restore the wetlands of the Biloxi Marsh area has a long history in coastal wetland restoration planning. Starting in the early 1970's and continuing to the present (May 2006), river diversions have consistently been proposed in federal, state and private plans. In addition, the salinity of the western portion of Mississippi sound can also be significantly affected by diversions of Mississippi River water. McCorquodale and Georgiou (2003) have shown that diversions at Blind River, Bonnet Carre, California Bay, Caernarvon, White Ditch and Bayou Lamoque can cumulatively reduce the mid-April salinity immediately north of the Chandeleur Islands by as much as 6 ppt, from about 22.5 ppt for conditions without increased diversions, to about 16.7 ppt with major diversions. This salinity reduction extends over the whole area north of the Chandeleur Islands and the Mississippi shoreline, from 88.6 to 89.0 degrees west longitude.

In 1975, Coastal Environments Inc. proposed a multiuse management plan for the eastern side of the Mississippi River to optimize salinity conditions and restore land building processes by employing freshwater diversions. This concept has been supported by the Citizen's Program for Coastal Preservation and Restoration and the Environmental Protection Agency in 1987 and by Templet and Meyer-Arendt in 1988. In 1990, this approach was recommended by the U. S. Army Corps of Engineers (USACE) and the Louisiana Land Owners Association.

The initial Louisiana Coastal Wetlands Restoration Plan, prepared in 1993 under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), called for implementing nine strategies to address the Pontchartrain Basin wetland problems. These strategies included introducing freshwater to reduce salinity and preserve marsh, closing or putting a gate on the MRGO, and creating marsh through the introduction of sediments.

The Governor's Office of Coastal Activities in 1994 prepared an environmental-economic blueprint for restoring the Louisiana coastal Zone that included both defensive

and offensive measures for the Biloxi Marsh area. The plan called for a freshwater diversion at Bonnet Carre of up to 30,000 cfs and a conveyance channel at Violet. The conveyance channel would include part of the MRGO and branch to the east along the southern side of Lake Borgne. The MRGO was to be closed with a structure where it crosses Bayou LaLoutre, with the MRGO remaining open both to the north and south of the closure.

Recent coastal restoration planning efforts have continued to emphasize the importance of freshwater diversions in producing a sustainable marsh. The Coast 2050 plan included a freshwater diversion at Violet, closing MRGO, stabilizing the north bank of MRGO, constricting the breaches into Lake Borgne, and marsh creation as regional ecosystem strategies. The current planning efforts being conducted by the federal government through the Louisiana Coastal Protection and Restoration Project (LACPR) and the state through the Coastal Protection and Restoration Authority (CPRA) have also included diversions, marsh creation and the management of MRGO.

### Modeling of Diversions

Quantitative evaluations of the effects of freshwater diversions have been limited. The hydrologic effect of MRGO on the salinity of the Biloxi Marsh area was evaluated by the U. S. Army Corps of Engineers' Committee on Tidal Hydraulics in 1995. They found that the increase in the average salinity of the Biloxi Marsh area caused by MRGO could be reduced by a combination of increased freshwater input and reduction of the tidal exchange of salt water into and out of MRGO. The reduction of the salt water intrusion would be accomplished by managing the flow of water into the bayous intersecting MRGO.

Pyburn and Odom (1996) considered several options for diverting water from the Mississippi River into the Biloxi Marsh area in order to reduce the salinity of water in the Biloxi Marsh area. One option was to divert water at the MRGO lock located at the connection of the Inner Harbor Navigation Canal (IHNC) and the Mississippi River. The

design consisted of box culverts able to divert up to a maximum of 30,000 cfs during the month of April.

As part of the Bonnet Carre Freshwater Diversion project a numerical modeling investigation of the Pontchartrain basin estuary salinity changes was conducted by the Hydraulics Laboratory at the USACE Waterways Experiment Station (McAnally and Berger, 1996). The purpose of the diversion project was to reduce the salinity in the Biloxi Marsh by 2 to 8 ppt in order to improve oyster productivity. Their results indicated that the estuary responded very slowly to the input of freshwater into the system with the effects on the Biloxi Marsh salinity occurring approximately 60 days after freshwater introduction. They also concluded that MRGO was a significant contributor to the salinity regime in the Biloxi Marsh area and that closing the connections between Lake Borgne and MRGO would reduce salinities up to 2 ppt between April through August time period.

McCorquodale and Georgiou (2003) conducted hydrodynamic modeling of Biloxi Marsh area as part of the Louisiana Coastal Area (LCA) study (U.S. Army Corps of Engineers 2004). The objective of the work was to model the hydrologic and salinity regimes that various freshwater diversions would create. Six diversion sites were included in the modeling; Bonnet Carre, Hope Canal, Caenarvon, California Bay, Whites Ditch and Bayou Lamoque. Diversion amounts for the mean monthly flow ranged from a low condition of about 1,000 cfs to a high of over 200,000 cfs. The various diversion amounts had a major impact on the salinity of the water east of the Biloxi Marsh. The average annual salinity for the base condition ranged between 20 ppt for lower flow conditions to 12 ppt for the higher flow conditions. Interior water salinity was reduced to less than 4 ppt under the greatest amount of diversion.

### Current Issues

Historically, the limitation of the current planning for the restoration of the Biloxi Marsh area is the lack of a full quantitative evaluation of the sustainability of the marsh in the light of continuing natural and man-made threats, and the role of wetland features in

providing hurricane flood protection. Details concerning the management of the water have not been provided in previous plans. Also the ability of small and moderate diversions to create emergent wetlands is limited to areas adjacent to the river and will take many years to accomplish. Finally, there has been little integration of the placement of sediments through pipeline conveyance into the overall planning for coastal restoration and marsh building.

The **new concept** being advocated in this plan is to manage the freshwater diversion approach by focusing on three issues:

1. The MRGO will be re-designed to facilitate its use as a means for controlling the dispersion of diverted water into the Biloxi Marsh area and wetlands southwest of the MRGO.
2. Rebuilding and sustaining the wetlands in the area will be accelerated with pipeline conveyed sediments accumulated at the diversion outflow or from existing water bottom sediments.
3. The restoration planning will include obtaining hurricane flood protection benefits.

### Diversion Channel

This Plan will capitalize on the close proximity of the Mississippi River to the MRGO. It is proposed that a diversion channel from the Mississippi River be constructed at one of two locations:

1. The preferred diversion channel location would be south of and parallel to the Violet Canal (Figure 1). The proposed corridor would be at a location that would least affect existing infrastructure.
2. A less preferred diversion channel location would be a widened and straightened Violet Canal connecting the Mississippi River and the MRGO. Any utilization of this corridor as a significant diversion location has been opposed in the past by local concerns because of the impacts to existing infrastructure.

The size of the diversion channel and its flow rate would be based on designs sufficient to carry a sediment load capable of restoring and sustaining the Biloxi Marsh and

surrounding areas. In order to better identify the size and capacity of the recommended diversion, BMLC is soliciting federal emergency appropriations for a diversion channel evaluation and has assembled a team of coastal resource experts to begin preliminary evaluation. The evaluation team anticipates the diversion channel will flow Mississippi River waters into the region between 40,000 – 110,000 cfs.

### MRGO Modifications

The diversion channel described above will deliver river water directly into the MRGO near the southwestern portion of Lake Borgne. The MRGO would then carry the river water southeasterly toward the Gulf of Mexico where it would be distributed through a series of water control structures into Bayou LaLoutre and into adjoining waterways and marshlands bordering both sides of the MRGO. For the MRGO to provide the maximum benefit as a freshwater and sediment conduit, it should be modified with the following features:

- a) The bank lines should be re-established at the original servitude width of 500 feet. These new armored banks would be created using large boulders or equivalent. Gaps would be placed at strategic points to allow water exchange and the ingress and egress of estuarine organisms. The narrowed channel would force water to flow faster and would increase its sediment-carrying capacity.
- b) Dredging in the narrowed channel would be strictly limited, with width and depth to be determined primarily by hydrologic requirements while taking into consideration depths needed to allow marine traffic to use the waterway. Hydrologic modeling is needed to determine the optimal design to accommodate fresh water and sediment flow. Accommodation of marine traffic will be considered, as long as these requirements do not negatively affect the capacity of the freshwater diversion project.
- c) The open water behind the new armored bank lines would be backfilled to create marsh and forested ridge platforms.
- d) Trees will be planted on existing dredged spoil banks and on newly created ridges behind the armored banks to improve wildlife habitat and to

serve as a protective buffer for inland infrastructure. During Hurricane Katrina, forested buffers provided valuable wave-breaking benefits that reduced erosion of nearby protection levees (Mashriqui, personal communication, April 4, 2006). This plan will extend the benefits of this type of natural armoring to other populated areas, including Chalmette.

### Water Control Structures

A third component of the diversion project is construction of two large water control structures in the MRGO: one at the intersection of Bayou LaLoutre, and the other near Lake Athanasio. These structures will provide two main benefits. First, they will allow for the allocation of river water into Bayou LaLoutre, then into the marshlands north and south of the Bayou LaLoutre ridge. Both Bayou LaLoutre and the MRGO south of the Bayou LaLoutre ridge would be restored as distributaries of freshwater and sediment into the Biloxi and Bayou Terre Aux Boeuf marshes. Second, the structures would serve as barriers to salt water intrusion during times of low river stages and as barriers to storm surges traveling up the MRGO towards the greater New Orleans metropolitan area.

The structures can be designed to accommodate marine traffic. A cost benefit analysis should be done to compare the cost of constructing a structure that can accommodate all or part of the expected marine traffic to the cost of relocating all or part of the marine facilities/terminals presently dependent on the MRGO. The design for these structures would be similar to that planned for the MRGO in the *St. Bernard Parish, Louisiana: A plan for Protection from Future Hurricanes* (Gagliano 2005).

