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Department of Natural Resources
Coastal Restoration Division and
Coastal Engineering Division

2007 Operations, Maintenance, and Monitoring Report

for

Mandalay Bank Protection Demonstration

State Project Number TE-41
Priority Project List 9

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Terrebonne Parish

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2007 Operations, Maintenance, and Monitoring Report
for
Mandalay Bank Protection Demonstration (TE-41)

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I. Introduction

The Mandalay Bank Protection Demonstration (TE-41) project is located along a 3.4-mi (5.5-km) segment of the Gulf Intracoastal Waterway (GIWW) inside the Mandalay National Wildlife Refuge (figure 1). It is approximately 6 mi (9.7 km) southwest of Houma, Louisiana, in the northeast portion of Terrebonne Parish. Vegetative communities in the project area include fresh marsh, scrub/shrub, seasonally flooded bottomland forest, and open-water areas with aquatic vegetation. The two fresh marsh vegetation types, fresh bulltongue and fresh maidencane, have relatively high diversity (Louisiana Department of Natural Resources – Coastal Restoration Division 2003).

From 1944 to 1983 the north and south shorelines in the project area have experienced an average land loss rate of approximately 13.17 ft yr^{-1} (4.01 m yr^{-1}) (May and Britsch 1987). Frequent wave action along the waterway coupled with soft, unstable marsh sediments has resulted in bank erosion and an overall widening of the channel. Adjacent freshwater marshes remain vulnerable to the damaging effects of erosion. The stretch of GIWW within the project area experiences a substantial volume of marine vessel traffic (Segura 2001). The traffic is a mixture of recreational vessels, large barges and barge combinations, tug boats, supply vessels, and crew boats. The estimated mid-channel wave height in the GIWW generated by winds and large vessel wakes is approximately 3.0 ft based upon calculations from preliminary design investigations (Coastal Engineering and Environmental Consultants, Inc. 2001).

The objective of the Mandalay Bank Protection Demonstration (TE-41) project is to compare both the treatment as well as the cost effectiveness of two off-bank and two blowout treatments' ability to provide protection against shoreline erosion, promote sedimentation, and promote vegetation growth in selected areas along the GIWW (figure 2).

The Mandalay Bank Protection Demonstration (TE-41) project was constructed in one phase beginning in April 2003 and completed in September 2003. The project has a demonstration period of five (5) years. Monitoring will continue for five (5) years post-construction; however, structures were designed and constructed for a twenty (20) year life which began in September 2003. The project budget does not include any funding provision for the operation, maintenance, or rehabilitation of any of the project features other than for the performance of inspections of the project features. Inspections were performed after the first and third years following construction completion. One final inspection remains for the fifth year following construction completion.

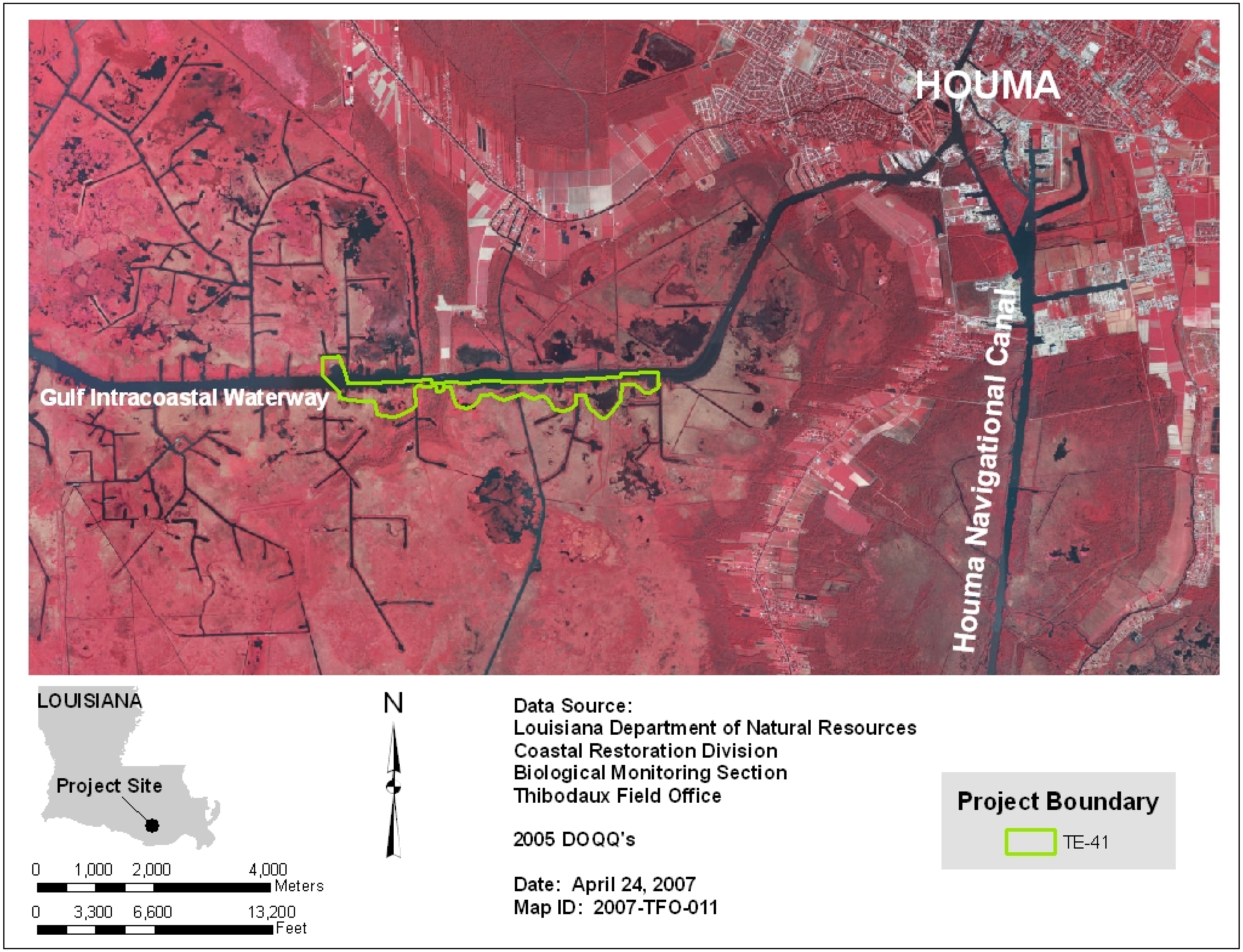

Figure 1. Mandalay Bank Protection Demonstration (TE-41) project location map.

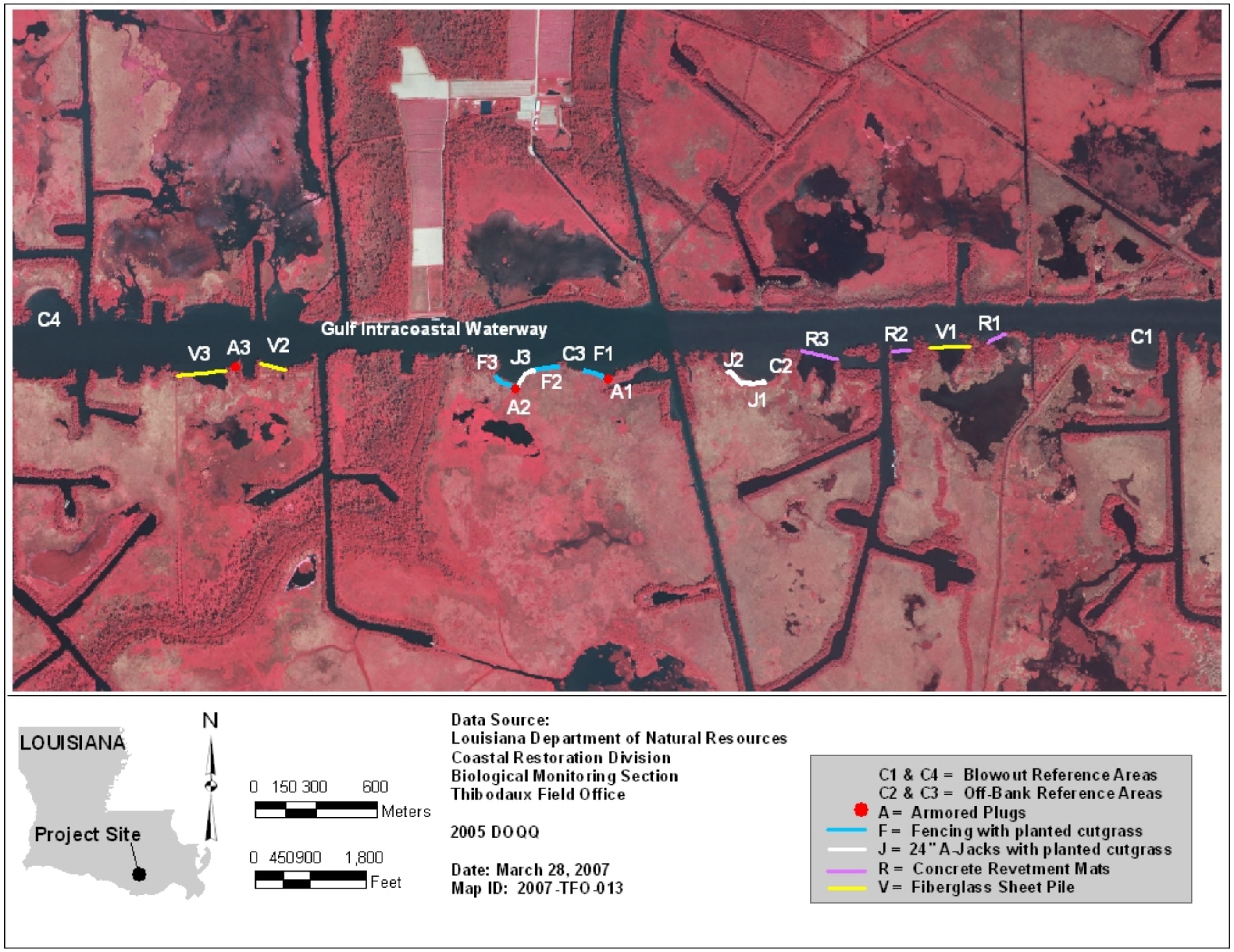

Figure 2. Location of treatments and reference areas for the Mandalay Bank Protection Demonstration (TE-41) project.

The principal project features include (Coastal Engineering and Environmental Consultants, Inc. 2004):

- Construction of approximately 1,223 ft (373 m) of submerged articulated concrete revetment mats.
- Construction of approximately 1,857 ft (566 m) of straight-walled fiberglass sheet pile.
- Construction of approximately 1,283 ft (391 m) of 24 inch (0.61 m) high A-Jacks® concrete blocks in an interlocking double row with two staggered rows of *Zizaniopsis miliacea* (Michx.) Doell & Aschers. (giant cutgrass) plantings on five foot centers between it and the shoreline.
- Construction of approximately 1,910 ft (582 m) of staggered treated lumber fencing with two staggered rows of *Z. miliacea* plantings on five foot centers between it and the shoreline.

Additional features include:

- Construction of approximately 501 ft (153 m) of concrete revetment armored plugs.

II. Maintenance Activity

a. Project Feature Inspection Procedures

The purpose of the inspection of the Mandalay Bank Protection Demonstration (TE-41) project is to evaluate the constructed project features in order to identify any deficiencies. The inspection results are used to prepare a report which details the condition of the project features and recommends any corrective actions considered necessary. Should it be determined that corrective actions are needed, Louisiana Department of Natural Resources (LDNR) shall provide in the report a detailed cost estimate for engineering, design, supervision, inspection, construction, contingencies, and an assessment of the urgency of such repairs (LDNR/CED and USFWS 2004). The inspection report also contains an estimated, projected budget for the upcoming three (3) years for operation, maintenance, and rehabilitation. The three (3) year projected operation and maintenance budget is shown in Appendix A.

As described in the Operations and Maintenance (O&M) Plan, three (3) project inspections are to be performed during the five (5) year demonstration period after the first, third, and fifth years following construction completion. This inspection will serve as the second of the three (3) project inspections.

The inspection of the Mandalay Bank Protection Demonstration (TE-41) project was held on February 19, 2007. In attendance were Daniel Dearmond and Elaine Lear from LDNR. The boat was launched at approximately 9:45 a.m. at Cannon's Boat Launch on Southdown Mandalay Road along Bayou Black. From the launch, Minors Canal was then used to arrive at the GIWW. The weather conditions included cloudy skies, temperatures in the lower 50's °F (ending with low 60's), and winds of approximately 10 to 15 mph. The water levels were much lower than during the previous inspection in 2005 (Lear and Dearmond 2007). At 10:10 a.m. a water elevation reading of 0.61 ft NAVD88 was taken from the staff gauge located just off of Minors Canal near the project secondary monument, TE41-SM-01 (MAND), before the inspection of the features began. It should be noted that the timber piling that the gauge is installed on was slightly out of plumb (less vertical than in 2005), and therefore the recorded reading is a little higher than the actual water level. Inspection of the project features began at approximately 10:35 a.m. at Site V3 (figure 2), the westernmost project feature, and then continued eastward along the GIWW until all features had been inspected. The inspection concluded at Site R1. After inspecting the project features, at 3:01 p.m. a water elevation of 0.61 ft NAVD88 was recorded from the staff gauge.

The field inspection included a complete visual inspection of the entire project site. Photographs were taken at each project feature (Appendix B), and field inspection notes were completed in the field to record the project feature conditions and any deficiencies (Appendix C).

b. Inspection Results

<u>Blowout Treatments</u>

<u>Sites R1, R2, and R3 – Revetment Mats / Elevated Shoreline (CPE Pipe) System</u>
At Sites R1 and R2, increased settlement has occurred in two locations along the revetment mat / pipe system at each site. At Site R1, the two low areas are located approximately 40 ft east of the settlement plate and near the west end. At the time of inspection the water depth above the top of the mats at the east low area was approximately 0.3 ft. At Site R2, the two low areas are located approximately 25 ft east of the settlement plate and near the west end. At the time of inspection the water depth above the top of the mats at the two low areas was approximately 0.1 ft. It should be noted that in these locations of observed settlement at Sites R1 and R2, fill material had to be placed in order to level the bottom before placement of the fabric, pipe, and mats during construction. No noticeable damage to the structures was apparent. The settlement plate riser pipes appeared to be in good condition. While the settlement plate riser pipe at Site R3 is visually out of plumb, this riser pipe was leaning upon installation. The warning signs and support piles at the three sites were in excellent condition. The bank tie-ins were in good condition with some bank erosion noted. Overall, the revetment mat structures appear to be intact and do not require any maintenance (Appendix B, Photos 1 – 15).

Approximately 75 ft to the east of the east tie-in of Site R1, an existing breach in the bank was plugged with dredged material from the GIWW during construction. This earthen plug has now been breached leaving the bank open again (Appendix B, Photo 6). This bank line breach should be noted in the demonstration project results.

Sites V1, V2, and V3 – Straight-Walled Fiberglass Sheet Pile System

During the inspection, water levels were such that the sheet pile structures were exposed to the bottom of the timber walers. No noticeable breaching or major damage to the structures was apparent. Some minor cracks, splits, and missing tops of sheet pile above the timber waler were observed. Timber walers appeared to be in good condition at all three sites. The galvanized tie rods and timber waler hardware were in good condition with only a minimal amount of corrosion present. The warning signs and support piles were in excellent condition. The bank tie-ins appeared in to be in good condition. Overall, the sheet pile structures appear to be intact and do not require any maintenance (Appendix B, Photos 16 – 30).

Off-Bank Treatments

Sites J1, J2, and J3 – Concrete Armor Units (24" A-Jacks®) with Giant Cutgrass

At the adjacent Sites J1 and J2, accretion has occurred, and the A-Jacks® (double row) are now covered by well-vegetated, accumulated material. The depth of cover over the A-Jacks® was found to be 1 ft to 2 ft in some locations. The extent of vegetated accretion appears to be greater than 200 ft in some locations as it extends from the old shoreline behind the A-Jacks® northward toward the GIWW beyond the warning signs at the two sites. Survival of the plantings at J1 and J2 appears to be significantly less than was observed during the 2005 inspection. Some groups were noted that may still be dormant from the winter. Also, it appears that some plantings have been transplanted, possibly by the hurricanes of 2005. At Site J3, the water level was just below the tops of the A-Jacks®. No accretion has occurred except at the west tie-in where the structure ties into the Site A2 plug. In fact, it appears as if the shoreline may have continued to experience some measure of erosion at this site. The survival rate of the plantings at Site J3 still appears to be the lowest (out of the three sites) as noted in the 2005 inspection report. The tie-ins appeared to be in good condition at the three sites. The warning signs and support piles at the three sites were in excellent condition. No maintenance is recommended for the concrete armor unit sites at this time (Appendix B, Photos 31 – 41).

Sites F1, F2, and F3 – Fencing with Giant Cutgrass

In general, the timber fencing and galvanized hardware at the three sites appeared to be in good condition with no signs of damage. One location of damage was noted however. At Site F2, approximately seven or eight fence spans were missing near the middle of the structure. It appears as if a barge struck the fence here. From communication with field personnel, it is believed this occurred in early May 2006. Most of the bank tie-ins were in good condition. The bank has eroded approximately 2 ft away from the west end of the fence at Site F2. The warning signs and support piles were in excellent condition at Sites F1 and F3. The warning sign support pile at Site F2 was struck by the barge as well and is now leaning with the sign partially submerged. At Site F3, significant accretion has occurred.

This fence site is adjacent to plug Site A2 where extensive accretion of material has occurred. In some locations material has accreted greater than 50 ft from the old shoreline behind the fence out to the warning sign. In the vertical direction the material has reached the second timber on the fence or higher. The plantings' survival rate at Site F3 appears to have drastically reduced from that noted in the 2005 inspection. As noted in the 2005 inspection, the survival rates of the planted giant cutgrass associated with Sites F1 and F2 appeared to still be very low. At Site F2, the identified maintenance needs were the leaning warning sign at Site F2 and the damaged fence sections. No maintenance funds are provided for the repair of any project features, so no maintenance will be performed on the fence. However, the damage to these sections as well as the length of time since the occurrence should be noted in the demonstration project results (Appendix B, Photos 42 – 54).

