Monitoring Series No. C/S-18- MSTY-0198-1

THREE-YEAR COMPREHENSIVE MONITORING REPORT

Coast 2050 Region 4

SABINE REFUGE PROTECTION
C/S-18

First Priority List Shoreline Protection Project
of the Coastal Wetlands Planning, Protection, and Restoration Act
(Public Law 101-646)

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ABSTRACT

Several factors, both natural and human-induced, have lead to the loss of freshwater marsh or conversion to more saline habitat in the region of Chenier plain marshes between the Calcasieu and Sabine Rivers in Louisiana. The U.S. Fish and Wildlife Service, in 1951, impounded an area of the Sabine National Wildlife Refuge between the higher salinity Central Canal, Burton-Sutton Canal, North Canal, and Beach Canal in Cameron parish. This impoundment is now the only freshwater marsh that exists between the Calcasieu and Sabine River systems. In order to protect the west levee of the impoundment from boat wakes (and resultant erosion), a rock dike was constructed in 1995 along the Burton-Sutton Canal/impoundment levee. To assess the effectiveness of the rock dike, a monitoring plan was established to measure any shoreline position changes using survey points along the vegetated edge of the levee. Aerial photography was used to document any changes in the vegetation composition in the impoundment that would presumably result from a failure of the levee to keep out the saline waters of the surrounding canals. At this time, the only data available is from the first survey of shoreline, and the preconstruction aerial photography. Subsequent data will be used to determine if either the shoreline position or vegetation composition has changed.

INTRODUCTION

Wetland loss has been attributed to many natural and anthropogenic causes. The construction of channels and canals for navigation and access to oil and gas structures has caused immediate destruction of some of Louisiana's coastal wetlands. These artificial channels are usually deeper and straighter than natural waterways, allowing greater flow velocities and greater intrusion of saline Gulf waters especially during periods of low outflow from coastal wetlands. Saltwater intrusion has been implicated as a major cause of wetland loss in coastal Louisiana. When saline water rapidly invades areas of fresh marsh, the existing vegetation may be killed leaving bare substrate subject to erosion before more salt tolerant plant species can revegetate the area (Turner and Cahoon 1987). Soil waterlogging will exacerbate the detrimental effects of saltwater intrusion by causing the accumulation of toxic compounds due to the highly reduced conditions (Turner and Cahoon 1987). The spoil banks created as a by-product of canal construction may cause water to become stranded in marshes when banks are breached or topped. Impounded freshwater areas are therefore especially susceptible to vegetation loss caused by introduction of surrounding saline water in the event of levee failure.

The earliest records of the Chenier Plain marshes between Cameron Creole and Sabine Lake indicate that it was an extensive freshwater marsh dominated by *Cladium jamaicense* (saw grass) and *Scirpus californicus* (giant bulrush) (U.S. Department of Agriculture [USDA] 1931). By 1949, the area was dominated by freshwater marsh along with saw grass marsh and intermediate marsh (O'Neil 1949). Freshwater marsh species included *Panicum hemitomon* (maidencane), *Typha* spp. (cattail), *Sagittaria lancifolia* (bull-tongue), *Eleocharis quadrangulata* (squarestem spikesedge), *Eleocharis macrostachya* (largespike spikesedge - listed as synonymous with *Eleocharis palustris*), *Eleocharis cellulosa* (gulfcoast spikesedge), *Zizaniopsis miliacea* (southern wildrice), *C. jamaicense*, *Phragmites australis* (common reed), *S. californicus*, and *Scirpus tabernaemontani* (softstem bulrush). Saw grass marsh was dominated by *C. jamaicense* and included *Typha* spp., *S. californicus*, *S. tabernaemontani*, *P. australis*, *S. lancifolia*, *Spartina cynosuroides* (big cordgrass), *Eleochari*s spp., and *Z. milliacea* near the edges. Intermediate marsh consisted of *C. jamaicense*, *P. australis*, *Typha* spp., *S. californicus*, *S. tabernaemontani*, *Scirpus americanus* (bulrush), *Spartina patens* (saltmeadow cordgrass), *S. lancifolia*, and *S. cynosuroides*. The marshes bordering Sabine and Calcasieu Lakes and the Gulf coast were largely brackish three corner marsh (predominately *S. americanus*) in 1949. The impoundment area was completely dominated by freshwater marsh (*P. hemitomon*, *Hydrocotyl* spp., *Eichhornia crassipes* [water hyacinth], *Pontederia cordata* [pickerelweed], *Alternanthera philoxeroides* [alligatorweed], and *Sagittaria* sp.) by 1968, and the area just outside of the impoundment was mostly intermediate marsh (low salinity with typical vegetation consisting of *S. patens*, *Vigna luteola* [deer pea], *Sagittaria* sp., *Echinochloa walteri* [water millet], *S. californicus*, *C. jamaicense*) (Chabreck and Linscombe 1968). Extensive brackish marshes (marshes of moderate salinity with typical vegetation consisting of *S. patens*, *S. americanus*, *Scirpus robustus* [saltmarsh bulrush] and *Ruppia maritima* [widgeongrass]) were also present from Sabine Lake east to the impoundment and along Calcasieu Lake at this time. The amounts of brackish marsh and intermediate marsh in 1978 were similar to 1968 (Chabreck and Linscombe 1978). By 1988, most of the area surrounding the impoundment consisted of brackish marsh except