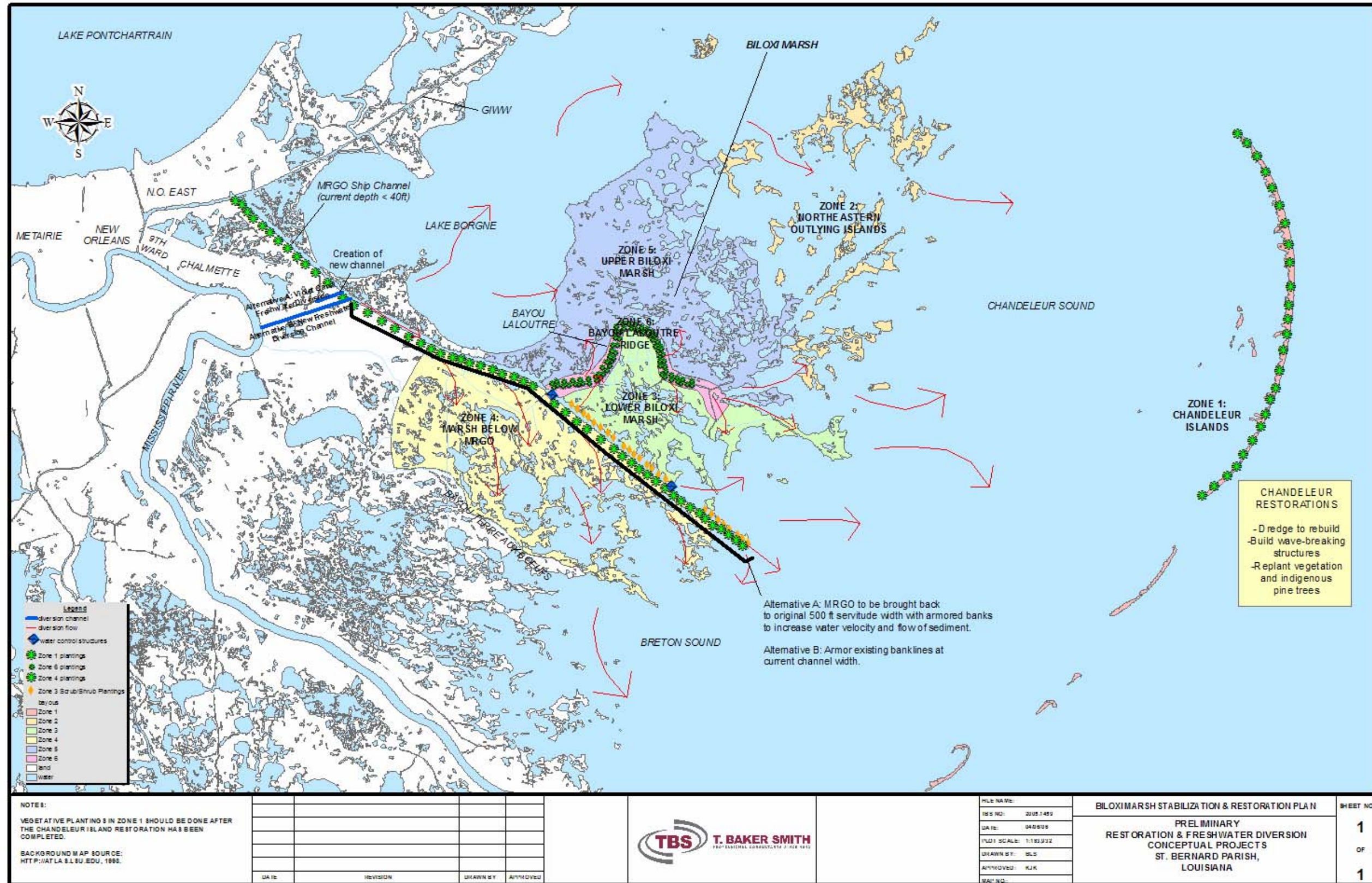


Figure 1. Proposed Freshwater Diversion Project

## BILOXI MARSH SUSTAINABILTY

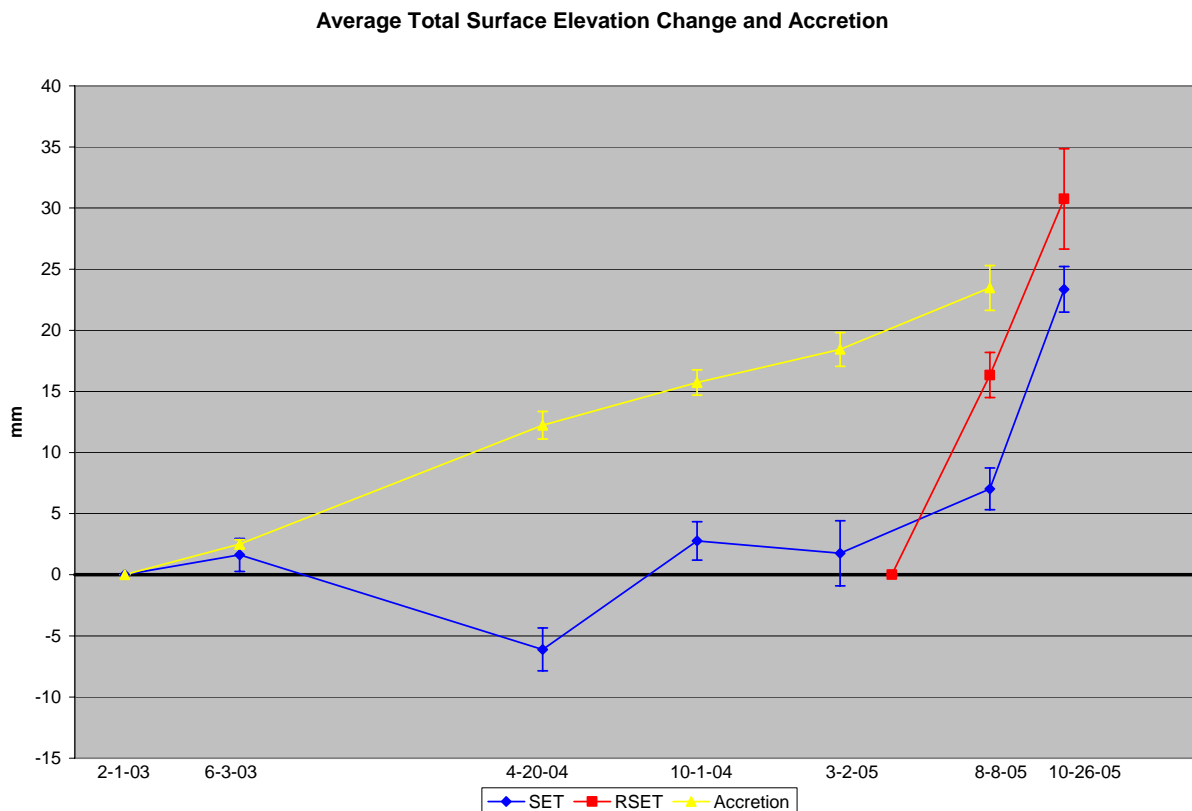
One of the concerns most frequently expressed regarding the restoration of coastal marshes in Louisiana, is that subsidence rates are so high that restored marshes are unlikely to be sustainable. The prediction of 21<sup>st</sup> century subsidence rates is complex, but most scientists agree that rates are unlikely to be higher than those experienced during the late 20<sup>th</sup> century when measured rates exceeded 1 cm/yr in many places. However, measurements of both subsidence and marsh soil development in the Biloxi Marsh show that marshes there are sustainable now and should be well into the future.

One of the key differences is that subsidence rates are lower in the St. Bernard Delta than in other parts of the Deltaic Plain (Gagliano, 1999). This is variously attributed to the age of the deltaic sediments, that the area does not lay over the deeply entrenched valley of the Mississippi where recent sediments are thickest, and/or the relative lack of canals from oil and gas extraction activities in the area. The sustainability of the marshes, however, depends on the balance between the subsidence rate and the rate at which marsh soils are being built.

The hydrology of the Biloxi Marsh, with the exception of the MRGO channel, has been largely unaltered. There are relatively few canals remaining from early oil and gas exploration, and current management of the land requires that oil and gas activities limit their effect on marsh hydrology. Soils are building up and maintaining their elevation in the face of subsidence and sea-level rise through a combination of organic matter accumulation (mostly plants roots) and periodic inputs of sediment. Even though there is no direct supply of sediment to these marshes from the Mississippi River, tropical storms events stir up bottom sediments from the Chandeleur Sound which are carried over the Biloxi Marsh by increased water levels and deposited as the storm waters recede.

Preliminary results from studies by the University of New Orleans (Reed, unpublished) show that over a two year period (February 2003 – March 2005) over 20 mm of material

was deposited on the salt marsh surface in the Blind Lagoon area (accretion in Figure 2). The elevation of the marsh, however, is also influenced by compaction of the soil beneath. The SET measurements in Figure 2 show that sometimes this compaction can outweigh the gain. This loss of elevation of a few mm, such as that shown in April 2004, can be due to plant growth cycles or seasonal changes in water levels. Importantly, net compaction is effectively balanced in these marshes by the inputs of material from storms. The increase in elevation between April and October 2004 is attributed to sediment inputs from Hurricane Ivan. Elevation also increased between March and August of 2005 due to late cold fronts and the effects of Tropical Storm Cindy. The dramatic increase between August and October is attributed to Hurricanes Katrina and Rita which left substantial sediment packages in these marshes. For the more brackish marshes of the Stump Lagoon area, the effects of Katrina and Rita were even more dramatic with elevation increase between August and October 2005 of over 35mm.



**Figure 2. Measurements of marsh soil development in salt marshes near Blind Lagoon. Accretion measures sediment of the surface of the marsh. SET measures net elevation change over the top ~6m of marsh, and RSET over the entire package of recent sediment (~20m). Data are averages from 15 locations.**

The concerns many express regarding the vertical sustainability of present or restored marshes in Louisiana, do not apply to the Biloxi Marsh. Their lower subsidence rates and largely unaltered marsh hydrology allow the marshes there to build their soils through natural processes. These processes will also influence any new marshes built in this area. Despite the relative vertical sustainability of the existing marshes, the Biloxi Marsh shorelines continue to convert to open water due to wave erosion during summer winds and especially tropical storms. This means there is a continual conversion of the marsh to open water which must be offset to ensure the entire sustainability of the system. The introduction of Mississippi River waters into the Biloxi Marsh can provide the sediments needed to convert open water areas to the elevation where marsh plants can grow, thus maintaining marsh area. Such a diversion would also supplement existing natural processes of accretion. As sediment is one of the most fundamental

limiting resources for coastal restoration in Louisiana, using the natural processes already operating in the Biloxi Marsh to sustain marshes and introducing a new sediment source are both an efficient and effective approach to sustaining existing marshes and building new vegetated wetlands.

## RESTORATION ZONES

The sustaining of existing marsh and building of vegetated wetlands through the natural processes of organic matter accumulation and Mississippi River sediment delivery is a slow process. While the diversion channel is being constructed, it will be necessary to protect and restore existing marshlands. These wetlands are being lost at an alarming rate due to wave and wake erosion, and wind and storm surge damage during tropical storm events. In order to offset the ongoing and accelerating land-loss for this area, individual restoration techniques have been designed for six Restoration Zones within the Biloxi Marsh estuary. Each Zone is briefly described with the major degradation force(s) affecting each respective Zone outlined. Land-loss calculations have been performed and illustrated for each Zone summarizing the extent and location from 2001 to 2005 using satellite imagery. This data used in conjunction with soils data, knowledge of restoration techniques, and anecdotal information aided in selecting individual restoration project locations. It is important that the corresponding "Figure" is referenced to understand each Restoration Zone's *Conceptual Projects*.

Areas and techniques selected for restoration and stabilization within this regional plan parallel those outlined in the Louisiana Coastal Protection and Restoration (LACPR) Preliminary Technical Report to Congress, as well as recognition of the Biloxi Marsh as a natural line of defense to tropical events. Specifically mentioned within the LACPR report are wave breaks, ridge refurbishment, marsh nourishment, and freshwater introduction into the region (USFWS 2006).

Vegetative plantings consist of three types; scrub/shrub, tree plantings and planting of marsh grass. The planting of marsh grass in muskrat eat-out areas is difficult to quantify from land-loss analysis due to the nature of muskrat populations and the natural re-generative ability of the marsh, however, this degradation problem should be addressed. To account for this problem 1.5% of the current land mass within Restoration Zone 5 should be selected for vegetative planting of muskrat eat-outs as this is the Zone of greatest concern for muskrat populations.

## **RESTORATION ZONE 1 – CHANDELEUR ISLANDS**

### Introduction

Restoration Zone 1, the Chandeleur Islands is characterized as the largest barrier island arc in the Gulf of Mexico forming a protective wave and storm surge barrier for the Biloxi Marsh as well as the New Orleans, St. Bernard Parish, and all Parishes along the shorelines of Lake Borgne and Lake Pontchartrain. Importantly, this island chain serves a day to day protector to the Biloxi Marsh from the erosion caused waves generated at sea by the southeasterly prevailing winds hitting the marsh unabated by a barrier island. Advanced Circulation Model (ADCIRC) modeling by the USACE and Interagency Performance Evaluation Task Force (IPET) demonstrate the Chandeleur Islands reduce wave and storm surge conditions impacting the mainland of southeast Louisiana. The Chandeleur Islands are included in the Breton National Wildlife Refuge (NWR) ([http://www.stateparks.com/Breton\\_nwr.html](http://www.stateparks.com/Breton_nwr.html)). All Federally-owned lands, except for North Breton Island, in Breton NWR became part of the National Wilderness Preservation System on January 3, 1975 (Public Law 93-632). Breton Wilderness, according to the Clean Air Act, is listed as a Class I Prevention of Significant Deterioration Area. Class I areas are the most stringently regulated as they are generally locations that have remained untouched by industry. This listing limits significant restoration efforts within this Zone and must be addressed. The U.S. Fish and Wildlife Service, the lead natural resource trustee, advocates large-scale restoration and planning for the NWR so that changes in existing legislation can be addressed (James Harris-USFWS, personnel communication). Legislation allowing

large-scale and/or site-specific restoration is ultimately needed in the Chandeleur Islands. Restoration Zone 1, the Chandeleur Islands is characterized as the largest barrier island arc in the Gulf of Mexico forming a protective wave and storm surge barrier for New Orleans and southeast Louisiana.

### Land Loss Analysis

In 2001, the Chandeleur Islands measured 7,420 acres in area. Historic change analysis over the last 100 years document that the Chandeleur Islands undergo well-established storm impact cycles of land loss followed by post-storm recovery conditions of land gain. The overall result, however, has been the ongoing degradation of the Chandeleur Islands and a net loss of land and island elevations. The impact of Hurricane Katrina eroded away 2,206 acres of land in the Chandeleur Islands representing a decrease of 29.7% in area (Figure 3). The average rate of shoreline erosion is 44.3 feet per year. Much of the land loss occurs along the Gulf shoreline and the pre-existing washover channels. Restoration in the Chandeleur Islands should take advantage of the storm impact cycle process.

### Conceptual Projects

Recommended restoration projects for Zone 1 include a program of annual vegetative plantings, beach/dune/marsh platform creation, and the use of coastal engineering structures. The need to make this program a continual and annual event should not be under estimated. All areas degraded as a result of Hurricane Katrina are recommended for immediate restoration.

- Annual Vegetative Plantings – The Chandeleur Islands Marsh Restoration CWPPRA Project PO-27 (<http://www.la.coast.gov/reports/display.asp?project+number+PO-27&reportType+general>) demonstrated that a dedicated program of annual vegetative planting is very cost-effective in bringing backbarrier marshes back in service.
- Beach/dune/marsh platform creation – Using shallow water delivery of sediment to the Chandeleur Islands can create beach/dune/marsh platform environments to sustain barrier island arc longevity. Restoration cycles on a 5 year schedule

will ensure the Chandeleur Islands remain the primary storm barrier for New Orleans and southeast Louisiana for generations to come.

- Coastal engineering structures – The use of breakwaters, terminal groins, and shoreline armoring must be an integral part of the restoration and sustainability effort. Although protection and restoration of the Chandeleur Islands through vegetative plantings and sediment delivery for beach/dune/marsh are the preferred methods of sustaining the Chandeleur Islands in a more natural state, these restoration techniques are insufficient in maintaining the island chain. Both vegetative plantings and beach/dune/marsh platform creation must themselves be protected from the intense erosion processes of the wave generated forces of the Gulf of Mexico. Since Hurricane George in 1998, a succession of very intense hurricanes have cut through the island chain and severely impaired their ability to stabilize and recover to any substantial degree through natural processes. In the aftermath of Hurricanes Katrina and Rita, it is now believed coastal engineering structures that provide hard structure armoring and storm surge dampening are essential to maintaining the very existence of the Chandeleur Islands. Loss of this barrier island chain is unacceptable. If this unique habitat, the Biloxi Marsh, and the metropolitan areas of St. Bernard Parish and New Orleans are to be preserved, strong consideration must be given for the utilization of coastal engineering structures as a means for protecting this valuable ecosystem and maintaining the Chandeleur Islands as the first line of defense against tropical storms. All restoration and protection techniques available should be used in concert to accomplish the goal of restoring the Chandeleur Islands.