<u>Additional Features</u>

<u>Sites A1, A2, and A3 – Armored Earthen Plugs</u>
The concrete revetment mats appeared to be in good condition. Material has accreted in front of sites A1 and A2. The most accretion has occurred at Site A2 where the extent of vegetated accretion reaches well beyond the warning sign. The bank tie-ins were also in good condition. The warning signs and support piles were in excellent condition. Overall, the armored plugs appear to be intact and do not require any maintenance (Appendix B, Photos 55 – 66).

c. Maintenance Recommendations

i. Immediate / Emergency Repairs

None at this time.

ii. Programmatic / Routine Repairs

Maintenance needs identified were the leaning warning sign at Site F2, the damaged fence sections at Site F2, and the breach east of Site R1. No maintenance funds are provided for the repair of project features; therefore, the timber fence and bank line breach will not be repaired but should be noted in the demonstration project results. The warning sign at Site F2 is not deemed an emergency repair need since the fence structures are located immediately adjacent to the bank of the GIWW and do not pose a hazard to navigation. However, repairs to the leaning support pile may be attempted by the Thibodaux Field Office.

III. Operation Activity

a. Operation Plan

None of the project features require operations.

b. Actual Operations

None of the project features require operations.

IV. Monitoring Activity

a. Project Objective and Goals

The objective of the Mandalay Bank Protection Demonstration (TE-41) project is to compare both the treatment as well as the cost effectiveness of two off-bank and two blowout treatments' ability to provide protection against shoreline erosion, promote sedimentation, and promote vegetation growth in selected areas along the GIWW (Louisiana Department of Natural Resources-Coastal Restoration Division 2003).

The following goals will contribute to the evaluation of the above objective:

1. Stop shoreline erosion in specified areas along the south shores of the GIWW.
2. Increase elevation in shallow open water behind treatments along the GIWW.
3. Maintain/increase the frequency of occurrence of submerged aquatic vegetation (SAV) within shallow open water blowouts along the GIWW.
4. Increase mean cover of *Z. miliacea* to 50% or greater after five growing seasons in planted areas adjacent to eroding shorelines of the GIWW.
5. Increase mean cover of emergent vegetation within shallow open water blowouts along the GIWW.
6. Evaluate the cost effectiveness of different treatments in selected areas along the GIWW.
7. Evaluate the integrity of the structures associated with treatments in selected areas along the GIWW.

b. Monitoring Elements

Shoreline Survey

To document the rate of shoreline retreat or progradation in both blowout and off-bank treatments, shoreline position was surveyed (outward edge of emergent vegetation) in all treatment and reference areas (Shaw® Coastal, Inc. 2004 and 2006). To determine shoreline position, three transect lines per treatment area were surveyed by professional surveyors to a permanent benchmark established in the project area (figure 3; Appendix D figures 1-4). The survey lines coincide with vegetation plot transects and sedimentation elevation transects in each area. Shoreline position was documented in fall of 2003 (as-built) funded through construction and again in fall 2005 (post-construction) funded by monitoring. The last data collection event will occur in 2008.

Elevation

To determine the elevation within shallow open water areas, topographic and bathymetric surveys were conducted along transects by professional surveyors (Shaw® Coastal, Inc. 2004 and 2006). Elevation transects were surveyed to a permanent benchmark established inside the project area. Three transects were delineated in each treatment area and in each reference area and they continue into the center of the channel (figure 3; Appendix D figures 1-4). To

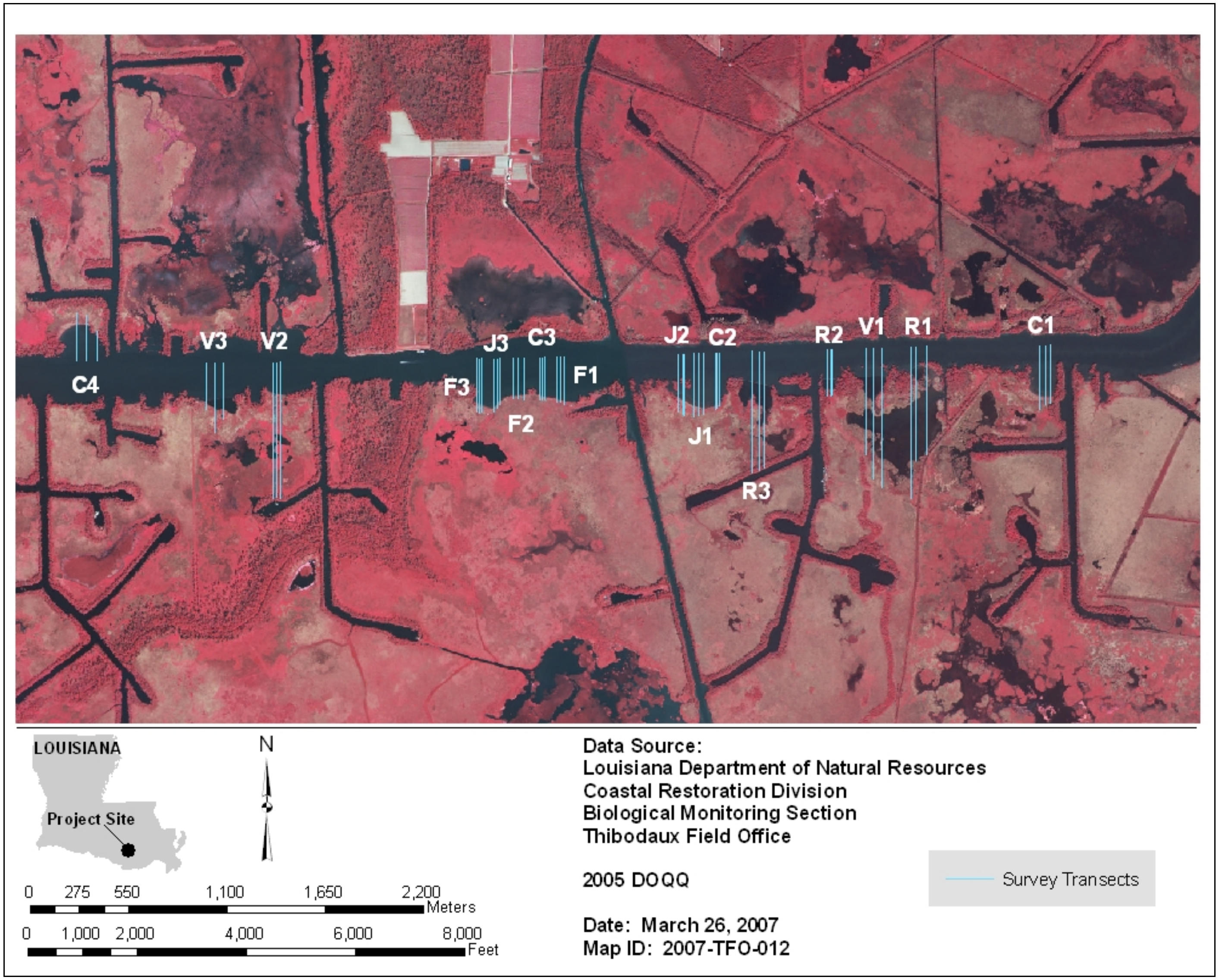

Figure 3. Transect location map for shoreline position, elevation, and vegetation monitoring activities on the Mandalay Bank Protection Demonstration (TE-41) project.

document structural movement and integrity, the tops of all structures were surveyed at the same points, during each elevation transect survey. Sediment and structure elevations were documented in the fall of 2003 (as-built) funded through construction, and in the fall of 2005 (post-construction) funded through monitoring, and will be documented again in 2008.

Vegetation

To determine changes in percent (%) cover of emergent vegetation, plots were randomly established along three line transects running north to south in each treatment and reference area (figure 3). For blowout treatments, four plots were randomly placed along each transect. Three of the plots were randomly placed within one of three zones based upon plot distance from the proposed structure (if a treatment plot) or channel (if a reference plot). A fourth plot per transect was established on the marsh surface at a randomly chosen distance from the vegetated shoreline. Zones were determined by dividing the longest transect in each treatment or reference area into three equidistant areas. For off-bank treatment and reference areas, one plot per transect was established in the water at a random distance (from the treatment or channel). Two additional plots were placed along each transect on the marsh surface at a random distance from the vegetated shoreline. A modification of the Braun-Blanquet method (Mueller-Dombois and Ellenberg 1974) was used to determine total percent cover as well as individual species cover within the plots using a 6.6 ft x 6.6 ft (2 m x 2 m) square placed over the southeast corner pole. Vegetation data was collected twice during pre-construction in the fall of 2001 and 2002, once in the fall of 2003 (as-built), and once post-construction in the fall of 2005, and it will be collected in the fall of 2008.

It is important to note that where corner poles could not be relocated during subsequent sampling periods, the field crew considered these plots inactive and re-established new plots as close to the missing ones as possible using both a Differential Global Positioning System (DGPS) receiver and hand-held Wide Area Augmentation System (WAS)-enabled equipment. A re-established plot was considered different and distinguishable from the inactive plot it replaced.

Percent Survival

To determine the survival of planted *Z. miliacea* behind off-bank treatments, the original planting scheme consisted of 18 permanent vegetation plots representing approximately 10% of the planted vegetation to be established among the off-bank treatments. Plots were to contain 12 plants planted in two staggered rows. The rows would have been spaced 5 ft apart with plants within each row spaced 5 ft apart. However, this scheme was modified during the installation of the plants. Percent survival was determined in the fall of 2003 (one month post-planting) and once in the fall of 2005 (post-construction), and will be determined again in the fall of 2008.

When the monitoring field crew proceeded with the 2003 as-built survival data collection behind the fencing and the A-Jacks® treatments, it was determined that the planting scheme outlined in the project design was not adhered to. There were treatments with one, two, three, or four staggered rows instead of the anticipated design. The following procedure was used to determine percent survival: 1) a plot was established between the shoreline and treatment at each elevation transect (N = 3 transects per treatment replicate); 2) the number of rows established behind each treatment was determined by visual inspection since it did not adhere to the design; 3) standing on the shoreline and facing each treatment, plantings to the left of the observer were selected; and 4) three plants per row were counted based upon the assumed 5-ft staggered spacing of the design and percentages of survival were determined for each treatment.

Submerged Aquatic Vegetation (SAV)

To determine the frequency of occurrence of SAV, open water areas inside blowout treatments and reference sites were randomly sampled (figure 4). Each blowout was sampled at random points along transects using the rake method (Chabreck and Hoffpauir 1962; Nyman and Chabreck 1996). The number of random points and transects was determined based upon the size and configuration of the blowout. Frequency of SAV occurrence was determined for each area from the number of points at which SAV occurred and the total number of points sampled. SAV was monitored twice pre-construction in the fall of 2001 and 2002, during the fall of 2003 (as-built), and once post-construction during the fall of 2005, and it will be documented again in the fall of 2008.

IV. Monitoring Activity

c. Preliminary Monitoring Results and Discussion

Preface: Weather Impacts on Monitoring

Observations made during construction inspection field trips, annual structure inspection field trips, and data collection trips through the years has confirmed that drought and tropical weather systems have had an impact inside the project and reference areas.

The October 2001 pre-construction sampling period occurred approximately four months after the end of a drought which lasted roughly from September 1999 through June 2001. The November 2002 pre-construction sampling period occurred shortly after Hurricane Lili made landfall as a category 2 storm on October 3, 2002, in Iberia Parish. This storm reached category 4 strength as it raked the northern Gulf coast of Louisiana. The floating marsh within the project area sustained damage as field crews observed the marsh balled up along the shoreline during sampling.

High water levels associated with Tropical Storm Bill left behind areas of accretion in mid-July 2003 during construction. Though data collection did not occur in 2004, one year post-construction, it is important to note that the northern Gulf coast was impacted in varying degrees by the effects of significant weather events occurring elsewhere in the Gulf. Among those were Hurricanes Ivan (category 4), Jeanne (category 3), Charley (category 3), and Francis (category 3), and Tropical Storm Matthew.

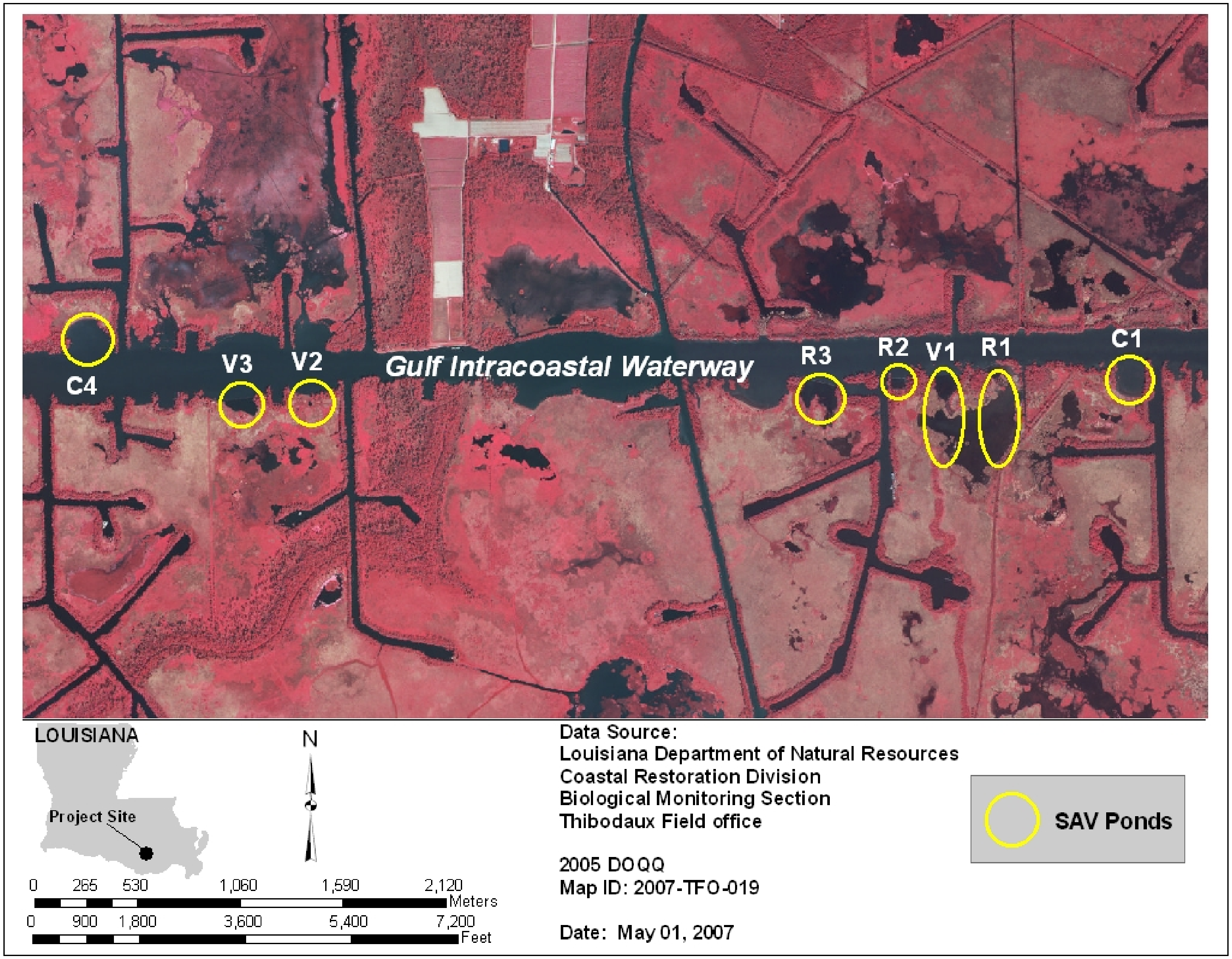

Figure 4. Location map of submerged aquatic vegetation (SAV) ponds for the Mandalay Bank Protection Demonstration (TE-41) project.

The most powerful storms to impact the project area in recent years were those which occurred just prior to the October 4, 2005, post-construction sampling period. Hurricane Katrina (category 5) made landfall only 23 miles east of New Orleans on August 29, 2005, while Rita (category 5) closely skirted the entire Louisiana coastline before making its landfall between Sabine Pass, Texas, and Johnson's Bayou, Louisiana, on September 24, 2005. Observations made during a follow-up structure inspection field trip in 2007 indicate that survival of the plantings as well as shoreline position and elevation were affected.

Shoreline Survey

An as-built shoreline survey was initiated in November 2003 and completed in January 2004 by Shaw Coastal, Inc. A limited pre-design survey in 2001 did not include shoreline position; therefore, comparative analysis between this data set and the 2003 data set is not possible. An additional shoreline survey was completed in October 2005 also by Shaw Coastal, Inc. Comparative analysis of the 2003 and 2005 data indicates approximate gains and losses for treatment and reference areas (table 1).

Table 1. Approximate average, maximum, and minimum shoreline gain/loss along treatment and reference area transects between January 2004 and October 2005, for the Mandalay Bank Protection Demonstration (TE-41) project (Shaw®Coastal, Inc. 2004; Shaw®Coastal, Inc. 2006).

Treatment	Average Gain/Loss (ft)	Minimum Gain/Loss (ft)	Maximum Gain/Loss (ft)
A-Jacks® with Cutgrass	44.26	9.97	73.19
Fencing with Cutgrass	27.07	0.131	70.01
Off-Bank Reference Areas	-19.13	-17.22	-18.11
Fiberglass Sheetpile*	24.44		
Concrete Revetment Mat*	-0.59		
Blowout Reference Areas	25.62	27.33	29.07

*Only one treament

The shoreline associated with both of the off-bank treatments (A-Jacks® with cutgrass and fencing with cutgrass) experienced a substantial average gain (35.67 ft; 10.87 m), while the off-bank reference area shoreline experienced an average loss of approximately -19.13 ft (-5.83 m). The shoreline associated with the A-Jacks® with cutgrass experienced a larger average gain of approximately 44.26 ft (13.49 m) than the fencing with cutgrass with an average gain of approximately 27.07 ft (8.25 m).

Only one treatment area for each of the blowout treatments (fiberglass sheetpile and concrete revetment mat) was analyzed because different interpretations of shoreline locations between the contractor's surveys would not allow for comparisons. The shoreline associated with the fiberglass sheetpile treatment experienced an average gain of approximately 24.44 ft (7.45 m), while the shoreline associated with the concrete revetment mat experienced an average loss of approximately -0.59 ft (-0.18 m). The blowout reference areas experienced an average shoreline gain of approximately 25.62 ft (7.81 m).