Project Costs

**Table 1. Estimated Projects Costs for Restoration Zone 1**

<b>Project</b>	<b>Quantity</b>	<b>Cost</b>	<b>Total Project Cost</b>
Marsh platform/dune creation	2206 acres	\$51,000/acre	\$112,506,000
Annual vegetative plantings	364 acres	\$3,956/acre	\$1,440,000
Coastal Structure Analysis			\$750,000 – 1,250,000
<b>Restoration Zone 1 Total:</b>			<b>\$114,696,000 – 115,196,000</b>

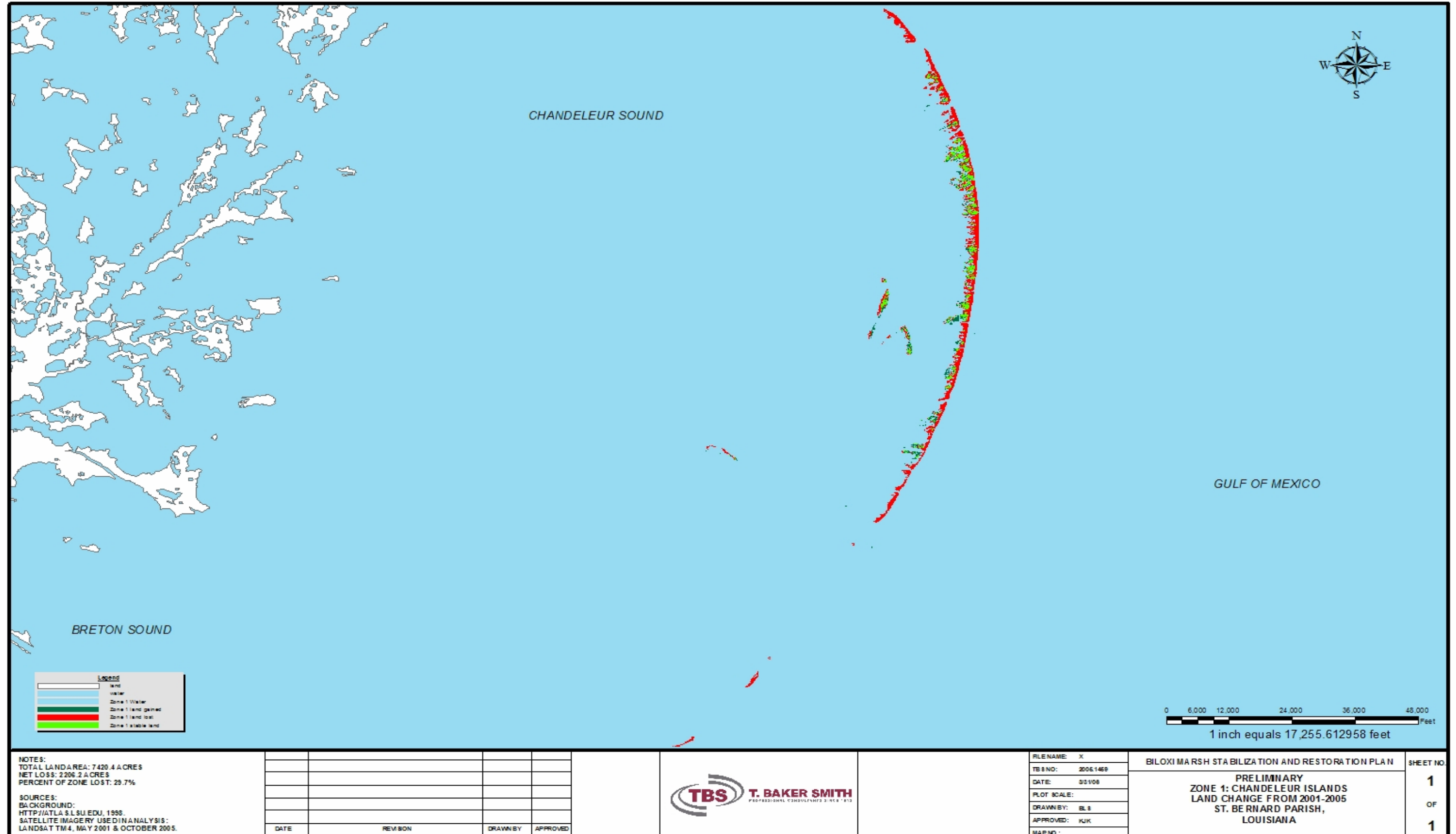


Figure 3. Land loss within restoration zone 1

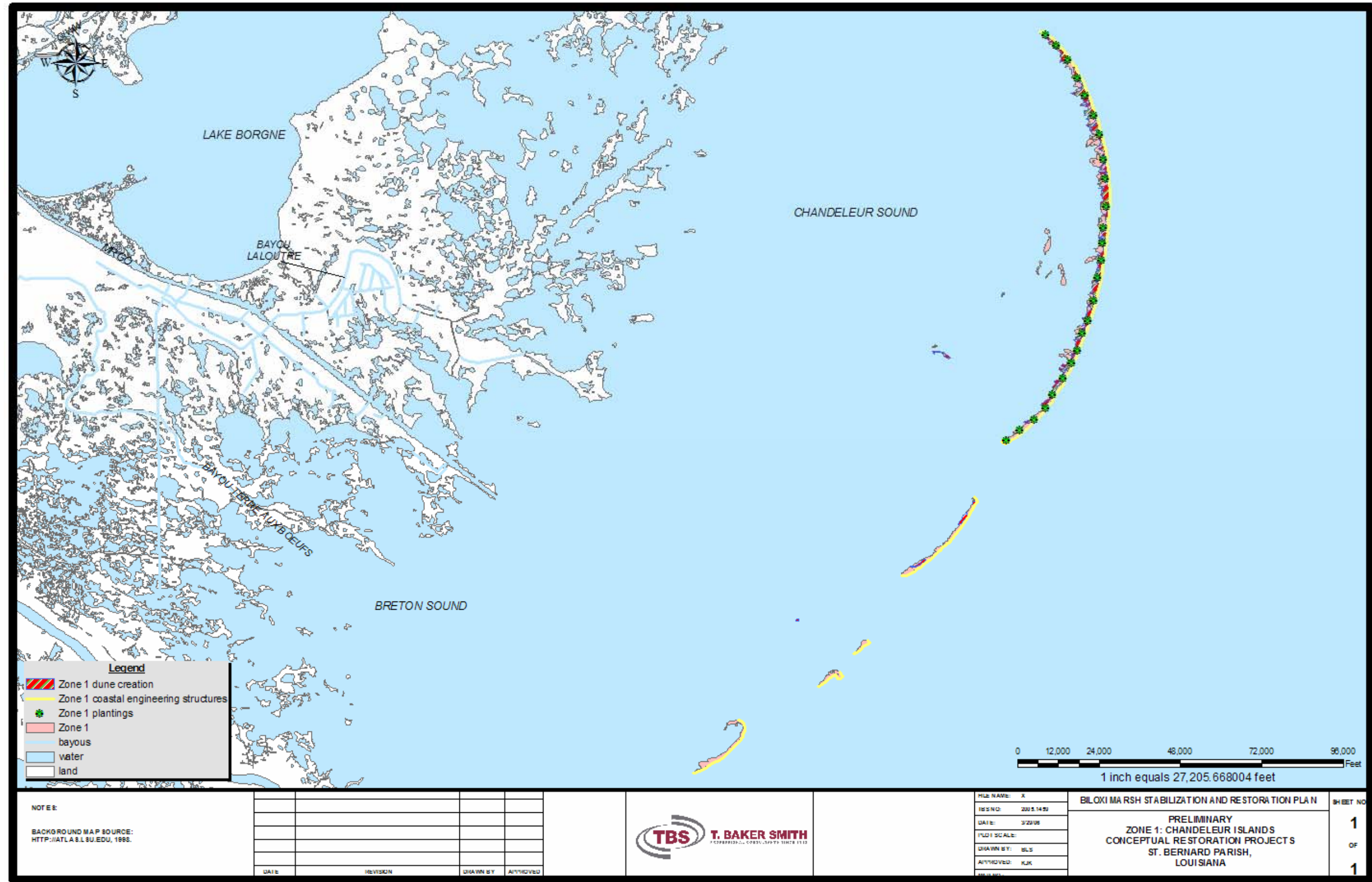


Figure 4. Proposed restoration projects within restoration zone 1

## **RESTORATION ZONE 2 – NORTHEASTERN OUTLYING ISLANDS**

### Introduction

This Restoration Zone is an isolated island chain north and east of Zone 5. This Zone is the northern most area of interest for this management plan and has shown the highest amount of land loss in the Biloxi Marsh complex. This area is characterized by scattered islands, bays and large open water lakes, including False Mouth Bay, Bay Boudreau, Drum Bay and Shell Island Lake. This entire Zone is under constant threat from active erosional forces generated as wave fetch develops across the exposed bays and lakes. This problem occurs on a daily basis and is exacerbated during tropical events. This Zone provides protection from wave energy and storm surge to the East Orleans Land Bridge and the Rigolets Pass area.

### Land Loss Analysis

Currently, 30,290 acres are contained within this Zone. Approximately 1,297 acres of land loss has occurred in this area from 2001 to 2005 representing a 4.3% decrease in the regional land mass (Figure 5). Much of this land loss is located at the land/water interface with increased rates along those areas facing the Chandeleur Sound.

### Conceptual Projects

Suggested restoration/stabilization projects for this particular area include bank armament and vegetative plantings and marsh creation/nourishment (Figure 6). This area provides seaward protection to the interior Biloxi Marsh, emphasizing the need for bank armament along those areas facing the Chandeleur Sound. However, if the area shows future regeneration due to the freshwater diversion and bank armament, additional restoration efforts could be effectively utilized.

### Project Costs

Total project costs for this Restoration Zone are estimated between \$35,142,800 and \$62,988,000 (Table 2). The variation in cost is dependent on the type of bank armament chosen for restoration and enhancement purposes.

**Table 2. Estimated Projects Costs for Restoration Zone 2**

<b>Project</b>	<b>Quantity</b>	<b>Cost</b>	<b>Total Project Cost</b>
Bank Armament	196,618	\$110 – 125/linear foot	\$21,628,000 – 24,578,000
Plantings (vegetative)	454	\$25,000/acre	\$11,350,000
Marsh Creation	451	\$4,800 - \$60,000/acre	\$2,164,800 – 27,060,000
<b>Restoration Zone 2 Total:</b>			<b>\$35,142,800 – 62,988,000</b>

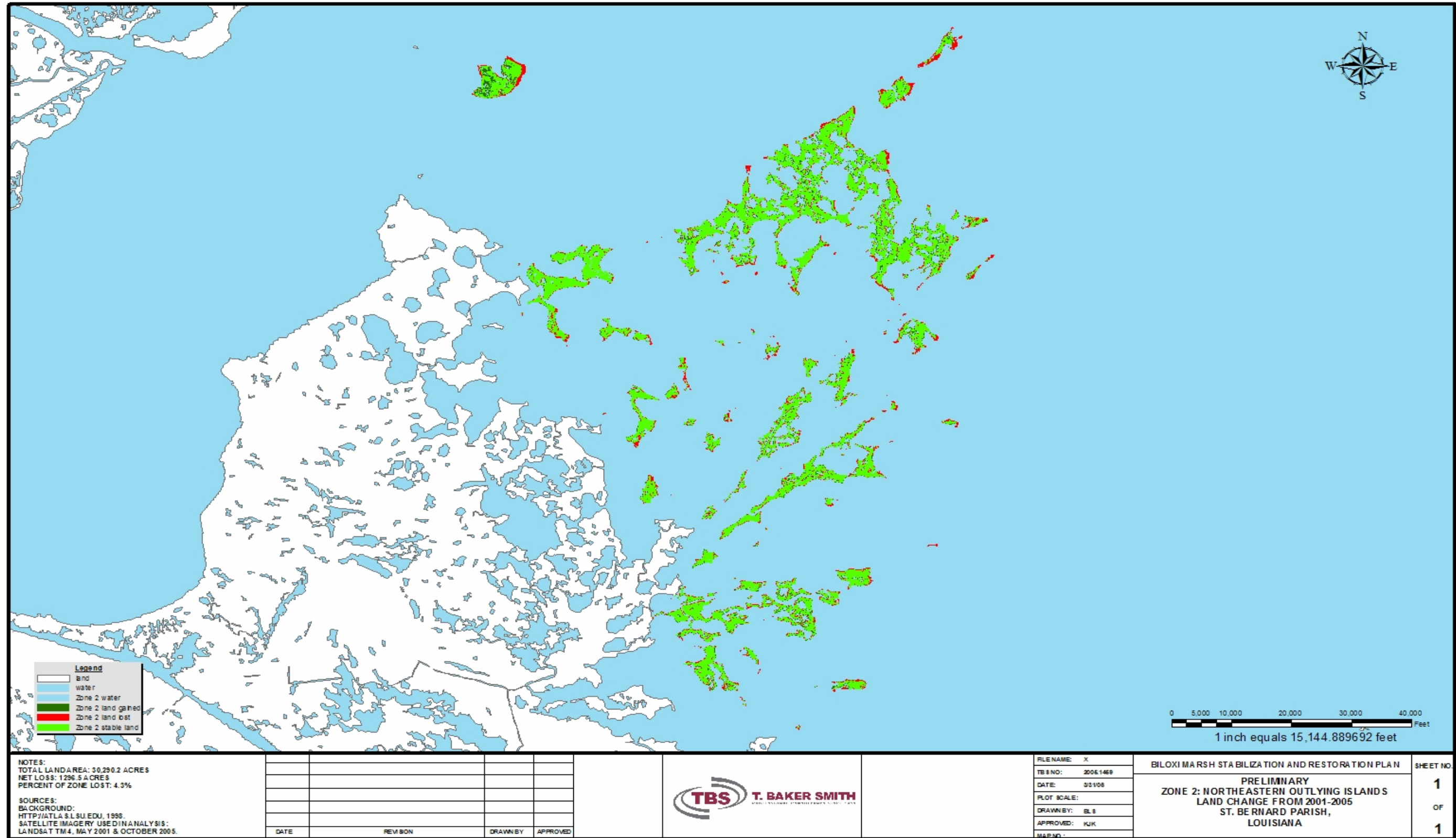


Figure 5. Land loss within restoration zone 2

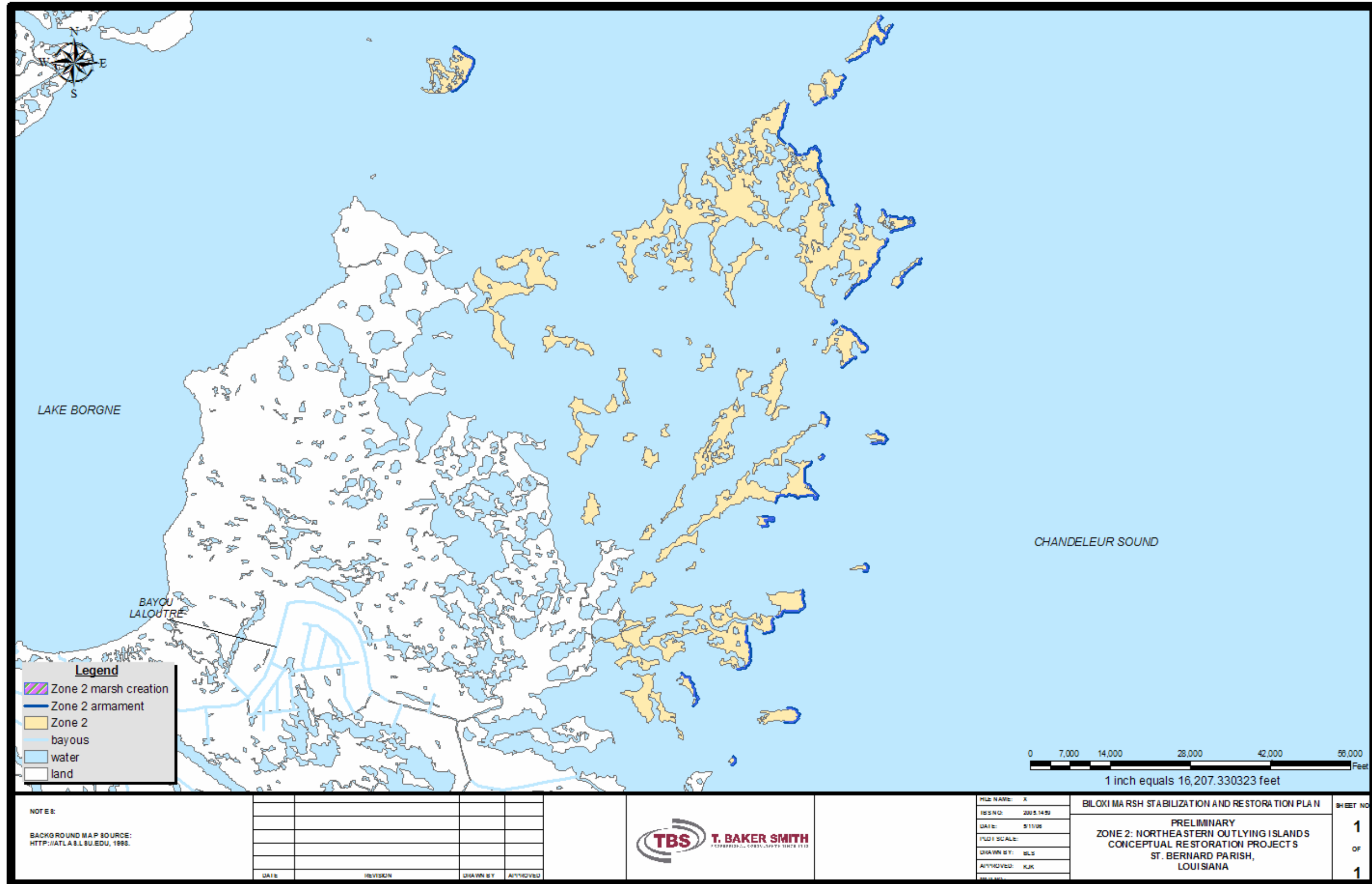


Figure 6. Proposed restoration projects within restoration zone 2

## **RESTORATION ZONE 3 – LOWER BILOXI MARSH**

### Introduction

Restoration Zone 3 is bounded by the Bayou LaLoutre ridge to the north, MRGO to the west and the Chandeleur Sound to the South. The majority of this area is a continuous land mass characterized by small bays, lakes, and meandering bayous. The southeastern portion of this Zone is under constant threat from marginal erosion forces generated as wave fetch which develops across Chandeleur Sound. This problem occurs on a daily basis and is exacerbated during tropical events.

### Land Loss Analysis

Currently, 27,465 acres are contained within this Zone. Approximately 410 acres of land loss has occurred in this area from 2001 to 2005 representing a 1.5% decrease in the regional land mass (Figure 7). Much of this land loss is located at the land/water interface with increased rates along those areas facing the Chandeleur Sound.

### Conceptual Projects

Suggested restoration/stabilization projects for this particular area include water control structures, bank armament, marsh creation, terraces, and vegetative plantings (Figure 8). Terraces have been selected for those areas with suitable soil types along the Bayou LaLoutre ridge. Vegetative plantings consist of tree plantings along the MRGO and vegetative plantings along the edges of created marsh.

For the past two years, the BMLC has nominated the Lake Athanasio Shoreline Protection and Marsh Creation Project for CWPPRA Project Priority List (PPL) 15 & 16 (Attachment A). During the project selection voting process for the PPLs, this project has received support from the participating federal and state resource agencies (especially the Louisiana Department of Natural Resource [LDNR] and the USACE). This project has not been selected for further evaluation, because of lack of support from the middle and upper basin voting parishes. While these parishes considered this project to be too far south of their perspective parishes to be of any benefit, hurricanes

Katrina and Rita have changed thought patterns and highlighted the importance of stabilizing and restoring the most southern reaches of the Pontchartrain Basin, due to the area's importance as a wave and storm surge barrier. Should funding become available, it is recommended that the Lake Athanasio Project be the first of the shoreline stabilization and marsh creation and/or nourishment projects for the Biloxi Marsh. Due to the lack of maintenance of the northern/eastern bank-line of the MRGO and the area's topography (seaward lakes opened to Breton Sound by construction of MRGO, with multiple large ponds inland of the opened lakes), the shoreline will very quickly migrate inland as far as 2.5 miles if the seaward land masses are lost (Figure 7). Additionally, once lost, restoration of these valuable peninsulas will be costly and difficult to reestablish.

Project Costs

Total project costs for this Restoration Zone are estimated between \$47,707,200 and \$164,457,500 (Table 3). The greatest variation in costs are attributed to marsh creation within this Restoration Zone.

**Table 3. Estimated Projects Costs for Restoration Zone 3**

<b>Project</b>	<b>Quantity</b>	<b>Cost</b>	<b>Total Project Cost</b>
Water Control Structure	4	\$150K – 450K/structure	\$600,000 – 1,800,000
Bank Armament	247,136	\$110 – 125/linear foot	\$27,185,000 – 30,892,000
Marsh Creation	1879	\$4,800 – 60,000/acre	\$9,019,200 – 112,740,000
Terraces	1083	\$5,000 – 8,000/acre	\$5,415,000 – 8,664,000
Plantings (scrub/shrub)	4100	\$15/tree installed	\$61,500
Plantings (vegetative)	412	\$25,000/acre	\$10,300,000
<b>Restoration Zone 3 Total:</b>			<b>\$47,707,200 – 164,457,500</b>