As was previously noted, a high water event associated with Tropical Storm Bill in August 2003 occurred during construction. Areas with muddy deposits were observed behind some of the newly constructed structures along the shoreline (J1, J2, F3). This may have contributed to shoreline progradation between the time of construction and the as-built shoreline survey; therefore, no quantitative data exists to match the early field observations.

The February 2005 structure inspections indicated additional progradation behind the same structures as well as immediately behind and in front of two of the armored plugs (A1, A2). Field observations made during the September 2005 vegetation data collection field trips confirm that the areas had prograded beyond the structures, were fully vegetated, and could support a person enough to walk on them, while the shoreline behind J3 appeared to have eroded. For sites J1 and J2, the A-Jacks® were buried by this material and could not be located. Conversely, vegetation plot PVC markers were located in open water for the adjacent off-bank reference C2. These observations qualitatively confirm the 2005 shoreline survey data that some shoreline progradation and erosion did occur in specific areas. It is possible that Hurricanes Katrina and Rita may have accelerated both of these occurrences.

During the 2007 structure inspections, field observations further confirmed even more vegetated accretion had occurred in front of J1, J2, and F3, as well as large areas of vegetated accretion in front of A1 and A2. It was noted that in the areas of J1 and J2 roughly as much as 200 ft (61 m) of progradation may have occurred from the old shoreline behind the structures, and roughly 50 ft (15 m) for the F3 treatment.

Elevation

A limited pre-design elevation survey of the proposed treatment and control areas was conducted in 2001; however, the data is not available. An as-built transect elevation survey for topography and bathymetry, including structure elevation data collection occurred concurrent with the shoreline position survey from November 2003 through January 2004. Another elevation survey was completed in October 2005. Due to the absence of the 2001 data set, and because the control points and benchmarks for this survey are unknown, LDNR could not tie the data to the secondary network of monuments. Elevation data from the topographic and bathymetric surveys taken in 2003 and 2005 by Shaw Coastal, Inc. were reviewed for quality assurance and quality control. The survey data files were imported into ESRI® ArcMap™ version 9.2 to create triangulated irregular network (TIN) layers for each area surveyed using the 3D Analyst function. The TIN layers were created for the 2003 and 2005 data sets. The final product of the TIN model is the elevation contour maps which are presented in Appendix D (figures 5-8) for the 2003 as-built survey and 2005 post-construction survey. The two models were then subtracted from each other using the “Minus” function in the 3D Analyst function in order to calculate the elevation change between the two surveys. The mean elevation change for all areas was 0.1 ft while the maximum change was 5.4 ft which occurred away from the project features along the bottom of the GIWW. The minimum change was -4.4 ft, which also occurred in the GIWW north of the fiberglass sheetpile structure farthest to the western end of the project area. Most areas showed no change to 1 ft of change. Figures 5-6 in the body of this report illustrate the elevation change maps that resulted from the analysis.

The TIN analysis does not appear to capture what has been observed during the field observations. Qualitative field observations made during an August 2003 project construction inspection trip indicated possible early project effects behind A-Jacks® structures installed at J1 and J2. Material deposited behind the structures was noticeable following a high water event associated with Tropical Storm Bill in mid-July 2003 which occurred during construction. The planting crew acknowledged difficulty with accessing the area behind the structures due to the mucky deposits. During the February 2005 Operations and Maintenance inspection, these same areas of accretion were observed behind sites J1 and J2. Observations of these areas during vegetation monitoring in fall of 2005 confirmed that they were larger, fully vegetated, and firm enough to walk on. Additional large areas of accretion were observed in front of A-Jacks® sites J1 and J2, as well as in front of fencing site F3 during the February 2007 annual inspection trip.

Vegetation

Vegetation data were collected during the fall of 2001, 2002, 2003, and 2005. Data analysis results and discussions for species reported inside the 6.6 ft (2 m) x 6.6 ft (2 m) plots are presented in this report. Location maps of the vegetation stations were included in the 2004 Operations, Maintenance, and Monitoring Report (Lear and Dearmond 2007).

Vegetation sampling targeted emergent vegetation rooted in the marsh substrate. *Eichhornia crassipes* (Mart.) Solms (water hyacinth) is a floating aquatic which was reported in numerous open-water blowout plots as well as in some off-bank marsh plots. Though this species was included in the “others” category during data analysis, it occurred in large transient floating mats in the open-water plots, subject to wind and water currents from one moment to the next. Its occurrence in plots on the marsh surface was due to high water events which deposited it when the water receded, and not because it rooted itself in those plots.

In 2001 and 2005, *E. crassipes* (Mart.) Solms comprised a much higher percent cover of the “others” category inside the blowout treatment areas compared to the blowout reference areas. For example, in 2001 this species comprised 11% of the 16% vegetation cover for all 12 species present in the “others” category in the fiberglass sheetpile treatment areas, while its cover was 0.21% of the 0.45% cover for the five species in the “others” category in the reference blowouts (figure 7). Similarly, in the concrete revetment treatment areas, it had 19% cover of the 24% cover for all nine species in that same category (figure 8).

In 2005 in the fiberglass sheetpile treatment areas *E. crassipes* (Mart.) Solms comprised 15% cover of the 40% cover for all 26 species in the “others” category, while it had only 0.54% cover of the 4.04% cover for all 7 species in the reference blowout areas (figure 7). Similarly, it had 15% cover of the 37% cover for all 19 species in the concrete revetment mat treatment areas (figure 8).

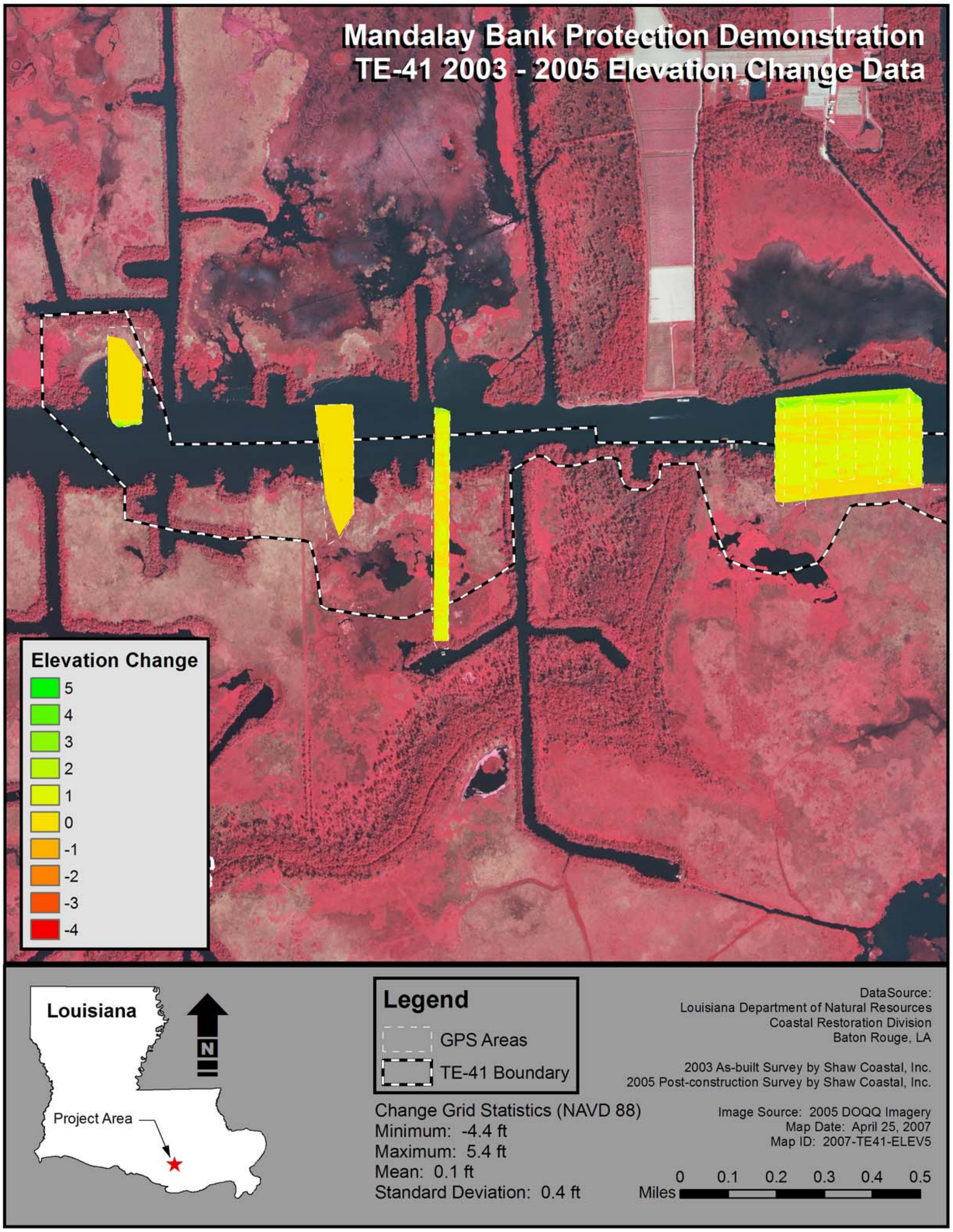

Figure 5. Elevation change map using the 2003 as-built survey data and the 2005 post-construction survey data for the structures on the western side of the Mandalay Bank Protection Demonstration (TE-41) project area.

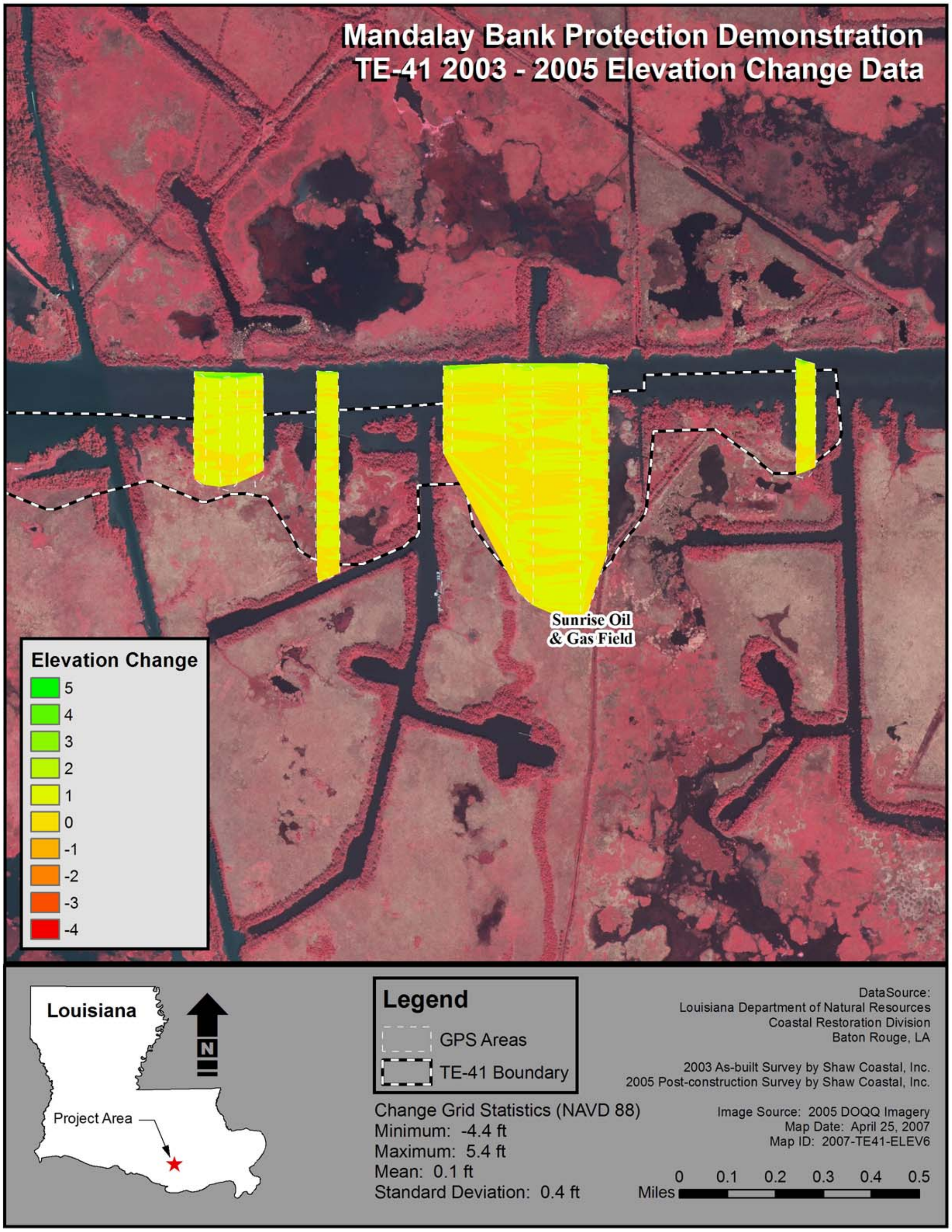

Figure 6. Elevation change map using the 2003 as-built survey data and the 2005 post-construction survey data for the structures on the eastern side of the Mandalay Bank Protection Demonstration (TE-41) project area.

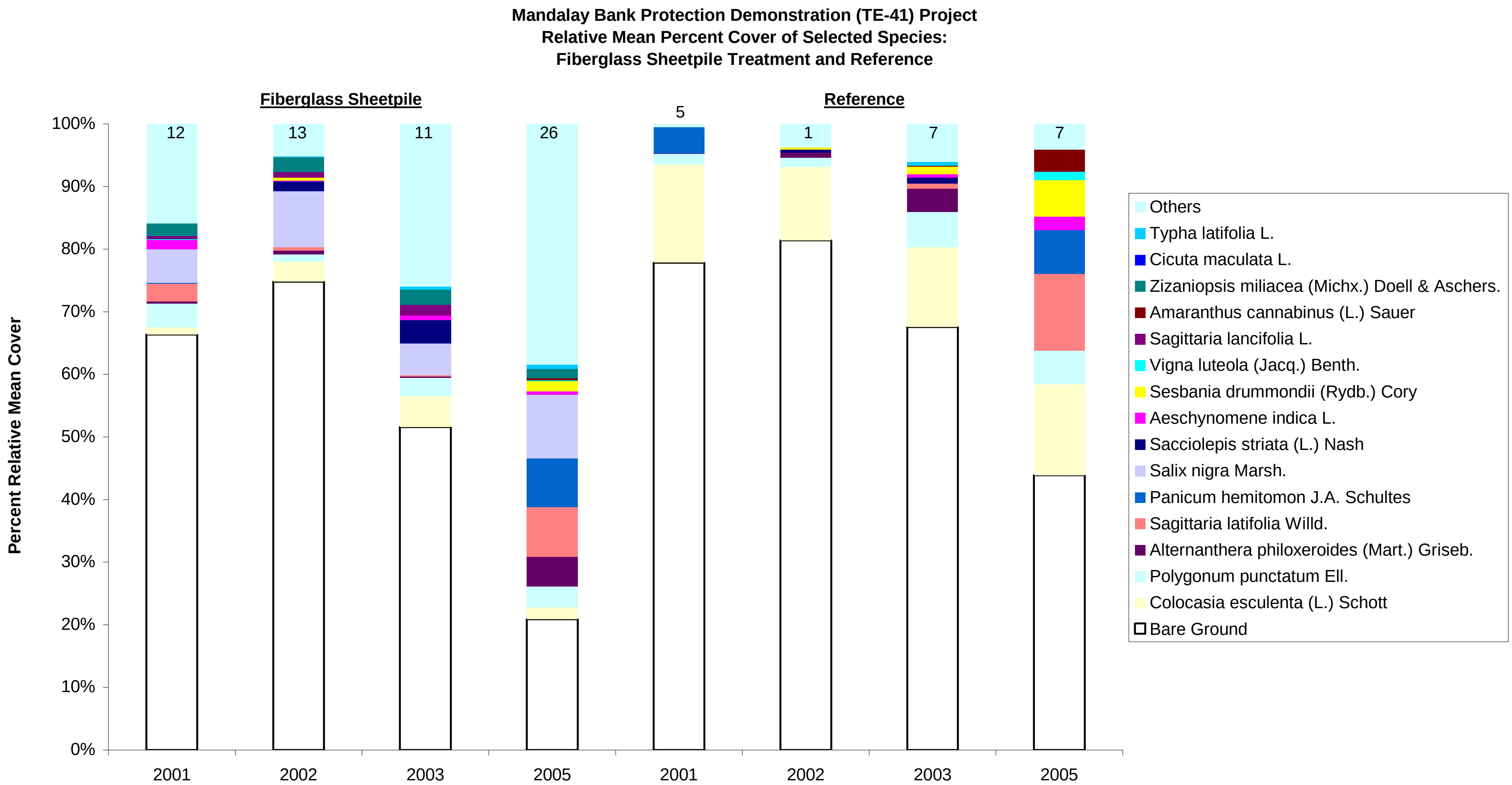

Figure 7. Relative mean percent cover of selected species inside the 2m x 2m Braun-Blanquet vegetation plots in blowouts for the Mandalay Bank Protection Demonstration (TE-41) project where years 2001 and 2002 represent pre-construction data, year 2003 represents as-built data, and year 2005 represents two years post-construction.