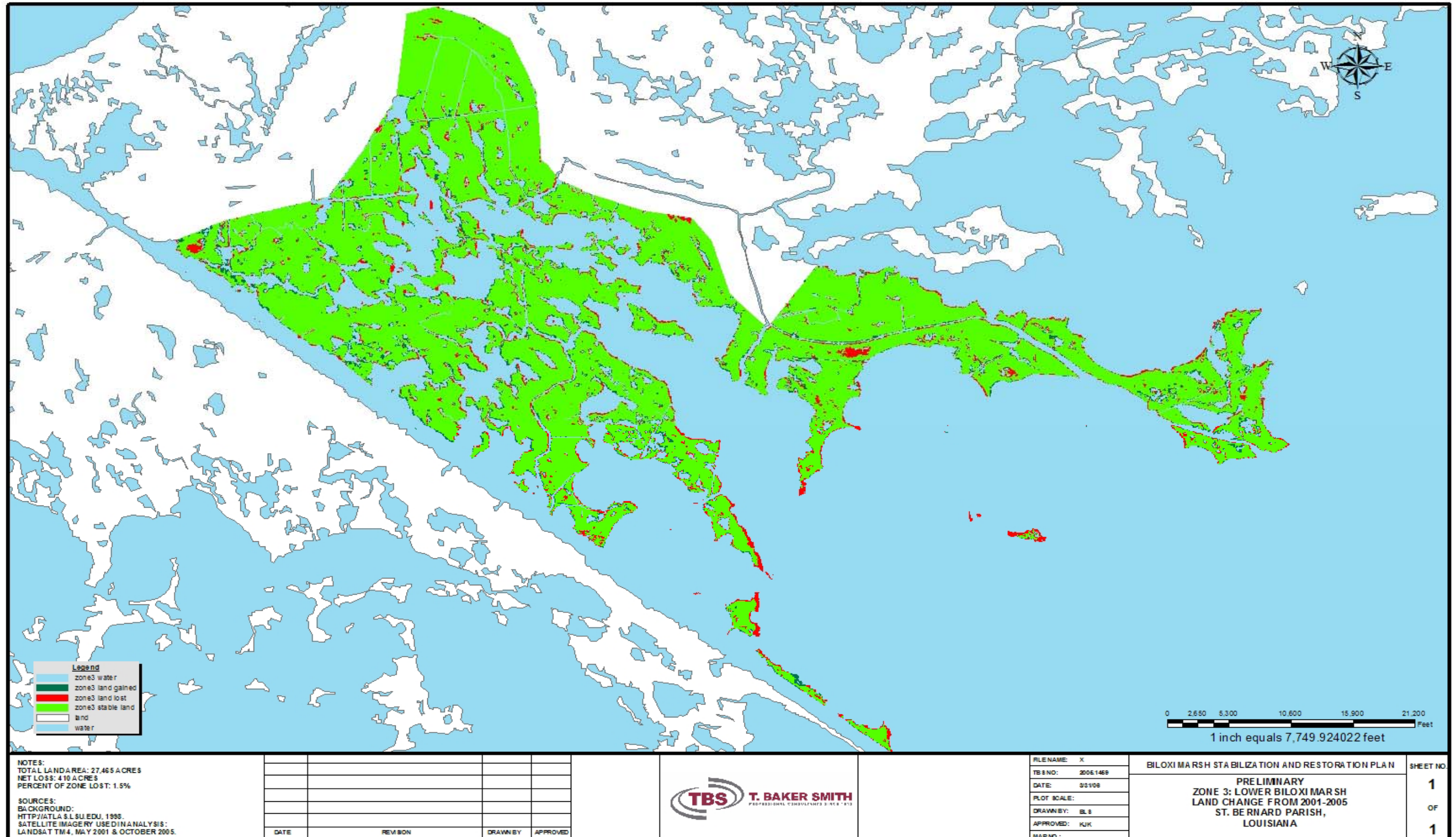


Figure 7. Land loss within restoration zone 3

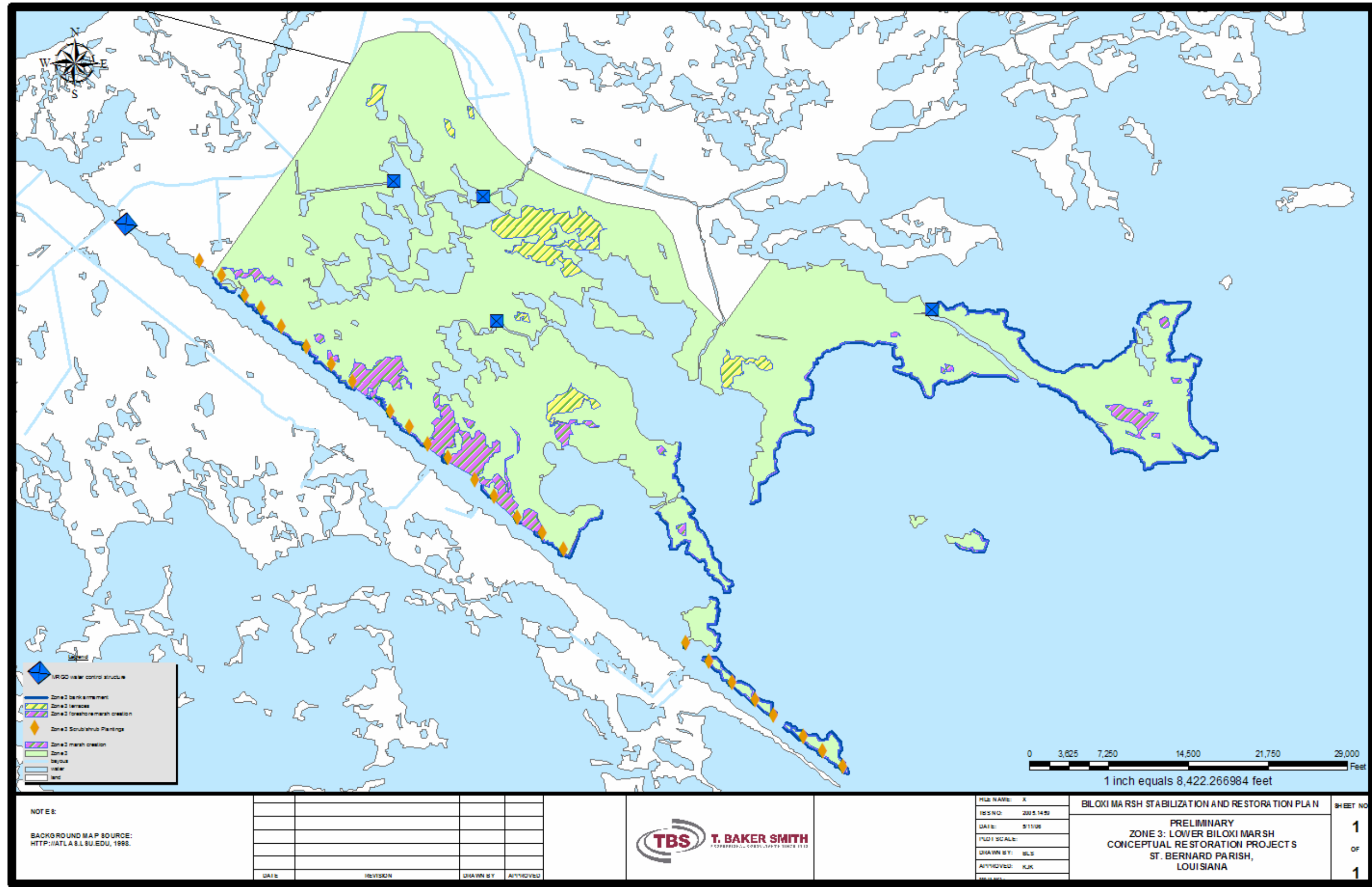


Figure 8. Proposed restoration projects within restoration zone 3

## **RESTORATION ZONE 4 – MARSH BELOW MRGO**

### Introduction

This Zone is a continuous landmass area south of the MRGO and north of Bayou Terre aux Boeufs, with a small percentage of isolated island chains on the easternmost end of the Breton Sound; it contains Lake Jean Louis Robin, Lake Coquille, Lake Calebasse, and Lake Machais. The majority of this Zone is under constant threat from marginal erosion forces generated as wave fetch develops across Breton Sound and rolls into the interior exposed lakes. This problem occurs on a daily basis and is exacerbated during tropical events. This region is the southernmost area of interest of this marsh stabilization and restoration plan.

### Land Loss Analysis

Currently, 60,014 acres are contained within this Zone. Approximately 648 acres of land loss has occurred in this area from 2001 to 2005, representing a 1.1% decrease in the regional land mass (Figure 9). Much of this land loss is located at the land/water interface with increased rates along those areas facing Breton Sound.

### Conceptual Projects

Suggested restoration/stabilization projects for this particular area include bank armament, marsh creation, marsh nourishment, and vegetative plantings (Figure 10). Vegetative plantings include tree plantings along the MRGO and vegetative planting of marsh creation/nourishment areas. Similar to Zone 3, it is recommended that outer reaches of the project area receive the first shoreline protection with subsequent protection moving progressively inland. This strategy is essential to the protection and sustainability of existing marshlands and will reduce long-term costs of restoration.

### Project Costs

Total project costs for this Restoration Zone are estimated between \$175,257,100 and \$532,983,900 (Table 4). Marsh creation accounts for the largest range in project costs. Bank armament and marsh nourishment also contribute to some of the variation.

**Table 4. Estimated Projects Costs for Restoration Zone 4**

<b>Project</b>	<b>Quantity</b>	<b>Cost</b>	<b>Total Project Cost</b>
Bank Armament	1,100,952	\$110 – 125/linear foot	\$121,105,000 – 137,619,000
Marsh Creation	5,839	\$4,800 – 60,000/acre	\$28,027,200 – 350,340,000
Marsh Nourishment	291	\$12,000 – 77,000/acre	\$3,500,000 – 22,400,000
Plantings (tree)	8,325	\$15/tree installed	\$124,900
Plantings (vegetative)	900	\$25,000/acre	\$22,500,000
<b>Restoration Zone 4 Total:</b>			<b>\$175,257,100 – 532,983,900</b>

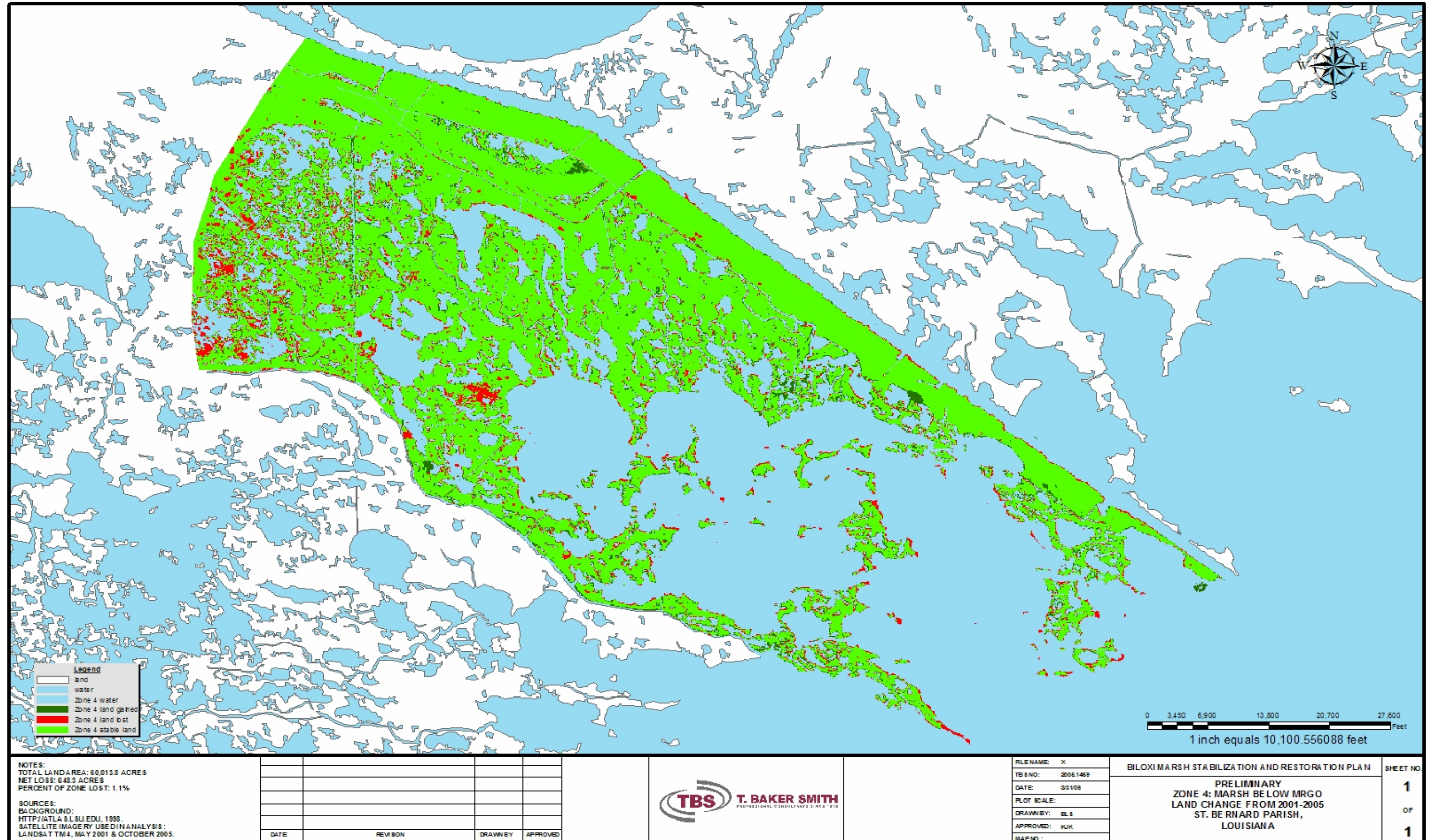


Figure 9. Land loss within restoration zone 4

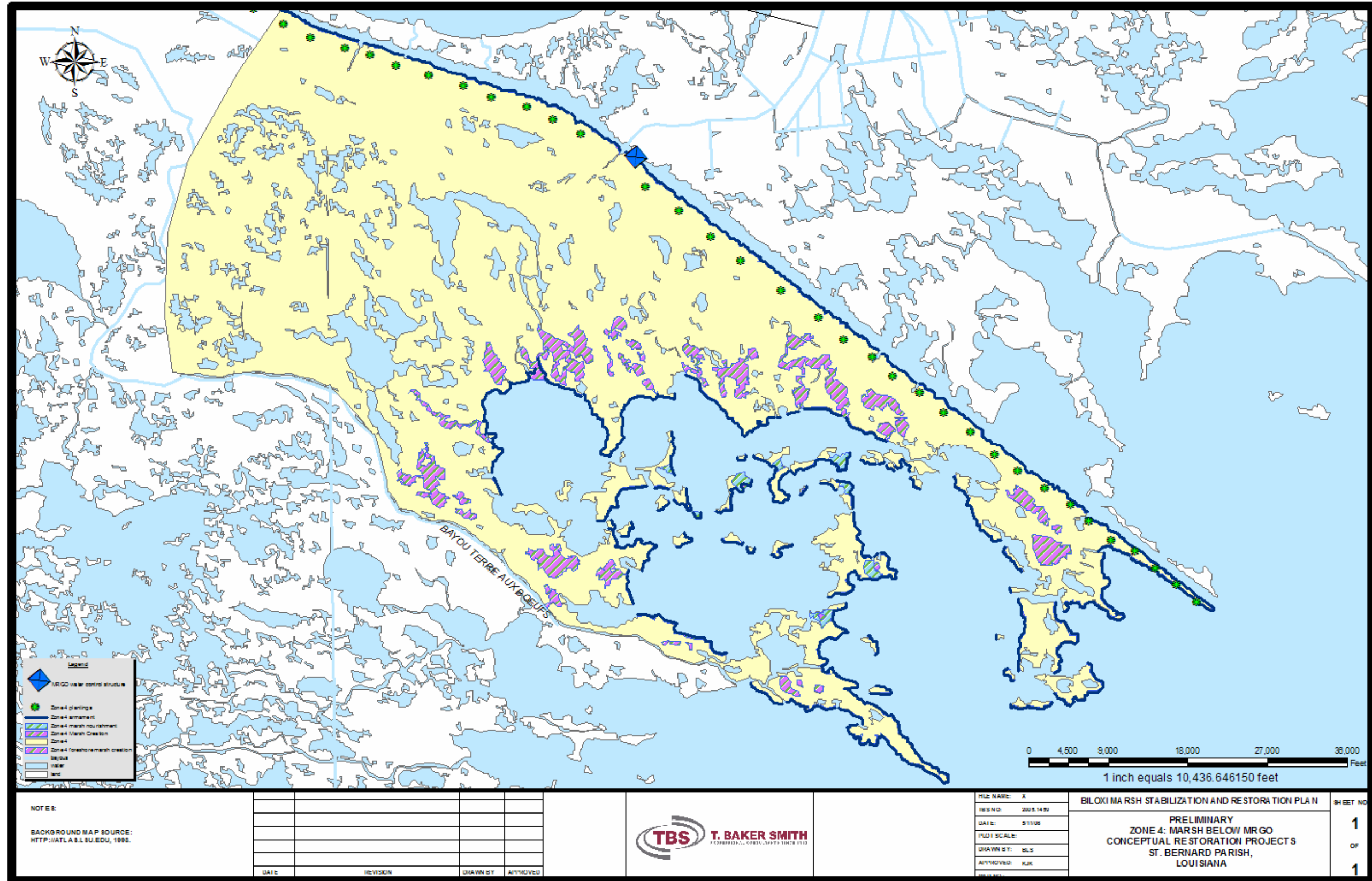


Figure 10. Proposed restoration projects within restoration zone 4

## **RESTORATION ZONE 5 – UPPER BILOXI MARSH**

### Introduction

Restoration Zone 5 is bounded by the Bayou LaLoutre ridge to the south, Lake Borgne to the west and by Zone 2's island chains to the east. The majority of this area is continuous land mass composed mostly of brackish to saline marshes, characterized by small lakes, bays, and meandering bayous. The western and easternmost portions of this Zone experience the highest rates of erosion due to wave fetch coming in from both Lake Borgne to the west, and that which filters through the bays and lakes to the east. Muskrat eat-outs and interior ponding are also common in this Zone. These problems occur on a daily basis and are exacerbated during tropical events.