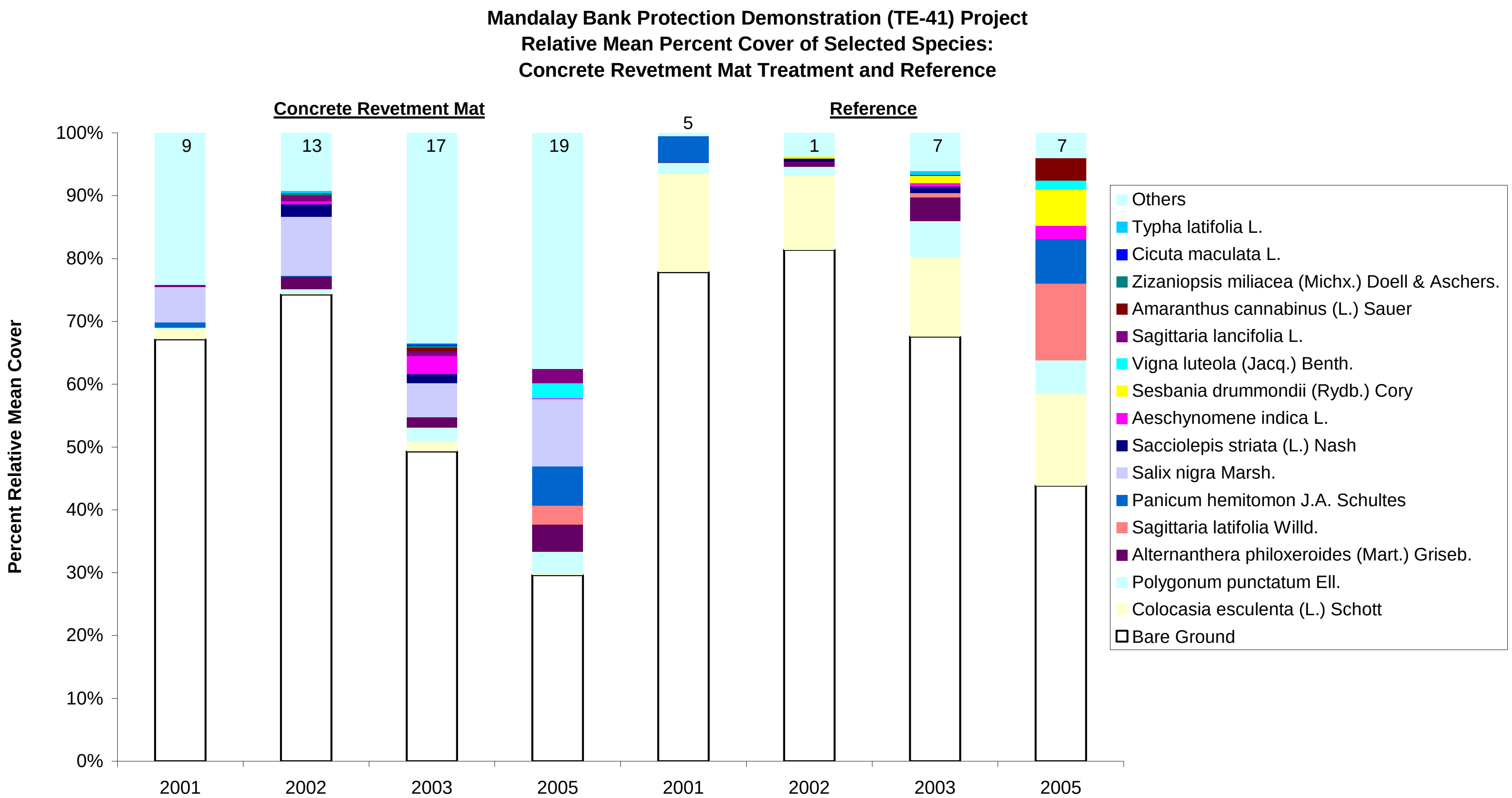

Figure 8. Relative mean percent cover of selected species inside the 2mx2m Braun-Blanquet vegetation plots in blowouts for the Mandalay Bank Protection Demonstration (TE-41) project where years 2001 and 2002 represent pre-construction data, year 2003 represents as-built data, and year 2005 represents two years post-construction.

Blowout Treatment and Reference Areas:
The relative mean percent cover of bare ground for fiberglass sheetpile treatment areas and the associated blowout reference areas increased in 2002 but substantially decreased by 2005 (figure 7). In the treatment areas species diversity increased from 22 to 25 reported species between 2001 and 2002, respectively. The number of reported species decreased in 2003 to 23 but substantially increased to 38 species in 2005. The most dramatic change occurred with respect to the relative mean vegetative cover where there was an increase in cover from 20% in 2002 to 78% in 2005. *Colocasia esculenta* (L.) Schott (coco yam) increased in relative mean percent cover between 2001 and 2003 from approximately 1% to approximately 5%, but decreased in cover to approximately 2% in 2005. The relative mean percent cover of *Polygonum punctatum* Ell. (dotted smartweed) decreased slightly from approximately 4% to approximately 3% cover between 2001 and 2005. *Sagittaria latifolia* Willd. (broadleaf arrowhead) increased in relative mean percent cover during the same time span from approximately 3% to approximately 8% cover.

The relative mean percent cover of bare ground for concrete revetment mat treatment areas and the associated blowout reference areas increased in 2002 but substantially decreased by 2005 (figure 8). In the treatment areas diversity steadily increased from 16 species in 2001 to 31 species in 2005, along with a substantial increase of relative mean vegetative cover of approximately 25% in 2002 to 70% in 2005. In the reference areas species diversity increased between 2001 and 2003 and remained the same in 2005 with 22 reported species. *P. punctatum* Ell. was not reported during the 2001 sampling period but by 2005 it had a relative mean percent cover of approximately 4%. Relative mean percent cover of *C. esculenta* (L.) Schott fluctuated between approximately 2% and less than 1% between 2001 and 2005. *Salix nigra* Marsh. consistently had the highest relative cover for any species in this treatment type between 2001 and 2005. This is probably because most of the plots for the blowout treatments were in open water yet the majority of vegetated plots were shoreline plots which ended up on or near spoil banks with a heavy tree canopy.

In the blowout reference areas, species diversity increased from 7 species in 2002 to 17 species in 2003 and 16 species in 2005 (figures 7-8). Although the reported number of species remained the same in the reference areas, the relative mean vegetative cover increased from 19% in 2002 to 57% in 2005. *C. esculenta* (L.) Schott consistently had the highest relative mean percent cover of all species, ranging from approximately 12% to approximately 16% between 2001 and 2005. Relative mean percent cover for *P. punctatum* Ell. steadily increased from approximately 2% to approximately 5% during this time span. The majority of vegetated plots in the reference blowouts were on floating marsh shorelines with no tree cover, unlike the treatment blowouts.

Off-bank Treatment and Reference Areas:
For the fencing with cutgrass treatments, relative mean vegetative cover increased from a low of 29% in 2002 to high of 72% in 2005 while the species diversity increased from 19 in 2002 to 25 in 2005 (figure 9). Relative mean percent cover of *P. punctatum* Ell. decreased from

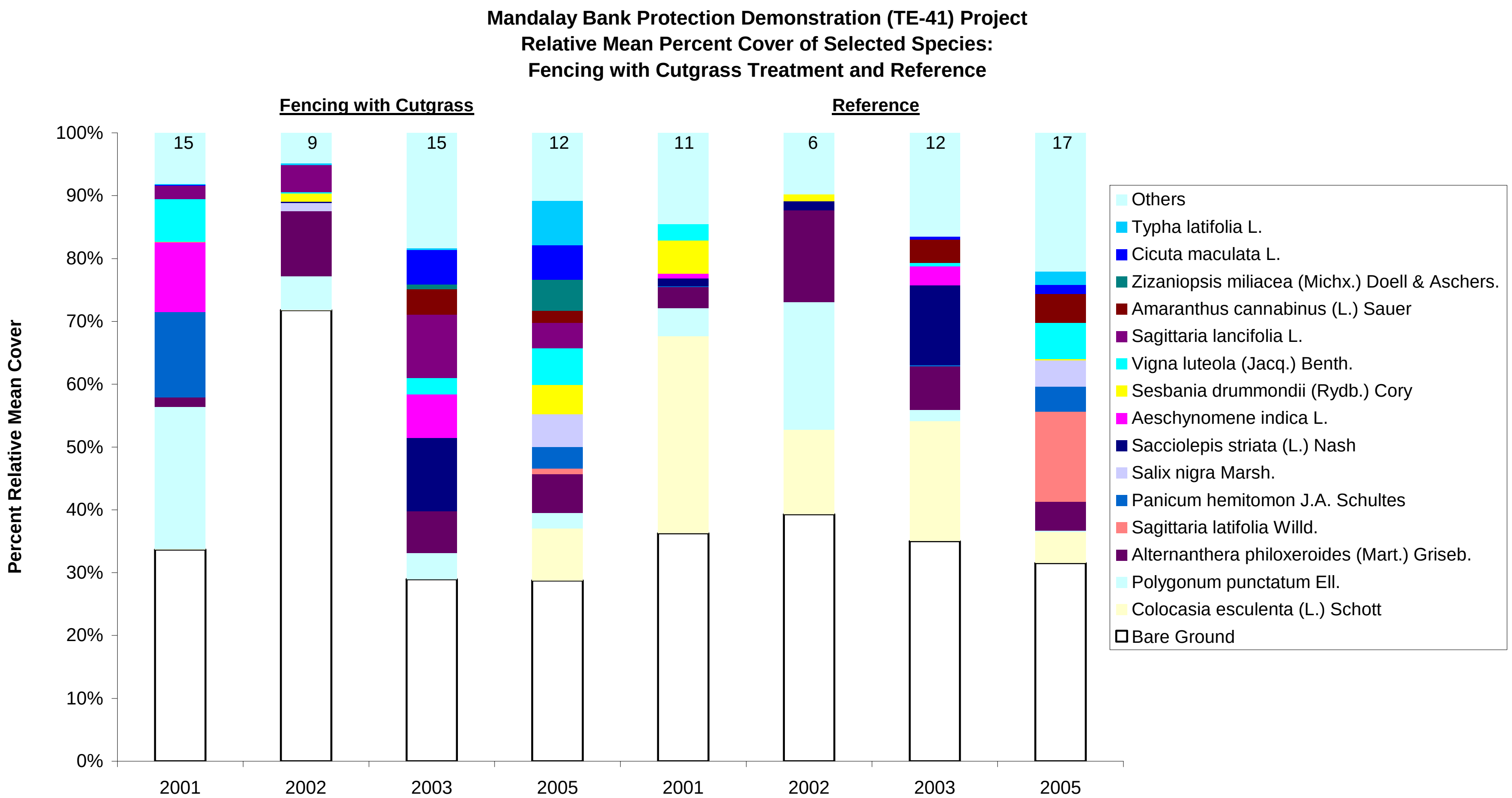

Figure 9. Relative mean percent cover of selected species inside the 2m x 2m Braun-Blanquet vegetation plots for off-bank areas for the Mandalay Bank Protection Demonstration (TE-41) project where years 2001 and 2002 represent pre-construction data, year 2003 represents as-built data, and year 2005 represents two years post-construction.

approximately 25% in 2001 to only 3% cover by 2005. *C. esculenta* (L.) Schott increased in relative mean percent cover from less than 1% to approximately 8% between 2001 and 2005. The relative mean percent cover of *Sagittaria lancifolia L.* (bulltongue) increased between 2001 and 2003 to 10% but decreased to 4% by 2005.

Relative mean vegetative cover for the A-Jacks® with cutgrass treatments steadily and substantially increased from approximately 63% to approximately 88% between 2001 and 2005 (figure 10). The number of species reported between 2001 and 2005 increased from 18 to 24 species with a slightly higher number of 26 reported during the 2003 sampling period. The relative mean percent cover of *P. punctatum* Ell. decreased from approximately 16% to approximately 7% between 2001 and 2005, with a cover of approximately 1% reported during the 2003 sampling period. *C. esculenta* (L.) Schott experienced a similar steady decrease in relative mean percent cover from approximately 24% in 2001 to approximately 2% cover in 2005. *S. latifolia* Willd. was not reported in 2001 but from 2002 to 2005 the relative mean percent cover for this species increased from approximately 3% to approximately 36%.

In the off-bank reference areas species diversity increased from 20 reported species in 2001 to 28 species in 2005 (figures 9-10). Relative mean vegetative cover remained stable from 2001 at approximately 64% to approximately 68% in 2005. *C. esculenta* (L.) Schott decreased in relative mean percent cover between 2001 and 2005 from approximately 31% to 5% cover, with an approximate increase of 6% relative mean cover between the 2002 and 2003 sampling periods. The relative mean percent cover for *P. punctatum* Ell. increased from approximately 4% in 2001 to approximately 20% in 2002, but had less than 1% relative mean cover by 2005. *S. latifolia* Willd. was not present from 2001 through 2003, yet it had a relative mean percent cover of 14% by 2005.

Relative percent bare ground in all treatment and reference areas tended to exhibit similar patterns from one sampling period to the next, with the exception of the off-bank treatment fencing with cutgrass in 2002. In this case, more plots of this treatment type were either washed out or partially eroded when compared to the A-Jacks® treatments with no eroded plots. Also, the shoreline along the fencing treatments was mostly bare ground and badly balled up in most of the plots. Some of those fencing treatment plots also had large wracks of storm debris inside of them. Since the project structures were not installed until 2003, the possibility exists that the storm effects from Hurricane Lili coupled with shoreline orientation may have had some bearing on the cover values.

Although the ratio of open water to marsh plots differs between blowout areas and off-bank areas (a 3:1 ratio for blowouts and a 1:2 ratio for off-banks), similar trends in relative cover between 2001 and 2005 have occurred in the treatment and reference areas for both. Overall, vegetation cover trends from lower mean cover to higher mean cover from 2001 to 2005, while bare ground trends in the opposite direction (figures 7-10). The exception to this would

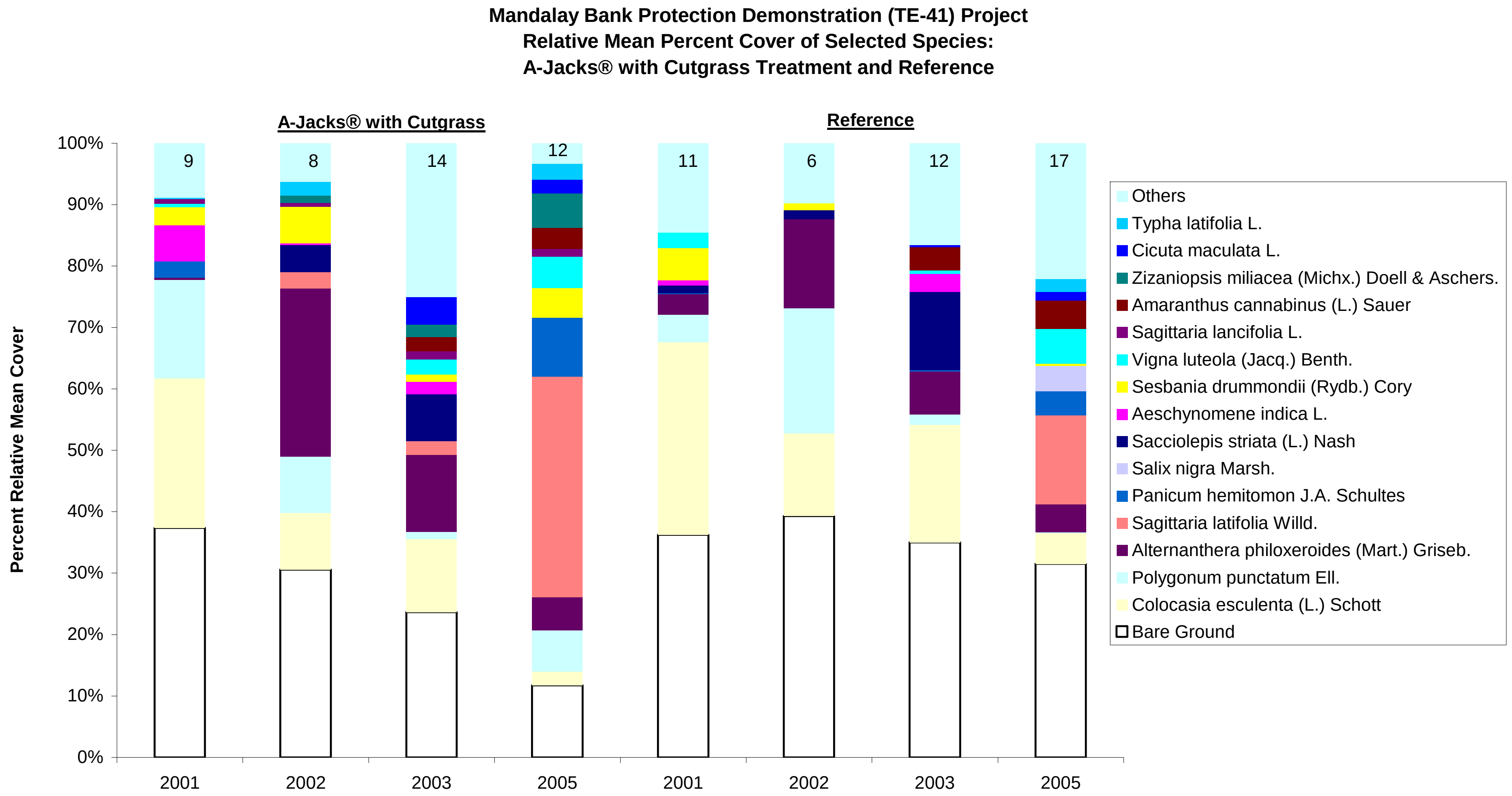

Figure 10. **Relative mean percent cover of selected species inside the 2m x 2m Braun-Blanquet vegetation plots for off-bank areas for the Mandalay Bank Protection Demonstration (TE-41) project where years 2001 and 2002 represent pre-construction data, year 2003 represents as-built data, and year 2005 represents two years post-construction.**

be in 2002 in the off-bank fencing with cutgrass treatments (figure 9), where bare ground cover trends higher than in 2001 before it drops again in 2003.

Percent Survival

Percent survival data was collected in the fall 2003 (N = 18 plots) one month post-planting, and in the fall 2005 (N = 17) two years post-planting. Only the treatments with planted *Z. miliacea* (Michx.) Doell & Aschers required this type of data collection (F1, F2, F3, J1, J2, and J3). Survival data collection will occur again in fall 2008. Comparative analysis between the data sets is presented in this report (Tables 2-4).

Table 2. 2003 and 2005 stations where percent survival data were collected in addition to percent cover and species composition data.

Treatments	2003 Stations	2005 Stations
F1	TE41-164, TE41-165, TE41-166	TE41-164, TE41-165, TE41-166
F2	TE41-170, TE41-171, TE41-172	TE41-170, TE41-171, TE41-172
F3	TE41-176, TE41-177, TE41-184	TE41-176, TE41-177, TE41-184
J1	TE41-158, TE41-159, TE41-160	TE41-158, TE41-159, TE41-160
J2	TE41-161, TE41-162, TE41-163	TE41-161, TE41-163
J3	TE41-173, TE41-174, TE41-175	TE41-173, TE41-174, TE41-175

*TE41-162 could not be relocated due to missing corner pole therefore it was inactivated.

Table 3. Percent survival of planted giant cutgrass inside of fencing and A-Jacks® treatments for fall 2003 vegetation monitoring one month post-planting.

Fencing with Giant Cutgrass				A-Jacks with Giant Cutgrass			
Treatment	Planted	Alive	Percent Survival	Treatment	Planted	Alive	Percent Survival
F1	24	9	37.5	J1	18	12	66.7
F2	24	9	37.5	J2	24	11	45.8
F3	27	12	44.4	J3	18	3	16.7
Total	75	30	40	Total	60	26	43.3

The 2003 analysis indicates that the fencing with cutgrass treatments (F1, F2, and F3) had 40.0% survival one month post-planting. The A-Jacks® with cutgrass treatments (J1, J2, and J3) had 43.3% survival one month post-planting (Table 3).

Table 4. Percent survival of planted giant cutgrass inside of fencing and A-Jacks® treatments for fall 2005 vegetation monitoring one month post-planting.

Fencing with Giant Cutgrass				A-Jacks with Giant Cutgrass			
Treatment	Planted	Alive	Percent Survival	Treatment	Planted	Alive	Percent Survival
F1	24	1	4.2	J1	18	Indeterminate	Indeterminate
F2	24	1	4.2	J2	24	?	?
F3	27	7	25.9	J3	18	1	5.6
Total	75	9	12	Total	60	?	?

Percent survival of planted giant cutgrass inside the fencing treatments went from 40% to 12% between the 2003 and 2005 sampling periods, a decrease of 28% (Table 4). Percent survival of planted giant cutgrass inside the A-Jacks® treatments could not be determined for two reasons. First, the planted species inside of treatment J1 station TE41-158 grew into a solid line so that the parent plants could not be distinguished from the newer ones making a count impossible. Second, the exact location of station TE41-162 inside of treatment J2 could not be determined during the 2005 sampling period due to a missing corner pole. This station was inactivated and data was not collected.

Vegetation stations used to analyze plant survival were also analyzed for the mean percent cover of *Z. miliacea* (Michx.) Doell & Aschers (giant cutgrass). Table 5 shows the the A-Jacks® treatment has a higher percent cover average than the fencing. The monitoring goal is to achieve 50% cover by year 2008. It appears that this goal may be achieved unless some unforeseen event prevents the current growth rate and spreading of the plants.

Table 5. Mean percent (%) cover of giant cutgrass inside of established vegetation plots located behind the structures.

Fencing with Giant Cutgrass			**A-Jacks with Giant Cutgrass**		
Treatment	**2003**	**2005**	**Treatment**	**2003**	**2005**
F1	0	8.33	J1	0	53.33
F2	1.67	0.67	J2	0	5
F3	6.67	23.33	J3	0	13.33
Average	2.78	10.78	Average	0	23.89

Observations made during annual inspection field trips and data collection trips through the years has confirmed that weather systems have had an impact on survival of the planted species. During 2005 fall vegetation data collection and during the February 2007 annual structure inspections, field personnel noticed that the planting scheme was drastically reconfigured for some of these treatments as a result of the powerful Hurricanes Katrina and Rita which impacted our coastline in 2005. During the February 2007 annual inspection, areas of progradation found in front of sites J1, J2, and F3 were fully vegetated and the field crew found that they were firm enough to walk on.

Submerged Aquatic Vegetation (SAV)

SAV was monitored twice pre-construction in the fall of 2001 and 2002, during the fall of 2003 (as-built), and once post-construction during the fall of 2005. Sampling only occurs in the blowout treatment and the associated reference areas. Table 6 shows a complete list of the species collected by year and treatment/reference.

Table 6. Complete species list of SAV species reported during the 2001, 2002, 2003, and 2005 sampling periods for the Mandalay Bank Protection Demonstration (TE-41) project.

Scientific Name	2001	2002	2003	2005
Empty Pull	M, S, R	M, S, R	M, S, R	M, S, R
Alga	S, R	M, S, R	M, R	M, S
Alternanthera philoxeroides (Mart.) Griseb.		M	S	M, S, R
Brasenia schreberi J.F. Gmel.			S	
Cabomba caroliniana Gray		M		M
Ceratophyllum demersum L.	M, S, R	M, S, R	M, S, R	M, S
Cyperus L.		S		
Egeria densa Planch.		R		
Eichhornia crassipes (Mart.) Solms		R	M, S	M, S, R
Hydrilla verticillata (L.f.) Royle	M, S	M, S, R	M, S, R	M, S, R
Hydrocotyle umbellata L.				M
Lemna minor L.			M, S, R	M
Limnobium spongia (Bosc) L.C. Rich. Ex Steud		M	M, S	
Luziola fluitans (Michx.) Terrell & H. Robin			M	
Myriophyllum spicatum L.	M, S		S	M, S, R
Najas guadalupensis (Spreng.) Magnus			S	M
Nelumbo lutea Willd.	M, S		M, S	M
Nuphar lutea (L.) Sm.			M	
Oxycaryum cubense (Poepp. & Kunth) Lye		S		
Paspalum fluitans (Ell.) Kunth			M, S	
Pistia stratiotes L.				M
Potamogeton diversifolius Raf.			M	
Ruppia maritima L.	M, S, R	M, S, R	M, S, R	
Salvinia minima Baker	M, S	M, S, R	M, S	M, S
Utricularia L.	S	S		
Vallisneria americana Michx.	M, S, R	M, S, R	M, S, R	M, S, R

Note: M represents Revetment Mat, S represents Fiberglass Sheetpile, and R represents Reference

The October 2001 pre-construction sampling period for SAV occurred approximately four months after the end of a drought which lasted roughly from September 1999 through June 2001. The highest relative frequency of occurrence for empty pulls was in the reference blowouts at approximately 52%, while the lowest frequency of approximately 29% occurred inside the fiberglass sheetpile treatments (figure 11). The highest relative frequency of occurrence of all species reported across all blowout treatments and reference blowouts was approximately 33% for *V. americana* Michx. inside the reference blowouts, followed closely by *C. demersum* L. inside the fiberglass sheetpile treatments with a relative frequency of occurrence of approximately 31%. Out of nine reported species, eight of those occurred across all blowout treatments and reference blowouts during the 2001 sampling period.

The effects of Hurricane Lili, which made landfall shortly before the November 6, 2002, pre-construction sampling period were noticeable. The highest relative frequency of occurrence of empty pulls was approximately 65% in the blowout reference areas, followed by approximately 58% inside the fiberglass sheetpile treatments and approximately 54% inside

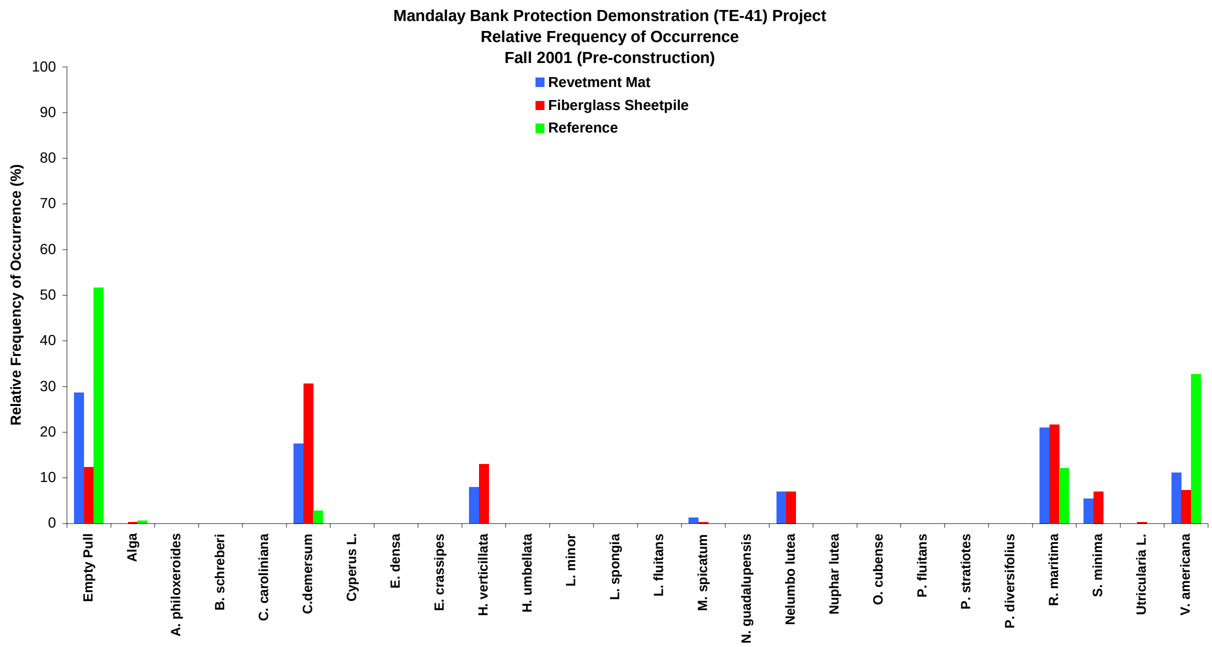

Figure 11. Relative frequency of occurrence of SAV in 2001 for the Mandalay Bank Protection Demonstration (TE-41) project.

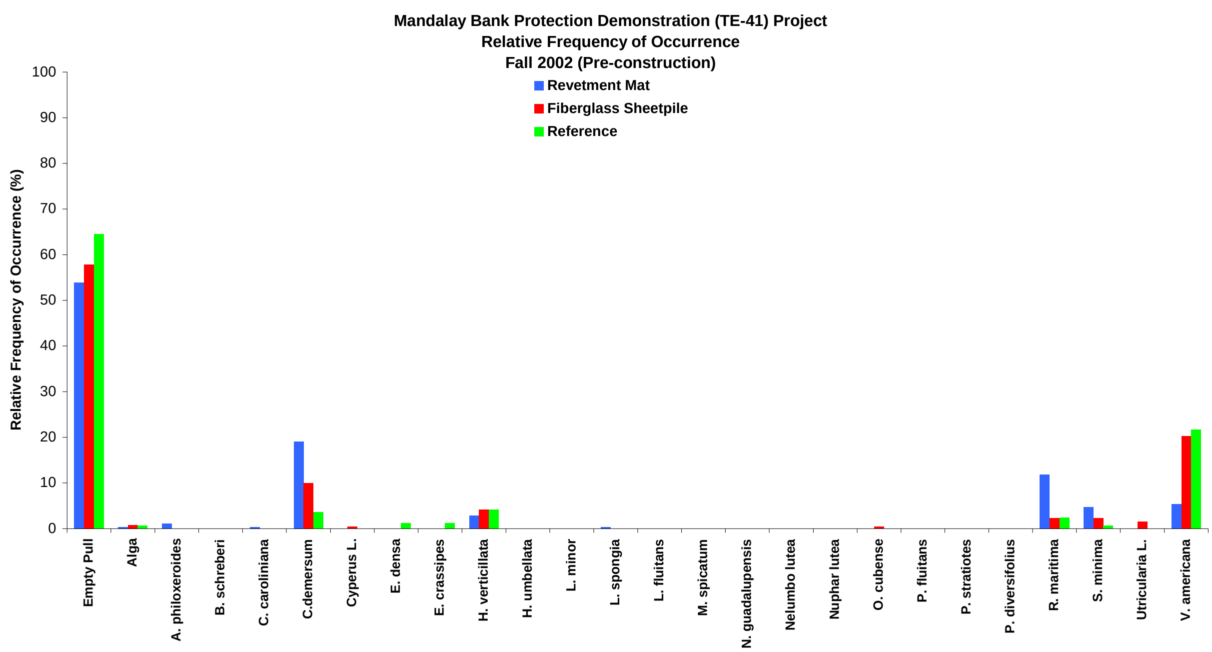

Figure 12. Relative frequency of occurrence of SAV in 2002 for the Mandalay Bank Protection Demonstration (TE-41) project.

the concrete revetment mat treatments (figure 12). The relative frequency of occurrence of empty pulls was higher than the 2001 sampling period. The highest relative frequency of occurrence of all species reported in 2002 across all blowout treatments and reference blowouts was approximately 22%, followed by approximately 21% for *V. americana* Michx. inside the reference blowouts and the fiberglass sheetpile treatments respectively. After this species, *C. demersum* L. had the next-to-highest relative frequency of occurrence of approximately 19% inside the concrete revetment treatments. Out of 14 reported species, six of those occurred across all blowout treatments and reference blowouts during the 2002 sampling period. The reduced frequency may be a result of hurricane activity and not a project effect.

Since the blowouts consist of large open-water areas with shorelines located relatively far from the GIWW, simple visual inspections would not have been adequate enough to determine if any material deposition from Tropical Storm Bill may have occurred in these areas. The highest relative frequency of occurrence of empty pulls was approximately 81% inside the reference blowouts, approximately 16% higher than the 2002 sampling period (figure 13). Relative frequency of occurrence of empty pulls inside the concrete revetment mat treatments and the fiberglass sheetpile treatments was approximately 23% in 2003. The highest relative frequency of occurrence of all species reported in 2003 across all blowout treatments and reference blowouts was approximately 20% for *R. maritima* L. inside the fiberglass sheetpile treatments, followed closely by *V. americana* Michx. inside the same treatments with 19%. *R. maritima* L. inside the concrete revetment mat treatments and *C. demersum* L. inside the fiberglass sheetpile treatments both had approximately 18% relative frequency of occurrence. Out of 18 reported species, five of those occurred across all blowout treatments and reference blowouts during the 2003 sampling period.

Two major hurricanes, Katrina and Rita, made landfall just prior to the October 2005 post-construction sampling period. The highest relative frequency of occurrence of empty pulls was approximately 94% inside the reference blowouts, approximately 13% higher than the 2003 sampling period (figure 14). An even greater difference between the two sampling periods occurred inside the concrete revetment mat treatments and the fiberglass sheetpile treatments with relative frequency of occurrence of empty pulls at approximately 66% and approximately 61% respectively for 2005. The highest relative frequency of occurrence of all species reported in 2005 across all blowout treatments and reference blowouts was approximately 17% for *C. demersum* L. inside the fiberglass sheetpile treatments and approximately 10% for the same species inside the concrete revetment mat treatments. *N. guadalupensis* (Spreng.) Magnus had a relative frequency of occurrence of approximately 9% inside the concrete revetment mat treatments. Out of the 14 reported species, five of those occurred across all blowout treatments and reference blowouts during the 2005 sampling period.

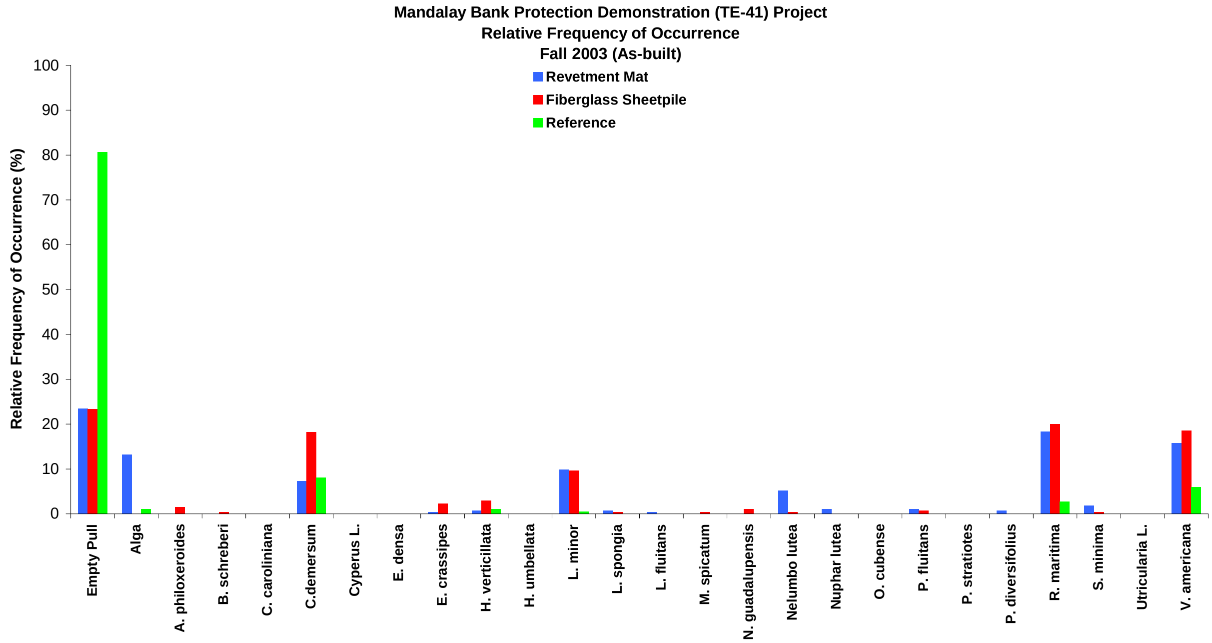

Figure 13. Relative frequency of occurrence of SAV in 2003 for the Mandalay Bank Protection Demonstration (TE-41) project.

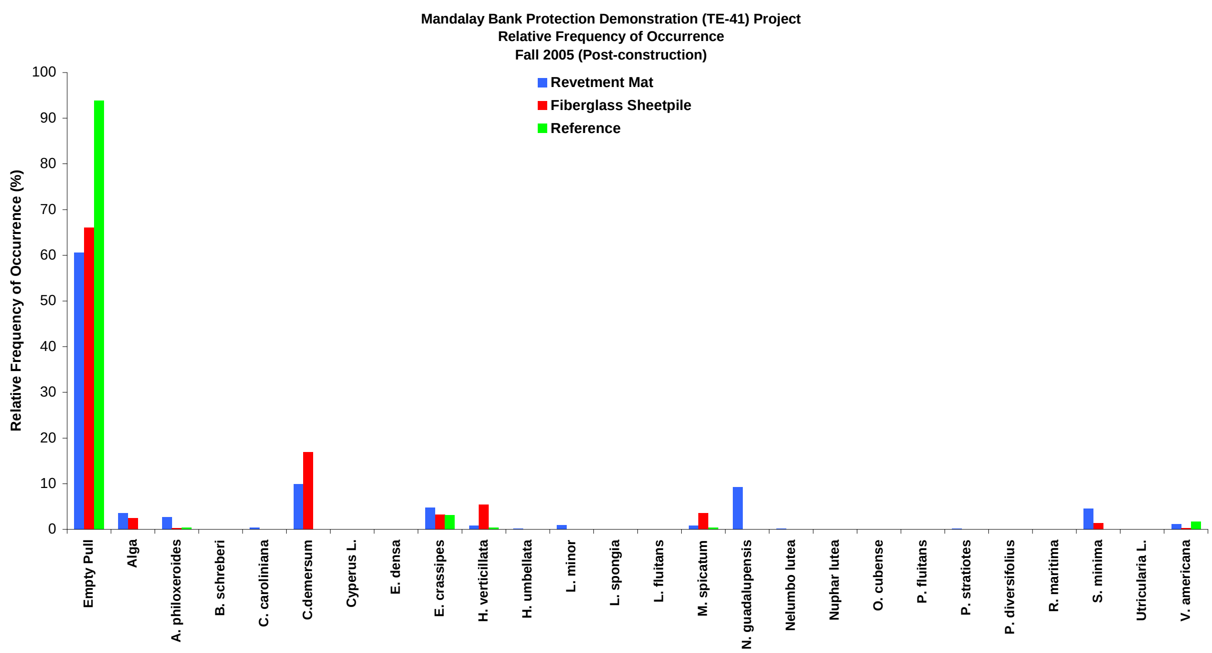

Figure 14. Relative frequency of occurrence of SAV in 2005 for the Mandalay Bank Protection Demonstration (TE-41) project.