### Land Loss Analysis

Currently, 74,820 acres are contained within this Zone. Approximately 2,202 acres of land loss has occurred in this area from 2001 to 2005 representing a 2.9% decrease in the regional land mass (Figure 11). Much of this land loss is located at the land/water interface with increased rates along the shoreline of Lake Borgne. Both the shoreline and the interior marshes of this Zone were severely impacted by Hurricanes Katrina and Rita.

### Conceptual Projects

Suggested restoration/stabilization projects for this particular area include bank armament, marsh creation, terracing, and vegetative plantings of muskrat eat-out areas (Figure 12). The Lake Borgne shoreline is the highest priority area for protection and restoration. Shoreline erosion from Hurricanes Katrina and Rita near the mouth of Bayou Grande was between 400 to 500 ft. in the worse areas.

### Project Costs

Total project costs for this Restoration Zone are estimated between \$63,201,000 and \$165,792,000 (Table 5). The variation in cost is attributed to marsh creation with a per acre difference of \$55,200.

**Table 5. Estimated Projects Costs for Restoration Zone 5**

<b>Project</b>	<b>Quantity</b>	<b>Cost</b>	<b>Total Project Cost</b>
Bank Armament	225,965	\$110 – 125/linear foot	\$24,856,000 – 28,246,000
Marsh Creation	1778	\$4,800 – 60,000/acre	\$8,535,000 – 106,680,000
Terracing	352	\$5,000 – 8,000/acre	\$1,760,000 – 2,816,000
Plantings (vegetative)	1122	\$25,000/acre	\$28,050,000
<b>Restoration Zone 5 Total:</b>			<b>\$63,201,000 – 165,792,000</b>

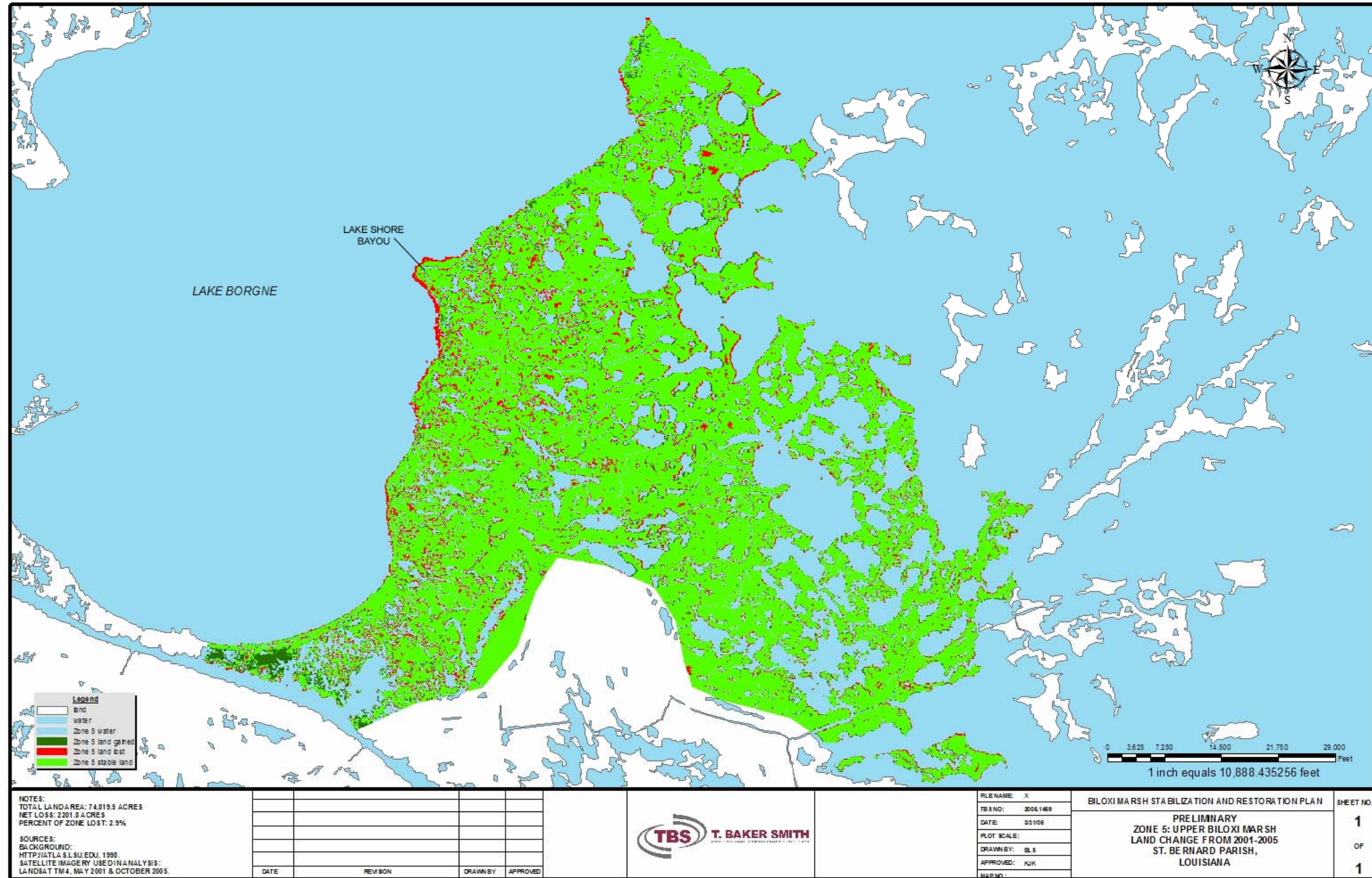


Figure 11. Land loss within restoration zone 5

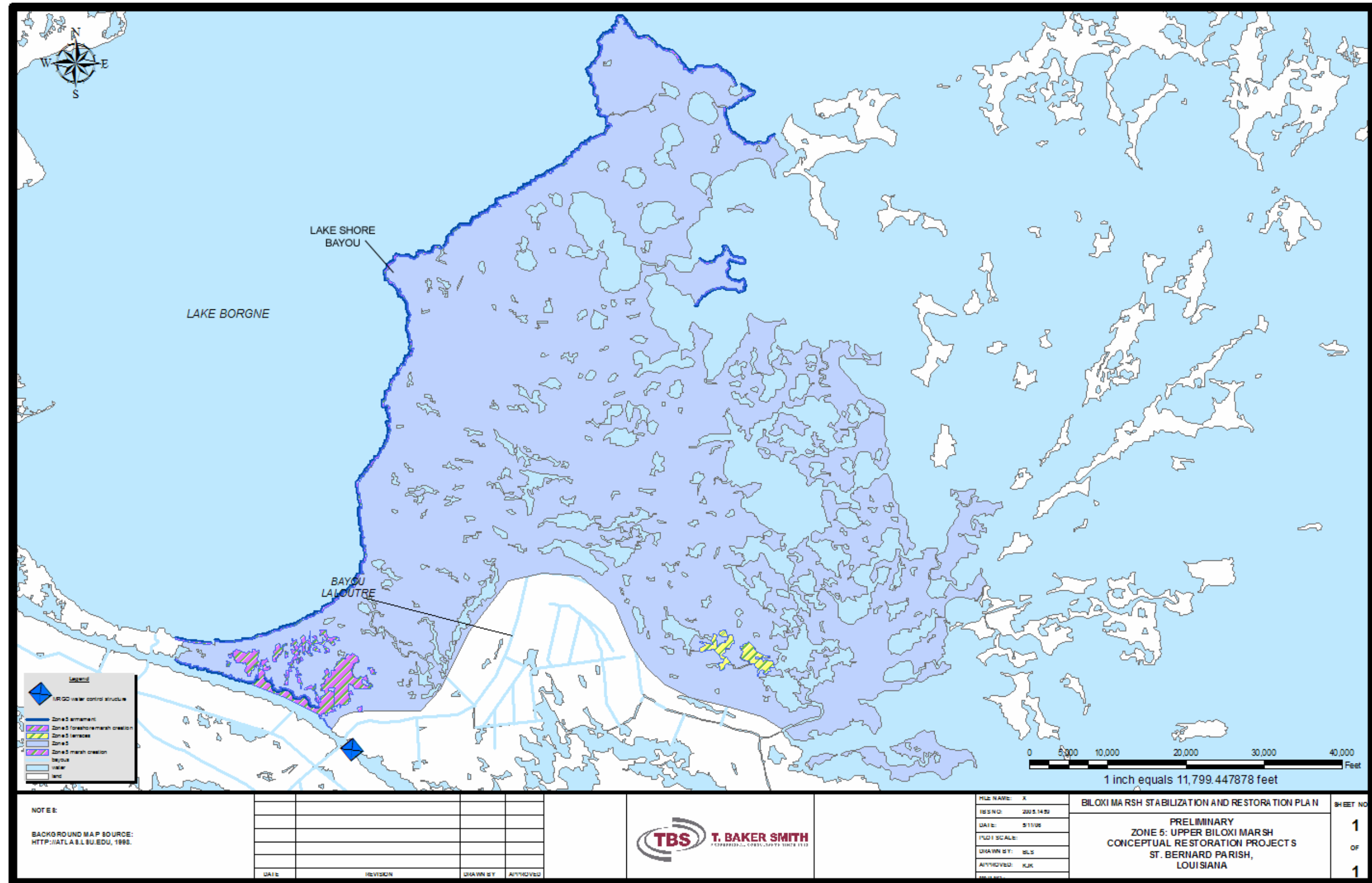


Figure 12. Proposed restoration projects within restoration zone 5

## **RESTORATION ZONE 6 – BAYOU LALOUTRE RIDGE**

### Introduction

Restoration Zone 6 contains the LaLoutre Ridge, an elevated area of land, eight to ten feet high, lined with live oak trees which create its own unique habitat. It is bounded to the north by Zone 5, Zone 3 to the south, the MRGO to the west. Bayou LaLoutre runs between the two ridge banks. The ridges are characterized by small oaks and marsh elder. The banks of these ridges are susceptible to tidal scouring and wake erosion from heavy boat traffic traveling through the bayou. These problems occur on a daily basis and have created cut banks on both sides of the bayou. The ridge provides seven linear miles of natural protection for areas further inland by dampening storm surge energy with the elevated ridge and vegetation. The existing trees and shrubs on the ridge were devastated by erosion of the banks of Bayou Laloutre which has been exacerbated by storm surges from Hurricanes George, Ivan, Katrina, and Rita. Prior to the construction of the MRGO ship channel, this area was subject to only intermediate salinities of 2-8 ppt and could support a more diverse array of vegetation. The area is now subject to salinities in excess of 19 ppt. This increase in salinities must be reversed to ensure the sustainability of restoration efforts within this zone.

### Land Loss Analysis

Currently, 8,618 acres are contained within this Zone. Approximately 60 acres of land loss has occurred in this area from 2001 to 2005 representing a > 1% decrease in the regional land mass (Figure 13). Most of this land loss is located along the banks of Bayou LaLoutre. In many places the ridge has eroded to the existing marshlands. Gaps have formed in the ridge in many places where the ridge has eroded to the existing marshlands. Open water ponds and streams have formed on the marsh side of some of these gaps due to tidal exchange and scouring. These open water areas will continue to expand unless the ridge is refurbished and the banks protected.

Conceptual Projects

Suggested restoration/stabilization projects for this particular area include bank armament along both sides of Bayou LaLoutre, marsh creation, terracing, water control structures, ridge refurbishment, and vegetative plantings (Figure 14). Vegetative plantings consist of two types, tree plantings along the ridge and vegetative planting of terraces.

Project Costs

Total project costs for this Restoration Zone are estimated between \$48,682,400 and \$68,542,300 (Table 6). Marsh creation and ridge refurbishment account for the largest discrepancies in project costs.