V. Conclusions

a. Project Effectiveness

Pre-construction transect elevation survey design data is not available to compare topography, bathymetry, and shoreline position to any subsequent post-construction surveys. The 2003 as-built transect elevation survey was used for comparison against the fall 2005 elevation survey in this report to determine project effects post-construction. The 2008 elevation survey will contribute additional information for comparison.

Qualitative field observations between 2001 and 2007 supports the shoreline position survey data that there has been some shoreline gain in treatment and reference areas except for the off-bank reference shorelines and the concrete revetment mat treatment shorelines where erosion has taken place.

The TIN analysis revealed a mean elevation change for all areas of 0.1 ft, with a maximum change of 5.4 ft, and a minimum change of -4.4 ft. The minimum and the maximum changes occurred outside of the treatment and reference areas in the GIWW channel just north of the constructed project features. Most areas showed no change to 1 ft of change.

Vegetation analysis reveals similar overall trends in both off-bank and blowout treatment and reference areas. Mean vegetation cover has increased steadily, while bare ground has conversely decreased between the 2001 and 2005 sampling periods. Also, species diversity has increased within this time period. The project area continues to exist as a floating marsh with a co-dominant mixture of freshwater species such as *Colocasia esculenta* (L.) Schott, *Polygonum punctatum* Ell., *Sagittaria latifolia* Willd., and *Panicum hemitomon* J.A. Schultes.

Percent survival of the planted species *Zizaniopsis miliacea* (Michx.) Doell & Aschers. substantially decreased from 40% in 2003 to 12% in 2005 behind the fencing. Percent survival behind the A-Jacks® in 2003 was 43.3%. Survival could not be determined for 2005 behind the A-Jacks® because the plantings behind one of the treatments grew into a solid line of plants from which the parent plants could not be distinguished, and because one of the plots could not be located. Noticeable damage to the plantings and the planting scheme was observed following Hurricanes Katrina and Rita.

SAV analysis indicates that between 2001 and 2005 the relative frequency of empty pulls steadily increased from 52% to 94% in the reference blowouts, while it fluctuated from 29% in 2001 to 54% in 2002 to 23% in 2003 then to 61% in 2005 in the concrete revetment mat treatment blowouts. In the fiberglass sheetpile treatment blowouts relative frequency of empty pulls followed a similar pattern to the concrete revetment mat treatment blowouts. The apparent increase in empty pulls in all reference and treatment blowouts in 2005 could possibly be attributed to Hurricanes Katrina and Rita. The relative frequency of *Vallisneria americana* Michx. steadily decreased in the reference blowouts between 2001 and 2005, but steadily increased in all treatment blowouts until it drastically decreased in 2005, another possible response to Hurricanes Katrina and Rita. In the reference blowouts, relative frequency of *Ceratophyllum demersum* (L.) steadily increased between 2001 and 2003, yet it is completely absent in 2005. Its frequency fluctuates inside the concrete revetment mat treatment blowouts between 2001 and 2005 as well as inside the fiberglass sheetpile treatment blowouts and eventually decreases, but not substantially.

b. Recommended Improvements

Discuss and decide amongst the project team prior to construction should damages to any structure during the demonstration period be repaired.

c. Lessons Learned

As documented in the 2004 OM&M report, as-built information for the plantings was not collected. As-built drawings and associated GPS files for the plantings should be provided for projects of this type as they are important tools for monitoring percent survival.

Pre-construction survey data should be available for comparison with as-built and post-construction survey data to aid in the assessment of elevation and shoreline position changes.

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Appendix A

Three (3) Year
Operations and Maintenance
Budget Projection

MANDALAY BANK PROTECTION DEMONSTRATION / TE41 / PPL9

Three-Year Operations & Maintenance Budgets 07/01/2007 - 06/30/2010

Project Manager	O & M Manager	Federal Sponsor	Prepared By
	Dearmond	*USFWS*	*Dearmond*

	2007/2008	2008/2009	2009/2010
Maintenance Inspection	$ -	$ 4,940.00	$ -
Structure Operation	$ -	$ -	$ -
Administration	$ -	$ -	$ -

Maintenance/Rehabilitation

05/06 Description:

	2007/2008
E&D	$ -
Construction	$ -
Construction Oversight	$ -
Sub Total - Maint. And Rehab.	$ -

06/07 Description

	2008/2009
E&D	$ -
Construction	$ -
Construction Oversight	$ -
Sub Total - Maint. And Rehab.	$ -

07/08 Description:

	2009/2010
E&D	$ -
Construction	$ -
Construction Oversight	$ -
Sub Total - Maint. And Rehab.	$ -

	2007/2008	2008/2009	2009/2010
Total O&M Budgets	**$ -**	**$ 4,940.00**	**$ -**

Appendix B

2007 O&M Inspection Photographs

Photo 1. *Site R1 – View along revetment mat system looking east.*

Water Elev. = +0.61' NAVD88
File: 100_0668 TE41 112 R1.jpg

Photo 2. *Site R1 – View of warning sign and settlement plate riser pipe looking south from GIWW.*

Water Elev. = +0.61' NAVD88
File: 100_0666 TE41 110 R1.jpg

Photo 3. *Site R1 – View along revetment mat system looking west.*

Water Elev. = +0.61’ NAVD88
File: 100_0669 TE41 113 R1.jpg

Photo 4. *Site R1 – View of west bank tie-in.*

Water Elev. = +0.61’ NAVD88
File: 100_0663 TE41 107 R1.jpg

Photo 5. *Site R1 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0671 TE41 115 R1.jpg

Photo 6. *Site R1 – View of re-opened breach in bank (dredged material placed during construction) east of R1 looking south from GIWW.*

Water Elev. = +0.61' NAVD88
File: 100_0672 TE41 116 Earth Plug.jpg

Photo 7. *Site R2 – View of revetment mat system looking southeast.*

Water Elev. = +0.61' NAVD88
File: 100_0647 TE41 091R2.jpg

Photo 8. *Site R2 – View of warning sign and settlement plate riser pipe looking south from GIWW.*

Water Elev. = +0.61' NAVD88
File: 100_0649 TE41 093 R2.jpg

Photo 9. *Site R2 – View of west bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0648 TE41 092 R2.jpg

Photo 10. *Site R2 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0653 TE41 097 R2.jpg

Photo 11. *Site R3 – View along revetment mat system looking east.*

Water Elev. = +0.61' NAVD88
File: 100_0640 TE41 084 R3.jpg

Photo 12. *Site R3 – View of warning sign and settlement plate riser pipe looking south from GIWW.*

Water Elev. = +0.61' NAVD88
File: 100_0639 TE41 083 R3.jpg

Photo 13. *Site R3 – View along revetment mat system looking west.*

Water Elev. = +0.61' NAVD88
File: 100_0641 TE41 085 R3.jpg

Photo 14. *Site R3 – View of west bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0637 TE41 081 R3.jpg

Photo 15. *Site R3 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0643 TE41 087 R3.jpg

Photo 16. *Site V1 – View of fiberglass sheet pile system looking east.*

Water Elev. = +0.61' NAVD88
File: 100_0658 TE41 102 V1.jpg

Photo 17. *Site V1 – View of warning sign looking south from GIWW.*

Water Elev. = +0.61' NAVD88
File: 100_0656 TE41 100 V1.jpg

Photo 18. *Site V1 – View of fiberglass sheet pile system looking west.*

Water Elev. = +0.61' NAVD88
File: 100_0657 TE41 101 V1.jpg

Photo 19. *Site V1 – View of west bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0654 TE41 098 V1.jpg

Photo 20. *Site V1 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0660 TE41 104 V1.jpg

Photo 21. *Site V2 – View of fiberglass sheet pile system looking east.*

Water Elev. = +0.61' NAVD88
File: 100_0569 TE41 013 V2.jpg

Photo 22. *Site V2 – View of warning sign looking south from GIWW.*

Water Elev. = +0.61' NAVD88
File: 100_0572 TE41 016 V2.jpg

Photo 23. *Site V2 – View of fiberglass sheet pile system looking west.*

Water Elev. = +0.61' NAVD88
File: 100_0570 TE41 014 V2.jpg

Photo 24. *Site V2 – View of west bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0568 TE41 012 V2.jpg

Photo 25. *Site V2 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0573 TE41 017 V2.jpg

Photo 26. *Site V3 – View of fiberglass sheet pile system looking east.*

Water Elev. = +0.61' NAVD88
File: 100_0560 TE41 004 V3.jpg

Photo 27. *Site V3 – View of warning sign looking south from GIWW.*

Water Elev. = +0.61' NAVD88
File: 100_0558 TE41 002 V3.jpg

Photo 28. *Site V3 – View of fiberglass sheet pile system looking west.*

Water Elev. = +0.61' NAVD88
File: 100_0559 TE41 003 V3.jpg

Photo 29. *Site V3 – View of west bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0557 TE41 001 V3.jpg

Photo 30. *Site V3 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0561 TE41 005 V3.jpg

Photo 31. *Site J1 – View of accretion and vegetation in front of warning sign looking west.*

Water Elev. = +0.61' NAVD88
File: 100_0621 TE41 065 J1.jpg

Photo 32. *Site J1 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0622 TE41 066 J1.jpg

Photo 33. *Site J1 – View of warning sign looking south.*

Water Elev. = +0.61’ NAVD88
File: 100_0625 TE41 069 J1.jpg

Photo 34. *Sites J1 and J2 – View of west bank tie-in (J1) and east bank tie-in (J2) looking north.*

Water Elev. = +0.61’ NAVD88
File: 100_0628 TE41 072 J1.jpg

Photo 35. *Site J2 – View of warning sign looking south.*

Water Elev. = +0.61' NAVD88
File: 100_0631 TE41 075 J2.jpg

Photo 36. *Site J2 – View of accretion and vegetation in front of warning sign looking east.*

Water Elev. = +0.61' NAVD88
File: 100_0632 TE41 076 J2.jpg

Photo 37. *Site J2 – View of west bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0635 TE41 079 J2.jpg

Photo 38. *Site J3 – View of west bank tie-in (covered by accreted material).*

Water Elev. = +0.61' NAVD88
File: 100_0589 TE41 033 J3.jpg

Photo 39. *Site J3 – View of A-Jacks® and shoreline near west end of treatment looking east.*

Water Elev. = +0.61’ NAVD88
File: 100_0591 TE41 035 J3.jpg

Photo 40. *Site J3 – View of warning sign looking south from GIWW.*

Water Elev. = +0.61’ NAVD88
File: 100_0602 TE41 046 J3.jpg

Photo 41. *Site J3 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0592 TE41 036 J3.jpg

Photo 42. *Site F1 – View of timber fencing and plantings looking east.*

Water Elev. = +0.61' NAVD88
File: 100_0606 TE41 050 F1.jpg

Photo 43. *Site F1 – View of warning sign looking south.*

Water Elev. = +0.61' NAVD88
File: 100_0607 TE41 051 F1.jpg

Photo 44. *Site F1 – View of west bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0605 TE41 049 F1.jpg

Photo 45. *Site F1 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0608 TE41 052 F1.jpg

Photo 46. *Site F2 – View of timber fencing and plantings looking west.*

Water Elev. = +0.61' NAVD88
File: 100_0600 TE41 044 F2.jpg

Photo 47. *Site F2 – View of damage to timber fencing looking northeast.*

Water Elev. = +0.61' NAVD88
File: 100_0597 TE41 041 F2.jpg

Photo 48. *Site F2 – View of damage to warning sign and fencing looking south.*

Water Elev. = +0.61' NAVD88
File: 100_0603 TE41 047 F2.jpg

Photo 49. *Site F2 – View of west bank tie-in looking northeast toward GIWW.*

Water Elev. = +0.61' NAVD88
File: 100_0594 TE41 038 F2.jpg

Photo 50. *Site F2 – View of east bank tie-in looking northeast toward GIWW.*

Water Elev. = +0.61' NAVD88
File: 100_0599 TE41 043 F2.jpg

Photo 51. *Site F3 – View of timber fencing, plantings, and accreted material looking southeast.*

Water Elev. = +0.61' NAVD88
File: 100_0578 TE41 022 F3.jpg

Photo 52. *Site F3 – View of warning sign looking south.*

Water Elev. = +0.61' NAVD88
File: 100_0577 TE41 021 F3.jpg

Photo 53. *Site F3 – View of west bank tie-in looking northwest toward GIWW.*

Water Elev. = +0.61' NAVD88
File: 100_0579 TE41 023 F3.jpg

Photo 54. *Site F3 – View of east bank tie-in looking south.*

Water Elev. = +0.61' NAVD88
File: 100_0583 TE41 027 F3.jpg

Photo 55. *Site A1 – View of armored plug standing on top of plug looking east.*

Water Elev. = +0.61' NAVD88
File: 100_0612 TE41 056 A1.jpg

Photo 56. *Site A1 – View of warning sign looking south.*

Water Elev. = +0.61' NAVD88
File: 100_0616 TE41 060 A1.jpg

Photo 57. *Site A1 – View of west bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0611 TE41 055 A1.jpg

Photo 58. *Site A1 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0614 TE41 058 A1.jpg

Photo 59. *Site A2 – View of armored plug standing on top of plug looking east.*

Water Elev. = +0.61' NAVD88
File: 100_0587 TE41 031 A2.jpg

Photo 60. *Site A2 – View of warning sign looking southeast.*

Water Elev. = +0.61' NAVD88
File: 100_0584 TE41 028 A2.jpg

Photo 61. *Site A2 – View of west bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0586 TE41 030 A2.jpg

Photo 62. *Site A2 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0588 TE41 032 A2.jpg

Photo 63. *Site A3 – View of armored plug looking south east.*

Water Elev. = +0.61' NAVD88
File: 100_0566 TE41 010 A3.jpg

Photo 64. *Site A3 – View of warning sign looking south.*

Water Elev. = +0.61' NAVD88
File: 100_0563 TE41 007 A3.jpg

Photo 65. *Site A3 – View of west bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0565 TE41 009 A3.jpg

Photo 66. *Site A3 – View of east bank tie-in.*

Water Elev. = +0.61' NAVD88
File: 100_0567 TE41 011 A3.jpg

Appendix C

Field Inspection Notes

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **TE-41 Mandalay Bank Protection Demonstration Project**

Date of Inspection: 2/19/07 Time: 10:42 AM

Structure No. Site A3

Inspector(s): Daniel Dearmond, Elaine Lear (DNR)

Structure Description: Armored Earthen Plug

Water Depth Inside: ______ Outside: ______

Type of Inspection: Annual

Weather Conditions: CLOUDY, LOW 50's F, WINDS 10-15

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Concrete Revetment Mats	GOOD			10	PHOTOS 7-11.
West Tie-in at Bank	GOOD			8-9	
East Tie-in at Bank	GOOD			11	SOME EROSION OF BANK UNDER MATS @ EAST TIE-IN
Warning Sign/ Support	GOOD			7	

Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?
Conditions of existing levees?
Settlement of rock plugs and weirs?
Noticable breaches?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **TE-41 Mandalay Bank Protection Demonstration Project**

Date of Inspection: 2/19/07 Time: 11:15 AM

Structure No. Site F3

Inspector(s): Daniel Dearmond, Elaine Lear (DNR)

Structure Description: Timber Fencing

Water Depth Inside: ______ Outside: ______

Type of Inspection: Annual

Weather Conditions: CLOUDY, MID 50'S F, WINDS 10-15

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Timber Fence	GOOD	NONE		20, 22, 24-26	PHOTOS 19-27, 29 , > 50' ACCRETION OF MAT'L IN SOME LOCATIONS ACCRETION ELEV. AT 2ND BOARD OR HIGHER
Galvanized Hardware	GOOD				NO SIGNS OF VANDALISM OR OTHER DAMAGE.
West Tie-in at Bank	GOOD			19, 23	
East Tie-in at Bank	GOOD			27, 29	
Warning Sign/ Support	GOOD	NONE		21	
Giant Cutgrass Plantings					SURVIVAL APPEARS TO BE MINIMAL. COMPARED TO 2 YEARS PRIOR (2005 INSPECTION), THERE IS DRASTIC REDUCTION

Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?
Conditions of existing levees?
Settlement of rock plugs and weirs?
Noticable breaches?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: TE-41 Mandalay Bank Protection Demonstration Project

Date of Inspection: 2/19/07 Time: 11:45 AM

Structure No. Site J3

Inspector(s): Daniel Dearmond, Elaine Lear (DNR)

Structure Description: Double Row 24" Concrete Armor Units

Water Depth Inside:____ Outside:____

Type of Inspection: Annual

Weather Conditions: CLOUDY, MID 50's °F, WINDS 10-15

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
24" Concrete Armor Units (A-Jacks)	GOOD	NONE		35,37	PHOTOS 33 – 37, 46 WATER JUST BELOW TOP OF A-JACKS. EDGE OF GEOGRID CURLED UP ABOVE WATER IN PLACES.
West Tie-in at Bank	GOOD			33-34	TIE-IN @ W BANK COVERED W/ ACCRETED MAT'L
East Tie-in at Bank	GOOD			36	
Warning Sign/ Support	GOOD	NONE		46	
Giant Cutgrass Plantings					PLANTINGS STILL SPARSE. SURVIVAL RATE APPEARS TO BE VERY LOW.

Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?
Conditions of existing levees?
Settlement of rock plugs and weirs?
Noticable breaches?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **TE-41 Mandalay Bank Protection Demonstration Project**

Date of Inspection: 2/19/07 Time: 12:40 PM

Structure No. Site F1

Inspector(s): Daniel Dearmond, Elaine Lear (DNR)

Structure Description: Timber Fencing

Water Depth Inside: 1.2 Outside: 1.3

Type of Inspection: Annual

Weather Conditions: CLOUDY, HIGH 50's °F, WINDS 10-15

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Timber Fence	GOOD	NONE		50	PHOTOS 48 - 52, 54 NO SIGNS OF VANDALISM OR OTHER DAMAGE
Galvanized Hardware	GOOD				
West Tie-in at Bank	BANK EROSION			48-49	BANK ERODED APPX 2' AWAY FROM TIE-IN
East Tie-in at Bank	GOOD			52,54	MAT'L HAS ACCRETED @ EAST TIE-IN IN FRONT OF PLUG A1.
Warning Sign/ Support	GOOD	NONE		51	
Giant Cutgrass Plantings					SURVIVAL RATE APPEARS LOW BUT BETTER THAN F2 + J3. SIMILAR TO LAST INSPECTION (2005).

Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?
Conditions of existing levees?
Settlement of rock plugs and weirs?
Noticable breaches?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **TE-41 Mandalay Bank Protection Demonstration Project**

Date of Inspection: 2/19/07 Time: 1:40 PM

Structure No. Site J2

Inspector(s): Daniel Dearmond, Elaine Lear (DNR)

Structure Description: Double Row 24" Concrete Armor Units

Water Depth Inside: ______ Outside: ______

Type of Inspection: Annual

Weather Conditions: CLOUDY, HIGH 50's °F, WINDS 10-15

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
24" Concrete Armor Units (A-Jacks)	GOOD	NONE		61, 76-78	PHOTOS 61, 73-80 A-JACKS COVERED BY VEG. ACCRETED MAT'L. ACCRETION (VEG.) OUT TO BEYOND SIGN
West Tie-in at Bank	GOOD			79-80	
East Tie-in at Bank	GOOD			73-74	
Warning Sign/ Support	GOOD	NONE		75	
Giant Cutgrass Plantings					SURVIVAL RATE APPEARS MODERATE TO LOW - SOME TRANSPLANTING NOTED (POSSIBLY FROM HURRICANES OF '05). SOME GROUPS STILL DORMANT FROM WINTER. SIGNIFICANTLY LESS PLANTINGS THAN 2 YRS PRIOR (2005 INSPECTION).

Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?
Conditions of existing levees?
Settlement of rock plugs and weirs?
Noticable breaches?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **TE-41 Mandalay Bank Protection Demonstration Project** Date of Inspection: 2/19/07 Time: 2:15 PM

Structure No. Site R3 Inspector(s): Daniel Dearmond, Elaine Lear (DNR)

Structure Description: Elevated Shoreline System (Revetment Mats & CPE Pipes) Water Depth Inside: 2.0 Outside: 1.7

Type of Inspection: Annual Weather Conditions: CLOUDY, LOW 60'S °F, WINDS 10-15

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Concrete Revetment Mats	GOOD	NONE		82, 84-85	PHOTOS 81-88 NO AREAS OF SIGNIFICANT SETTLEMENT.
West Tie-in at Bank	GOOD			81	
East Tie-in at Bank	GOOD			87-88	BANK SHOWS SIGNS OF EROSION.
Settlement Plate	GOOD	NONE		86	SLIGHTLY LEANING.
Warning Sign/ Support	GOOD	NONE		83	

Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?
Conditions of existing levees?
Settlement of rock plugs and weirs?
Noticable breaches?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **TE-41 Mandalay Bank Protection Demonstration Project**

Date of Inspection: 2/19/07 Time: 2:40 PM

Structure No. Site V1

Inspector(s): Daniel Dearmond, Elaine Lear (DNR)

Structure Description: Fiberglass Sheet Pile Wall (Double)

Water Depth B/T ~~Inside:~~ 1.3 Outside: 2.2

Type of Inspection: Annual

Weather Conditions: CLOUDY, LOW 60's °F, WINDS 10-15

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
Fiberglass Sheet Pile	GOOD			99,101-103,105	PHOTOS 98 - 105
Timber Walers	GOOD				
Galvanized Tie Rods and Hardware	GOOD		MINIMAL		
West Tie-in at Bank	GOOD			98	
East Tie-in at Bank	GOOD			104	
Warning Sign/ Support	GOOD	NONE		100	

Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?
Conditions of existing levees?
Settlement of rock plugs and weirs?
Noticable breaches?

MAINTENANCE INSPECTION REPORT CHECK SHEET

Project No. / Name: **TE-41 Mandalay Bank Protection Demonstration Project**

Date of Inspection: 2/19/07 Time: 2:55 PM

Structure No. ______

Inspector(s): Daniel Dearmond, Elaine Lear (DNR)

Structure Description: EARTHEN PLUG (DREDGED MATERIAL PLACED IN BREACH AT BANK EAST OF R1)

Water Depth Inside: ______ ~~Outside:~~ ℄ BREACH: 2.1'

Type of Inspection: Annual

Weather Conditions: CLOUDY, LOW 60'S F, WINDS 10-15

Item	Condition	Pysical Damage	Corrosion	Photo #	Observations and Remarks
EARTHEN PLUG	POOR / BREACHED			116	THE CUT HERE HAS RE-OPENED. ~6' WIDE, WATER DEPTH @ CENTER OF BREACH = 2.1'

Position of stoplogs at the time of the inspection?
Are there any signs of vandalism?
Conditions of existing levees?
Settlement of rock plugs and weirs?
Noticable breaches?

Appendix D

Survey Transect Location Maps
and
2003 and 2005 Elevation Contour Maps

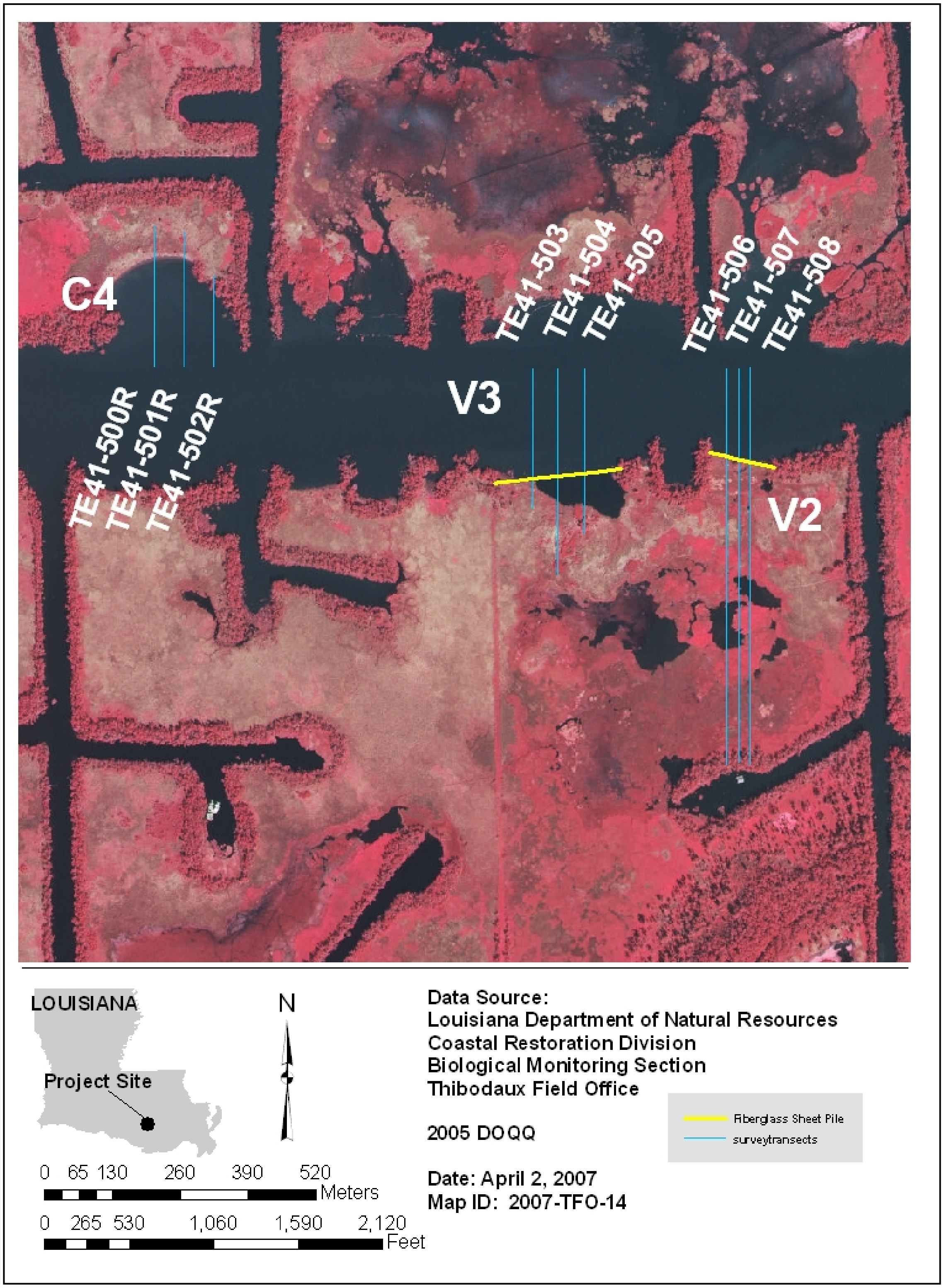

Figure 1. Location map of elevation survey transects inside the blowout reference C4 and blowout fiberglass sheetpile treatments V3 and V2 for the Mandalay Bank Protection (TE-41) Demonstration project.

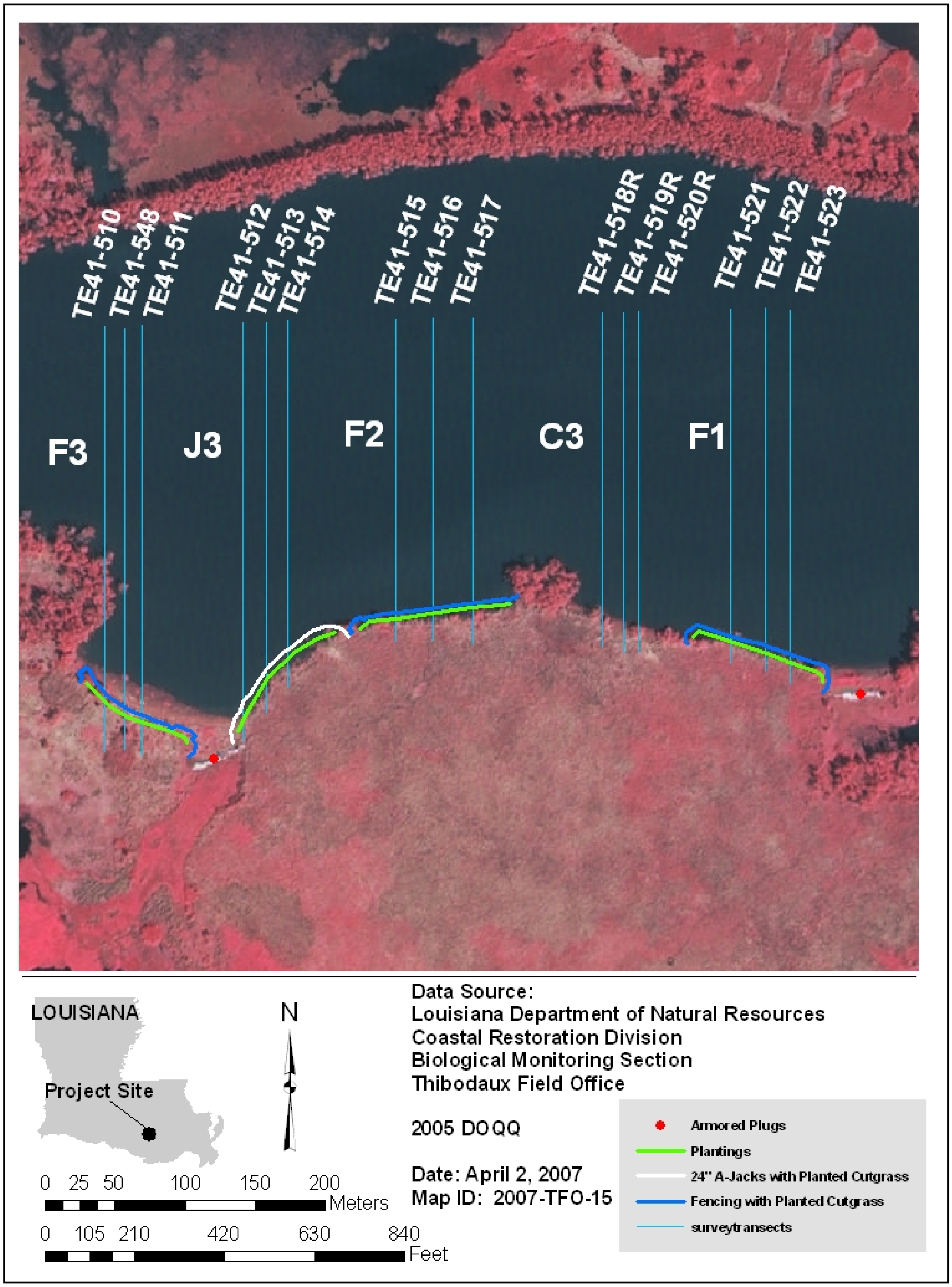

Figure 2. Location map of elevation survey transects inside the off bank fencing with planted giant cutgrass treatments F3, F2, and F1, off bank A-Jacks® with planted cutgrass treatment J3 and off bank control C3 for the Mandalay Bank Protection (TE-41) Demonstration project.

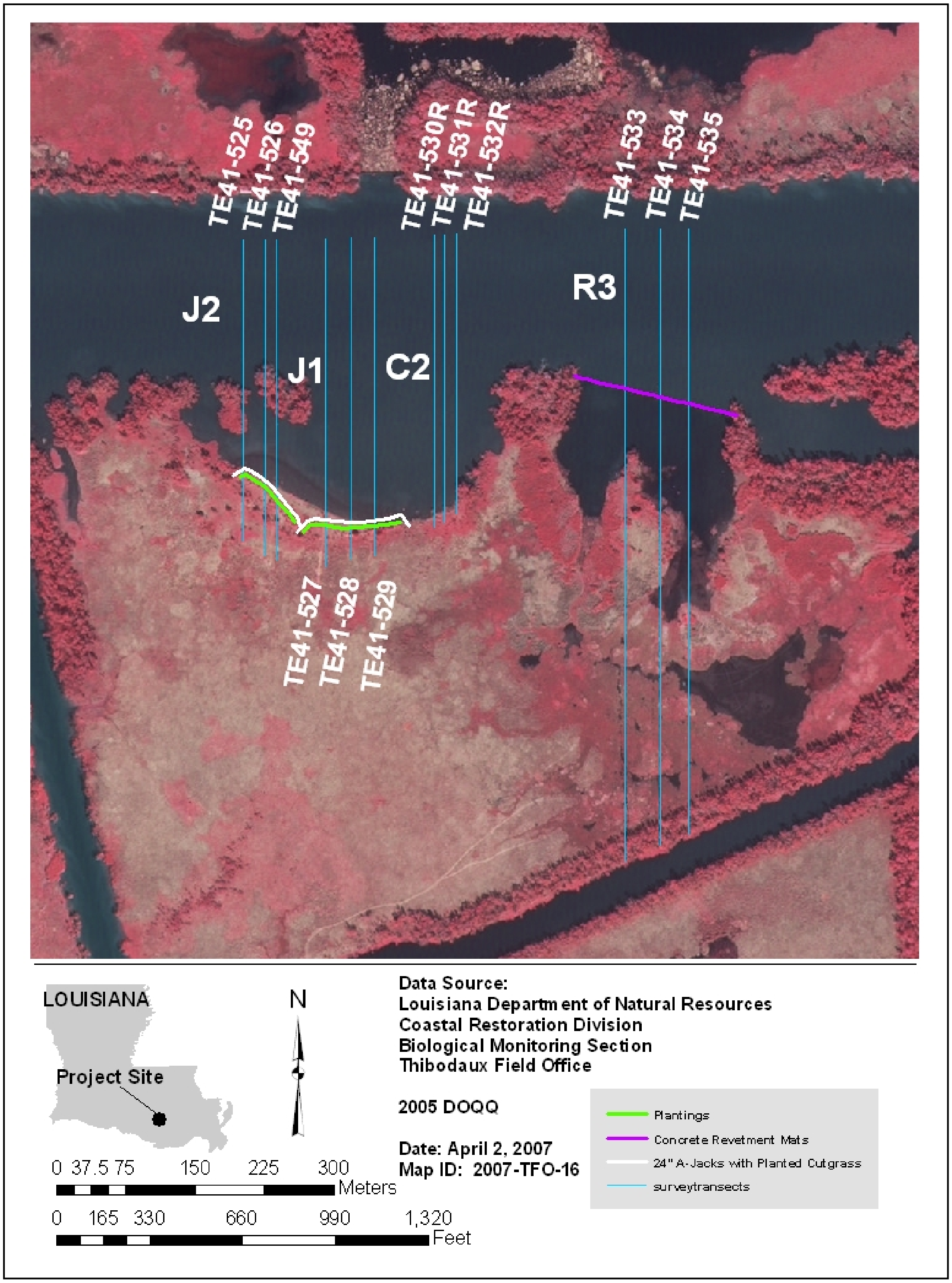

Figure 3. Location map of elevation survey transects inside the off bank A-Jacks® with planted cutgrass treatments J2 and J1, off bank control C2, and blowout concrete revetment mat treatment R3 for the Mandalay Bank Protection (TE-41) Demonstration project.