**Table 6. Estimated Projects Costs for Restoration Zone 6**

<b>Project</b>	<b>Quantity</b>	<b>Cost</b>	<b>Total Project Cost</b>
Water Control Structure	6	\$150K – 450K/structure	\$900,000 – 2,700,000
Bank Armament	150,500	\$110 – 125/linear foot	\$16,555,000 – 18,812,500
Marsh Creation	87	\$4,800 – 60,000/acre	\$417,600 – 5,220,000
Ridge Refurbishment	1,100,000	\$25 – 35/yard	\$27,500,000 – 38,500,000
Plantings (tree)	5,651	\$15/tree installed	\$84,800
Plantings (vegetative)	129	\$25,000/acre	\$3,225,000
<b>Restoration Zone 6 Total:</b>			<b>\$48,682,400 – 68,542,300</b>



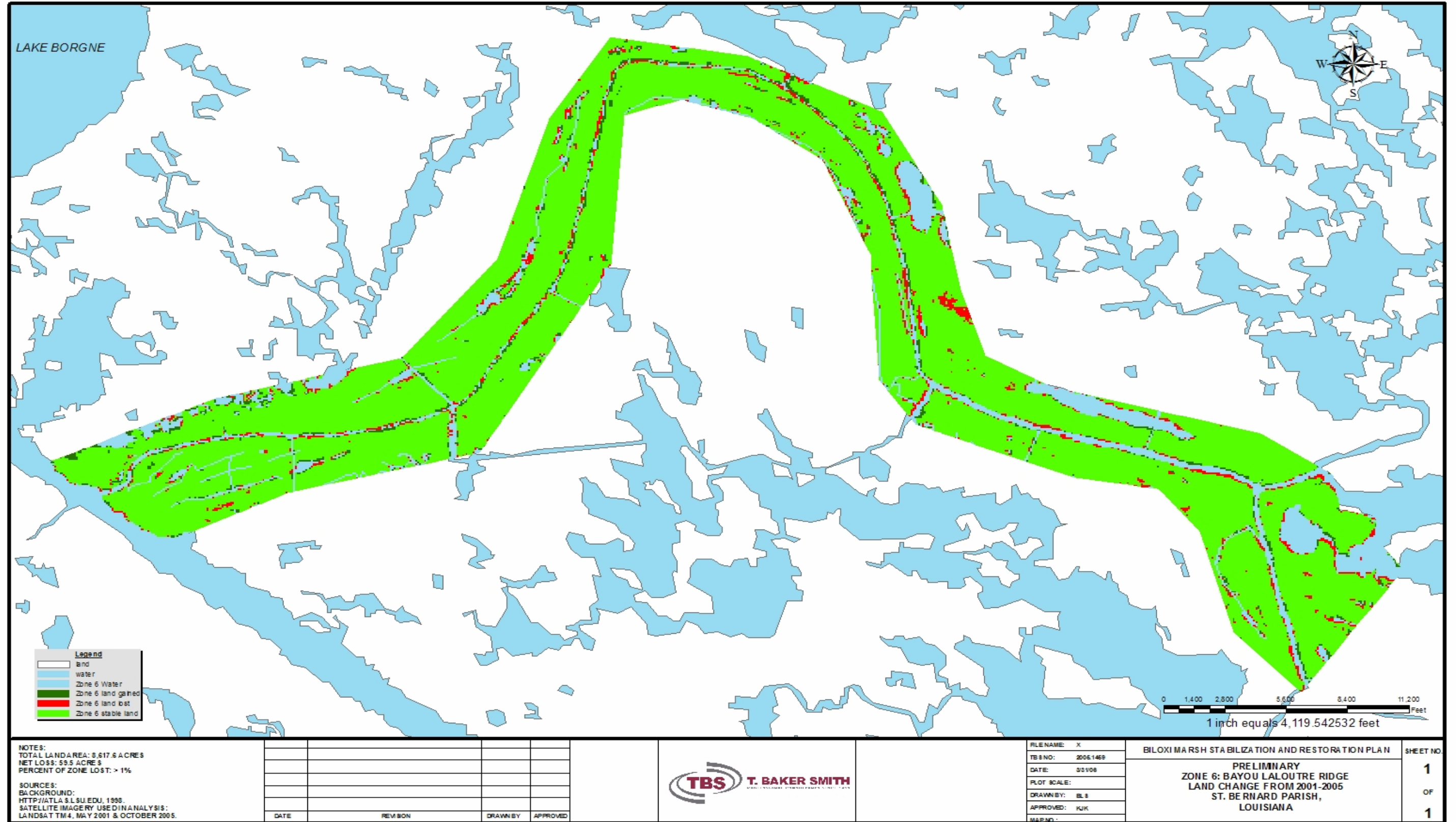


Figure 13. Land loss within restoration zone 6

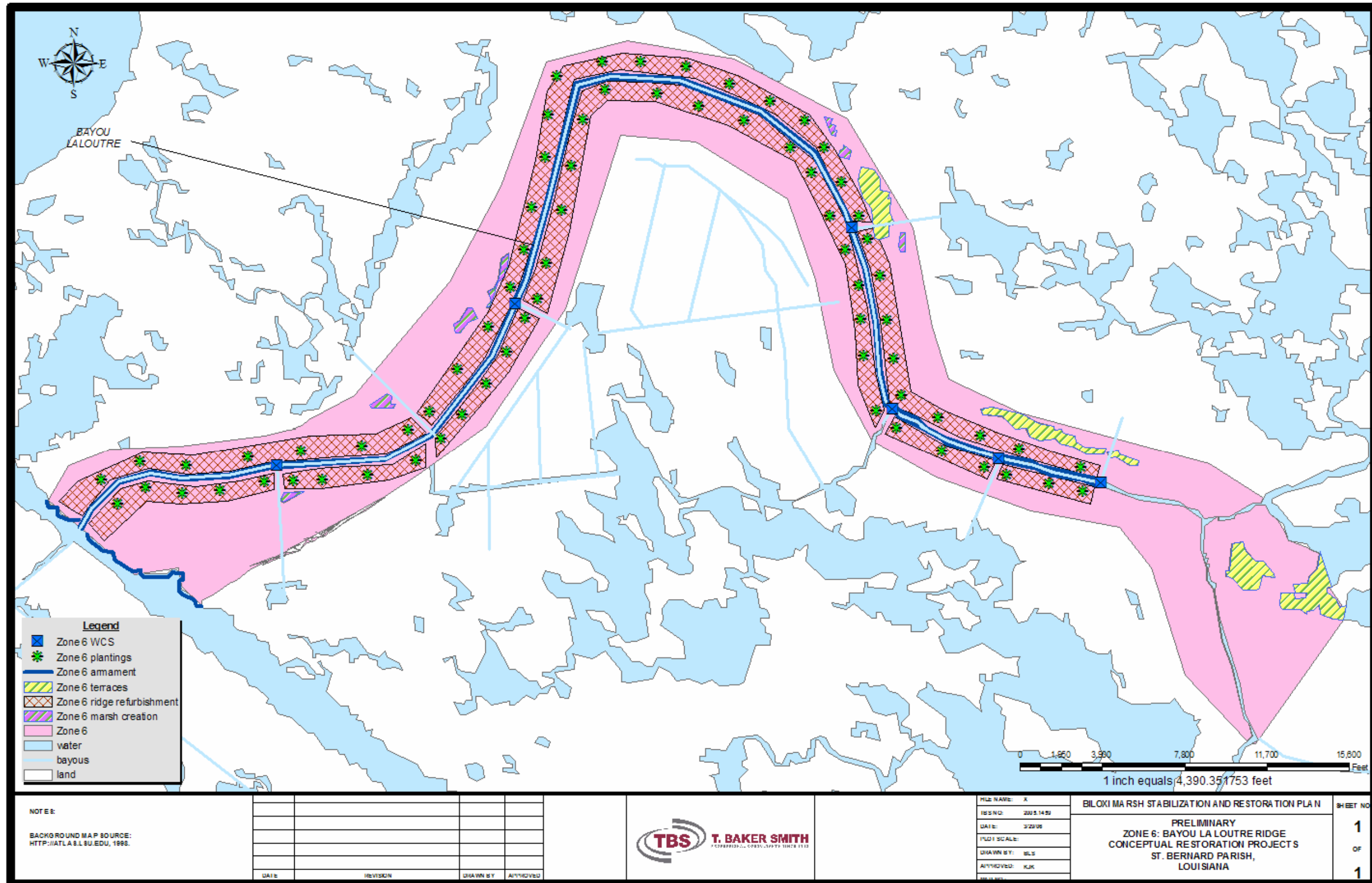


Figure 14. Proposed restoration projects within restoration zone 6

## PROJECT IMPLEMENTATION

This Plan is cognizant of the fact that all projects presented are contingent on the availability of funding from the federal, state, and local governments, as well as the private sector. The development of this Plan started several years prior to Hurricanes Katrina and Rita taking into consideration the pre-Katrina and Rita coastal restoration standards for wetland benefits as well the availability of funding. Post Katrina and Rita conditions and funding environment required a re-evaluation of *The Biloxi Marsh Stabilization and Restoration Plan*. The Plan scope was made more regional with added emphasis and consideration given to regional ecosystem's role in protecting New Orleans and the surrounding parishes from tropical storm events. Additionally, we added the major fresh water diversion feature which has regional benefits ranging from the introduction of fresh water and sediment into Lake Borgne, Chandeleur Sound, Breton Sound and the Biloxi Marsh to introduction of fresh water into Mississippi Sound to help Mississippi's aquaculture industry. The relationship of restoring the coastal wetlands of St. Bernard Parish to the enhancing the protective affect of the levees surrounding populated areas has always been acknowledged, but never clearly understood until Hurricane Katrina devastated the region. The region does not have time to wait for another Katrina type event, but understanding the limitations of funding, this Plan has developed a list of Near-Term and Long-Term Projects and Strategies that can be utilized for planning and implementation purposes as funding becomes available.

### NEAR-TERM PROJECTS AND STRATEGIES

- **Mississippi River Diversion Evaluation, Modeling and Design (Diversion Design)** – A Mississippi River, Diversion Evaluation for the Lower Pontchartrain Basin near the Violet Canal needs to be conducted at the earliest possible moment. A significant diversion that provides freshwater and sediment is the only technique that will sustain the Biloxi Marsh. It is recommended that this study be funded with Federal and/or State Emergency Appropriations or

Louisiana's Coastal Impact Assistance Program (CIAP) Section 384 of the Energy Policy Act of 2005 funding. The evaluation will require hydrologic modeling that can help determine flow quantities into the estuary and scheduling of events that will sustain and rebuild existing wetlands. Funding through either of these sources will allow for quicker analysis than the usual federal Feasibility Studies. The usual Water Resources Development Act (WRDA) procedure is too slow with the Feasibility Study portion taking 3-5 years. The sustainability portion of the Biloxi Marsh Stabilization and Restoration Plan and all other coastal restoration initiatives for the Pontchartrain Basin hinge on this diversion evaluation. This evaluation will provide the necessary information for distributing the Miss. River waters into various Restoration Zones and to the state of Mississippi.

- **Lake Athanasio Shoreline Protection and Marsh Creation/Nourishment Project** – This project has been nominated as a CWPPRA project for the last two project priority lists prior to Hurricane Katrina. The project received support by the federal and state agencies, but was passed over for further evaluation by projects in the upper and middle portions of the Pontchartrain Basin. The Biloxi Marsh Stabilization and Restoration Plan stresses the importance of maintaining the lower portion of the basin in a bottom to top protection strategy. Post-Hurricane Katrina has since highlighted the need for just such a project for the protection and sustainability of the Biloxi Marsh complex.
- **Bayou LaLoutre Ridge Restoration, Marsh Creation, and Plantings** – Federal Supplemental Appropriations (H.R. 4939 and Senate Report SR230) have designated \$15M to the restoration of the Bayou LaLoutre ridge. The restoration of this ridge is a vital part of the Biloxi plan and was provided its own unique restoration zone. It is recommended that the monies appropriated to restore this ridge be directed by the federal government to achieve its intended purpose. Additionally, preliminary investigations indicate approximately 90 acres of marsh could be created adjacent to the ridge.

- **Lake Borgne Shoreline Protection** – Federal Supplemental Appropriations (H.R. 4939 and Senate Report SR230) have designated \$10M to protect the shoreline along Lake Borgne. Like the Bayou LaLoutre Ridge restoration, this money should be directed for its intended purpose and not redirected outside of the area. It is recommended that the shoreline nearest the MRGO be armored first and then those areas impacted greatest by Hurricanes Katrina and Rita such as the Lake Shore Bayou area south of Point Aux Marchettes. In this area, Lake Shore Bayou has eroded into Lake Borgne, therefore, the shoreline should be armored and marsh created to reestablish the natural meander to pre-Katrina conditions. It is recommended that all shoreline protection be supplemented with beneficial use of dredge material for marsh creation/nourishment behind the hard structure armament.
- **Tree Planting** – It has been well documented that protection of the levee systems of St. Bernard Parish and the N.O. Metropolitan area from storm surge is greatly enhanced by levees fronted by elevated protection. A tree planting program is low cost and can be initiated without coastal regulatory restrictions. This program should be initiated as soon as possible along the MRGO spoil deposit areas and the Bayou LaLoutre Ridge.

## **LONG TERM PROJECTS**

- **Mississippi River Diversion** - The Biloxi Marsh Stabilization and Restoration Plan has been designed as a planning and adaptive management coastal restoration tool. Upon completion of the Hydrologic Modeling in the Mississippi River Diversion Evaluation, the Biloxi Marsh Stabilization and Restoration Plan will be adapted for Best Management Practices (BMP) in accordance with the new information. The Biloxi Marsh Plan and any other coastal restoration plan must have the ability to change as new information is gathered. This is and has always been the intention of this plan. Recommendations for the distribution of

Mississippi River waters into the Biloxi Marsh and to the State of Mississippi will continue to be based on the best available science at that time.

- **Legislative Change in Breton Wilderness Designation** – Currently the Chandeleur Islands are included as part of the Breton National Wildlife Refuge and are included in the National Wilderness Preservation System. All of the islands in this area except, North Breton Island, are listed as a Class I Prevention of Significant Deterioration (PSD) Area. Class I areas are the most stringently regulated as they are generally locations that have remained untouched by industry. This listing limits significant restoration efforts within this zone and must be addressed. It is recommended that the State of Louisiana recommend to its federal congressional delegation that immediate steps be taken to change the listing of the Breton NWR as a Class I PSD Area. This will be the only way to adequately protect and maintain the island chain. It has been evident since Hurricane George in 1998, that the Chandeleur Islands cannot recover from the tropical storms of the last decade without man-made intervention.
- **Chandeleur Island Restoration** - The restoration and maintenance of the Chandeleur Islands will be a long process and will require a dedicated funding source. Those natural restoration techniques used in the CWPPRA Chandeleur Island Restoration Project have already been established and can be initiated in both the Near-term and Long-Term strategies, but were included in the Long-Term section because of the sheer magnitude of the project. As the de-listing of the Islands as a Wilderness area is pursued, preliminary engineering and design for hard structure armoring can begin as funding becomes available. Restoration of the Islands can be accomplished using techniques applied in similar projects such as the Timbalier and Whiskey Island Restoration Projects.
- **Shoreline Protection/Marsh Creation/Marsh Nourishment** – The Coastal Planning, Protection, and Restoration Act (CWPPRA or Breaux Act – Public Law

101 - 646) Little Lake Shoreline Protection and Marsh Creation Project (BA-37) is presently being construction with the goal of protecting, rebuilding and nourishing 1,373 acres of existing degraded marsh in Lafourche Parish, Louisiana. This project is believed to be the prototype for fast-tracking the creation of emergent wetlands and revitalizing existing wetlands. The total cost of the project is \$36M. For an approximate cost of \$26,000/acre, wetlands can be armored with shoreline protection and refurbished to healthy sustainable wetlands. The Biloxi Marsh Plan recommends dedicated funding to begin a shoreline protection/marsh creation/marsh nourishment program that would target those outer shorelines of Restoration Zones 2-5 where land loss was greatest from Hurricanes Katrina and Rita and/or those long linear peninsulas in threat of disappearing in the near future.

## **SUMMARY**

While conceptual in nature, this Plan has assembled a team of experts who have conceptualized all of the synergistic projects designed to enhance and protect a regional ecosystem which includes the Biloxi Marsh. Conceived and funded several years prior to Hurricanes Katrina and Rita by Biloxi Marsh Lands Corporation, the Plan has been adapted to include regional benefits ranging from protecting New Orleans and the surrounding Parishes from storm surge events to preventing salt water intrusion and introduction of fresh water into Mississippi Sound. Completion of these projects will protect the life and property of local communities as well as protect the ecological function of this valuable regional ecosystem which includes as its predominant feature the Biloxi Marsh. Estimated project economic costs are quite low (Table 7) in comparison to human tragedy related to and the cost of recovering from recent tropical events.

**Table 7. Total Project Costs per restoration zone**

<b>Restoration Zone</b>	<b>Project Costs</b>
Restoration Zone 1	167,656,000
Restoration Zone 2	\$35,142,800 – 62,988,000
Restoration Zone 3	\$47,707,200 – 164,457,500
Restoration Zone 4	\$175,257,100 – 532,983,900
Restoration Zone 5	\$63,201,000 – 165,792,000
Restoration Zone 6	\$48,682,400 – 68,542,300
Freshwater Diversion	To Be Determined After Study
<b>Total:</b>	<b>\$537,646,500 – 1,162,419,700</b>

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**APPENDIX A**  
**LAKE ATHANASIO PROJECT**

## PPL16 PROJECT NOMINEE FACT SHEET

### January 12, 2006

#### Project Name

Lake Athanasio Shoreline Protection and Marsh Creation Project

#### Coast 2050 Strategies

- Coastwide Common Strategies
  - Dedicated dredging, to create, restore, or protect wetlands
  - Maintenance of gulf, bay, and lake shoreline integrity
- Region 1 Previously Proposed Strategies
  - Protect Bay/Lake Shorelines
    - *An Environmental-Economic Blueprint for Restoring the Louisiana Coastal Zone: The State Plan* – Governor's Office
  - Use of dredged material
    - CWPPRA Basin Report
    - Lake Pontchartrain Basin Foundation CMP (recommendations by Saltwater Intrusion/Wetland Loss Committee)
- Region 1 regional ecosystem strategies
  - Protect Bay/Lake Shorelines
  - Restore/Sustain Marshes – dedicated delivery of sediment for marsh building
- Region 1 mapping unit strategies
  - Dedicated Dredging
  - Beneficial Use of Dredge Material
  - Restore Fringing Marsh Islands

#### Louisiana Coastal Area Comprehensive Study Keystone Strategy

Marsh Creation by Dedicated Sediment Delivery

#### Project Location

Region 1, Pontchartrain Basin. St. Bernard Parish. Along the west shoreline of the Point Eloi Peninsula from Mosquito Bight point to Point Eloi; along the northeast shoreline from Canal Pecal to the first man-made canal to the northeast; and from the Mississippi River Gulf Outlet (MRGO) to Canal Pecal.

#### Problem

What problem will the project solve?

Shoreline erosion in the project area threatens to breach several parts of the land bridges separating Lake Eloi, Lake Athanasio and Breton Sound that will create wider expanses of open water between Eloi Bay and Lakes Eloi and Athanasio. When the peninsulas are lost, the southeast shoreline boundary of the Biloxi Marsh Area will move approximately 2.5 miles inland. The 1983 to 1990 loss rate for the Eloi Bay mapping unit is  $-0.34\%/yr$ . Field inspections after the hurricanes of 2005 have revealed erosion, fragmentation and partial denuding of marshes predominantly on sound side of Lake Athanasio suggesting a substantial increase in the historic erosion rate. This in part,

demonstrates the role of outer wetlands in providing protection to more interior habitats. This project would create up to 223 acres of marsh and 23,000 ft of shoreline protection to rebuild, strengthen, and maintain the integrity of the peninsulas.

### **Proposed Project Features**

At this time, two features will be constructed:

1. Approximately 23,000 ft rock dike along east shoreline of the Point Eloi, northeast shoreline of Lake Athanasio Peninsula, and west shoreline from MRGO to Canal Pecal.
2. Approximately 223 acres of marsh creation between the existing shoreline and rock dike and in an interior pond with dedicated dredging from either Breton Sound or the Mississippi River Gulf Outlet (MRGO).

If the project is selected as a candidate, nourishment of marsh fragmented by the 2005 hurricanes would be considered in addition to or in lieu of some of the marsh creation.

### **Goals**

The goal of the project would be to create up to 223 acres of marsh initially and 23,000 ft of shoreline protection to rebuild, strengthen, and maintain the integrity of the lake and sound peninsulas.

### **Preliminary Project Benefits**

What is the total acreage benefited both directly and indirectly?

How many acres of wetlands will be protected/created over the project life?

(see below table)

- Assumed a 50% reduction in the 1983-1990 rate applied to the marsh creation acres.
- Assumed 100% reduction in a guessed shoreline erosion rate of 5 ft/year (no data available at this time) applied to the straight-line distance (to be conservative) over 20 years = 53 ac.
- Assumed background loss rate of  $-0.34\%/yr$  applied to existing marsh to be protected from shoreline erosion = 3 acres of loss.

There would be 266 net acres in the future with the project at target year 20.

- 2) What is the anticipated loss rate reduction throughout the area of direct benefits over the project life (<25%, 25-49%, 50-74% and >75%)? Based on stopping shoreline erosion (100% reduction while structures remain intact; erosion rate is unknown at this time) and the estimated loss rate of the created marsh, the overall anticipated loss rate reduction throughout the area of benefit is 50-74%.
- 3) Do any project features maintain or restore structural components of the coastal ecosystem such as barrier islands, natural or artificial levee ridges, beach and lake rims, cheniers, etc.? Both the marsh creation and shoreline stabilization components of the project would re-establish and maintain lake rims.
- 4) What is the net impact of the project on critical and non-critical infrastructure? The project would have marginal to no impact on the Mississippi River Gulf Outlet (MRGO) and other critical and non-critical infrastructure. Instead it would provide the outermost protection for the Breton Sound wetlands that do provide substantial surge protection for St. Bernard Parish.

- 5) To what extent does the project provide a synergistic effect with other approved and/or constructed restoration projects? There are no other projects in the immediate vicinity for this project to provide synergy.

**Identification of Potential Issues**

The proposed project has the following potential issues: O&M, utilities/pipelines, etc.

**Preliminary Construction Costs**

The construction cost plus 25% contingency is estimated to be approximately \$24,780,000.

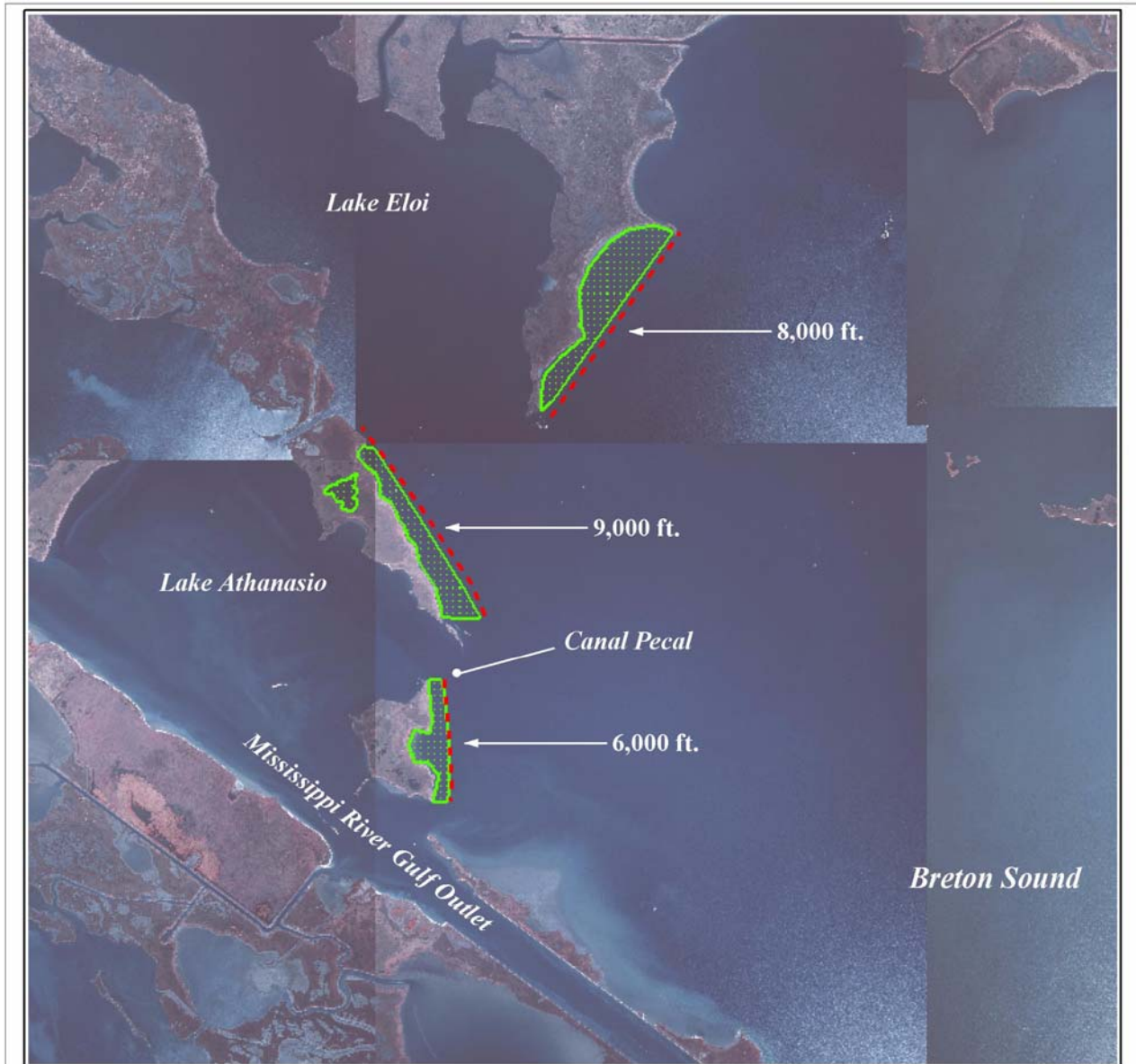
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	Acres	FWOP Loss Rate	FWOP TY20	FWP Loss Rate	FWP TY20
Shoreline Protection	53	-0.34%	0	-0.34%	50
Marsh Creation	223		0	-0.17%	216
Total			0		266
TY20 net	266				





Louisiana  
Project Location

### Lake Athanasio Shoreline Protection and Marsh Creation Project (PPL16 Project Nominee)

- - - Shoreline Protection \*
- Marsh Creation \*

\* denotes proposed features

Map ID: USGS-NWRC 2006-11-0040  
Map Date: January 5, 2006

Scale 1:63,900

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2004 Digital Orthophoto Quarter Quadrangle