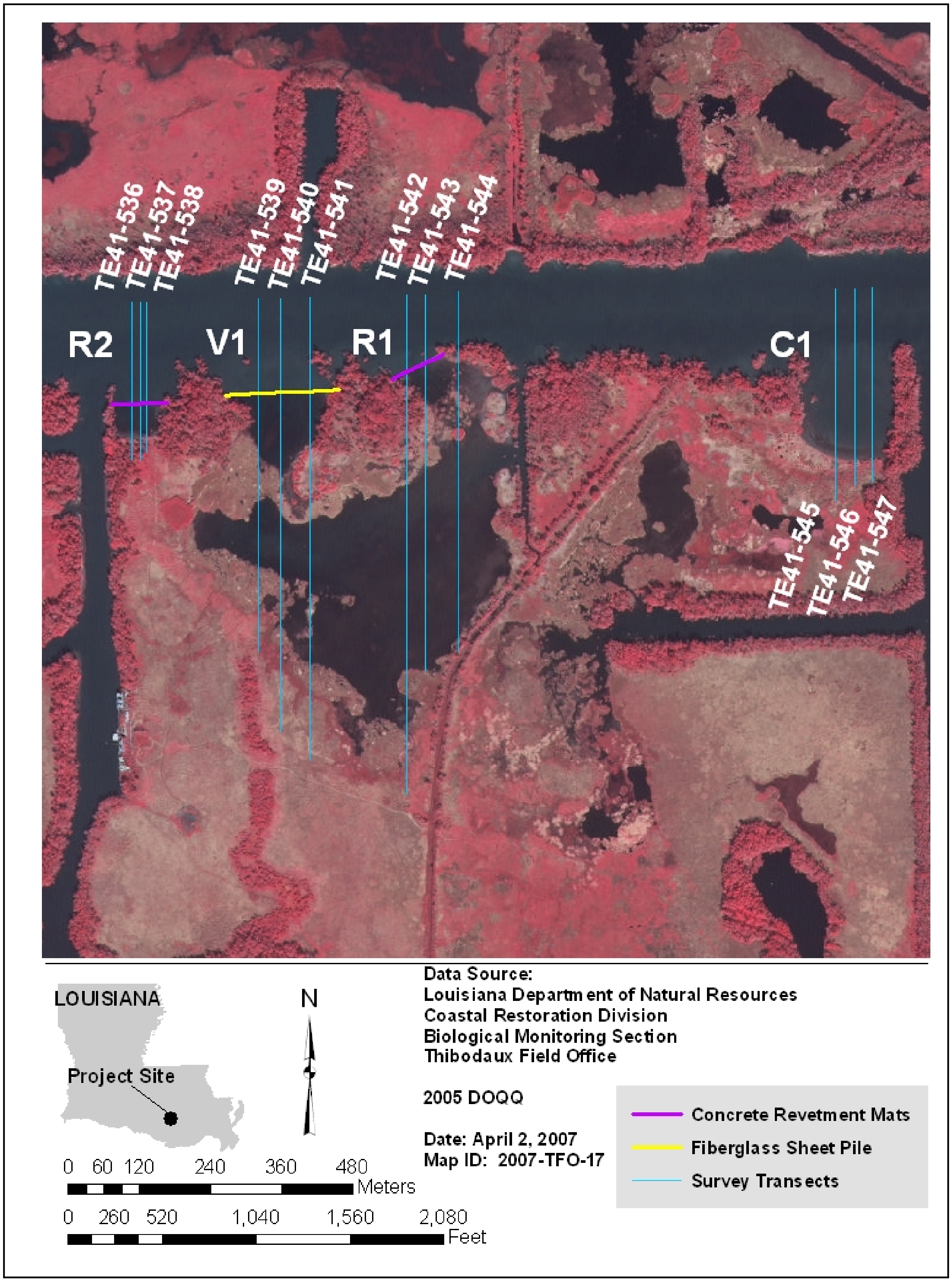

Figure 4. Location map of elevation survey transects inside the blowout concrete revetment treatments R2 and R1, blowout fiberglass sheetpile treatment V1 and blowout control C1 for the Mandalay Bank Protection (TE-41) Demonstration project.

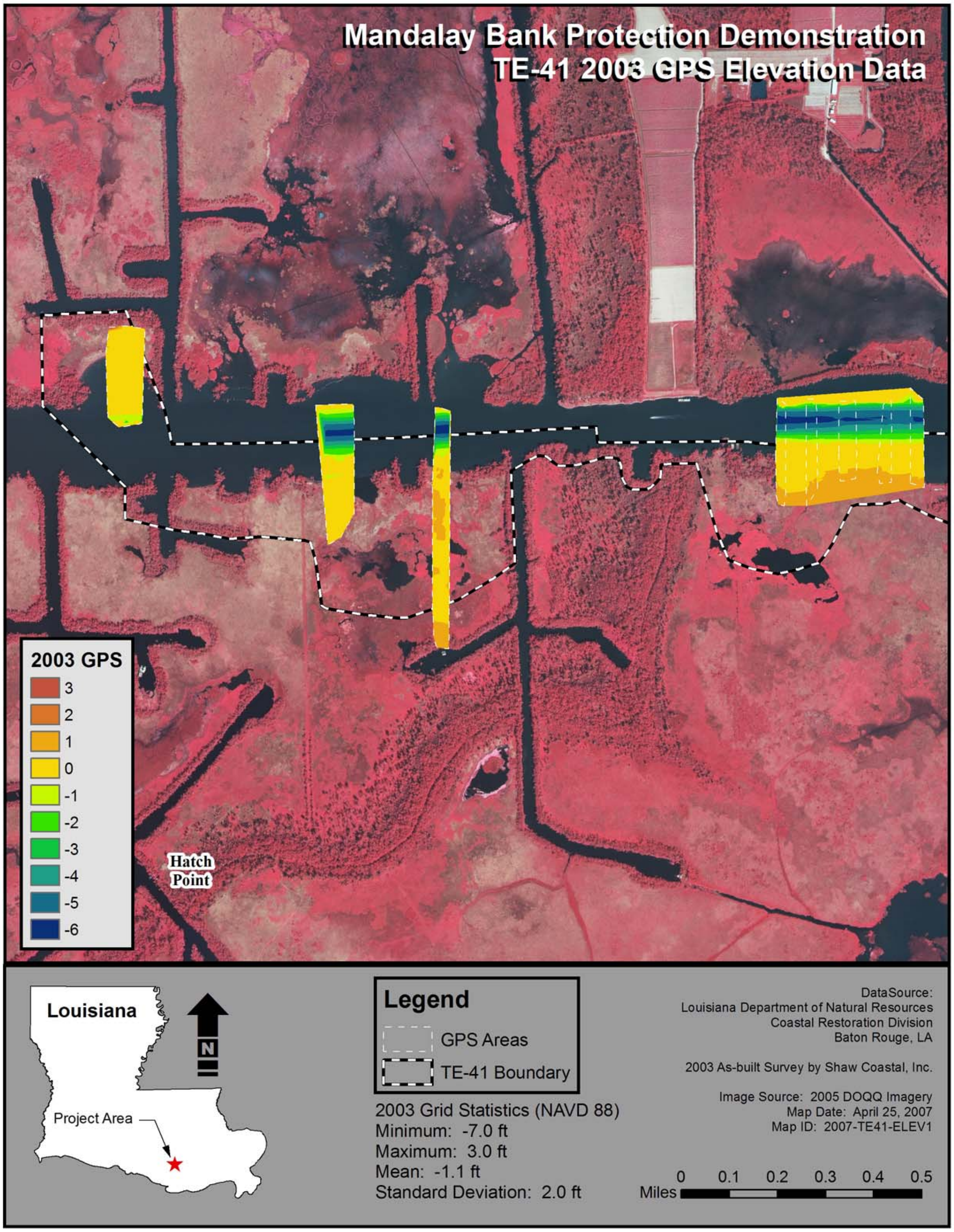

Figure 5. Elevation contour map of the areas surveyed in 2003 (west side of the project area).

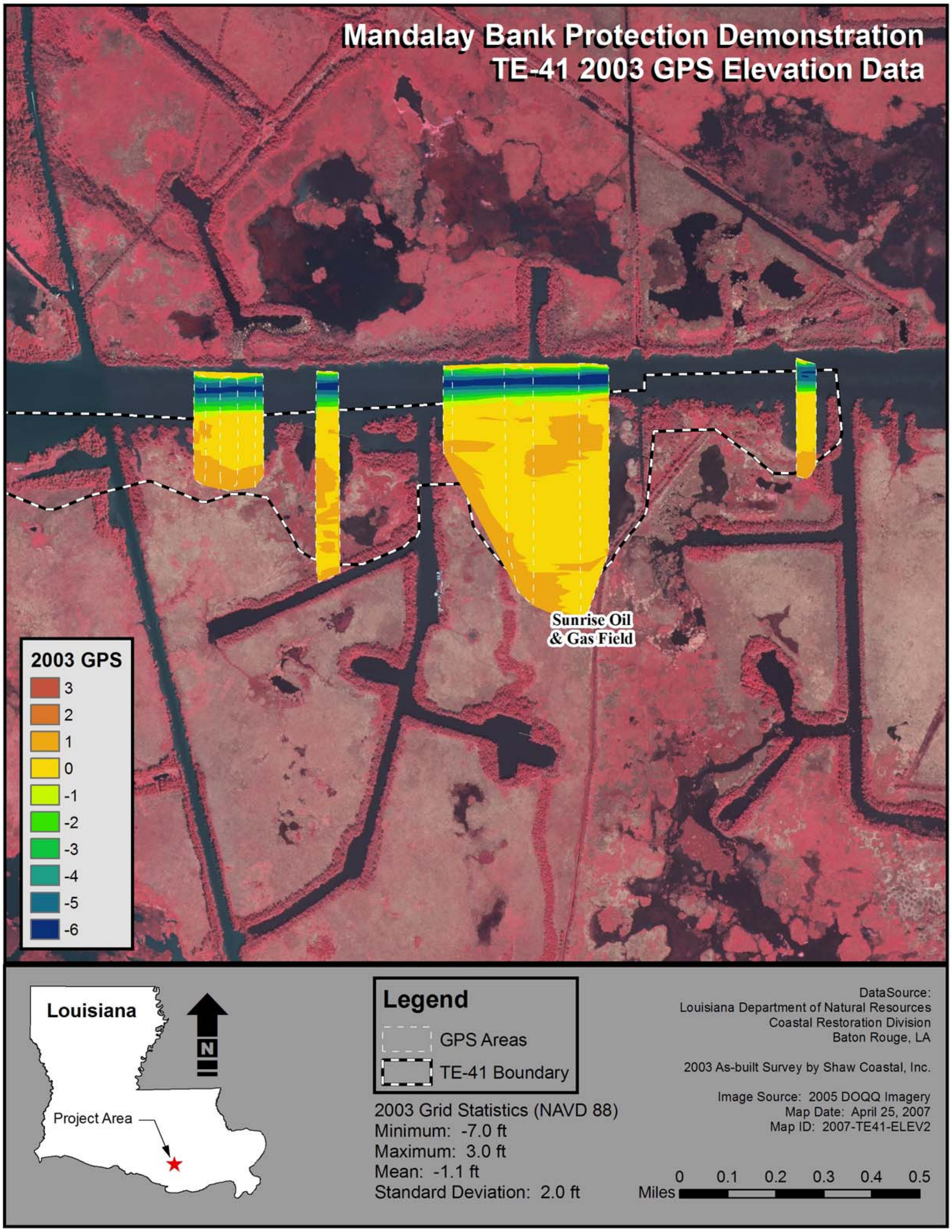

Figure 6. Elevation contour map of the areas surveyed in 2003 (east side of the project area).

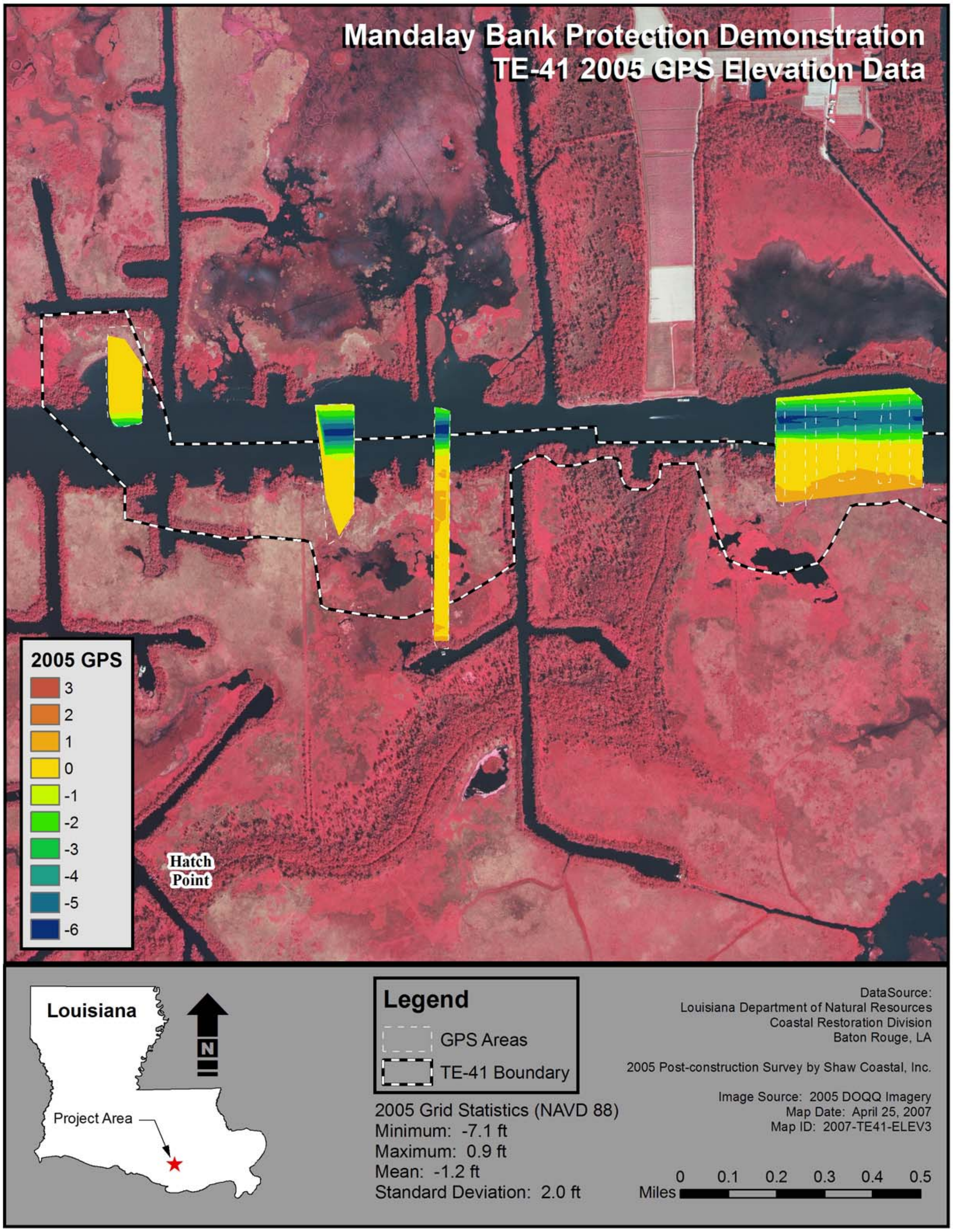

Figure 7. Elevation contour map of the areas surveyed in 2005 (west side of the project area).

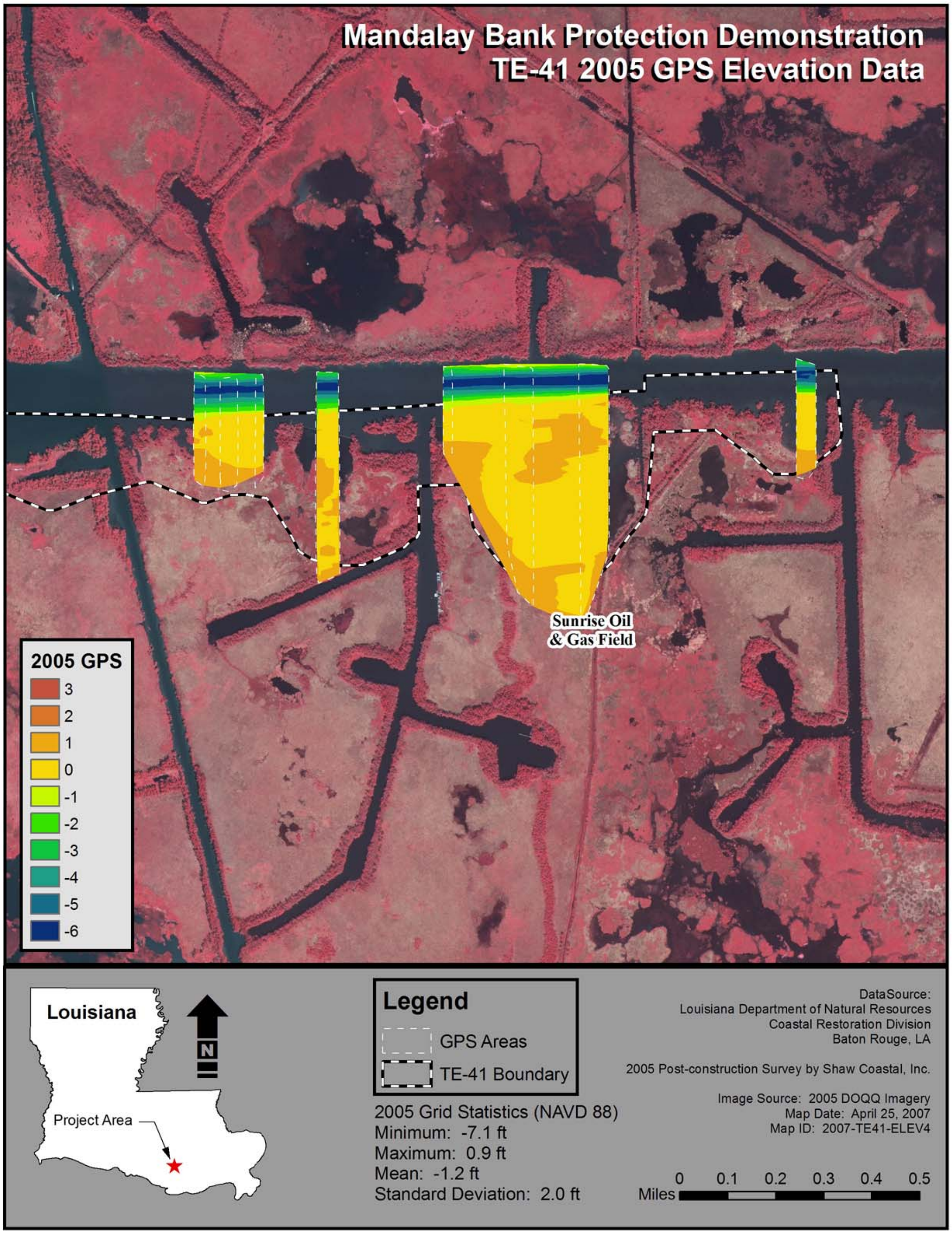

Figure 8. Elevation contour map of the areas surveyed in 2005 (east side of the project area).