for a large area of intermediate marsh south of the impoundment (Chabreck and Linscombe 1988). The impoundment is now virtually the only remaining area of coastal freshwater marsh between the Calcasieu and Sabine Rivers.

As early as the late 1800's work was being conducted to widen and deepen the channels that connect Sabine Lake and Calcasieu Lake to the Gulf of Mexico (Natural Resources Conservation Service [NRCS] 1993). Further widening and deepening of these channels continued through the 1970's. Beginning in the early 1900's several canals were dug which transverse the marshes between Sabine and Calcasieu Lakes. Also, the Gulf Intracoastal Waterway (GIWW) was constructed in the early 1900's, connecting the Sabine River to the Calcasieu River. Many of the small canals connected the interior marshes to Sabine and Calcasieu Lakes. These lakes have become more saline over time because of the greater influx of gulf water allowed by the larger dredged channels. This more efficient connection to saline water has contributed to the conversion of the interior marshes from fresh to intermediate and brackish. Severe saltwater intrusion and flooding caused by hurricanes Audrey and Carla, in 1957 and 1961 respectively, and droughts in the early 1960's have also contributed to the loss or conversion of freshwater marsh in the Calcasieu-Sabine area (Valentine 1976).

The Sabine Refuge Protection project (C/S-18) is located approximately 20 miles (32.2 km) west-southwest of Hackberry, Louisiana, on the east levee of the Burton-Sutton Canal (BSC) adjacent to the Sabine National Wildlife Refuge (SNWR) Impoundment 3 (figure 1). This 27,000 ac (10,927 ha) freshwater impoundment provides habitat for freshwater game fish, alligators, furbearers, and migratory and resident waterfowl. Although not monitored regularly in the project area, salinity in Impoundment 3 is believed to be stable at $\leq$1.0 ppt according to SNWR personnel. The presence of freshwater vegetation such as *Z. miliacea* and *Nelumbo lutea* (yellow-lotus) within the impoundment indicate that salinities are typically very low. Water level within the impoundment is maintained at approximately 1.8 ft (0.55 m) (mean sea level; staff gages not tied to any datum) (Borden-Billiot 1998) using three 90 ft (27.4 m) long variable crest weirs.

The existing west levee along Impoundment 3, constructed in 1951, also forms the east spoil bank along the BSC. The BSC, constructed in the early 1900's, is used by barges and boats to reach two oil and gas fields located on the southern part of the refuge. Boat wake-induced erosion has resulted in sloughing of levee material into the BSC. It is estimated that the levee is eroding at the rate of 0.27 ft/yr (0.08 m/yr) (Louisiana Coastal Wetlands Conservation and Restoration Task Force [LCWCRTF] 1991; U. S. Fish and Wildlife Service [USFWS] 1991). Continued erosion could result in multiple breaches of the levee, allowing higher salinity waters from the Calcasieu Ship Channel and Sabine Lake to enter the impoundment via the BSC. According to SNWR personnel, salinities of 14.7 ppt have been recorded in the BSC. Since much of the freshwater marsh within the impoundment is highly organic and floating, saltwater intrusion and increased tidal exchange would likely convert as much as 13,000 ac (5,261 ha) of the impoundment to shallow open water (LCWCRTF 1991; USFWS 1991). The loss of floating and submersed vegetation is expected to increase wind-induced wave erosion of the remaining marsh within the impoundment. Bank erosion along this canal, as well as weathering of the spoil bank, necessitated protecting the levee from

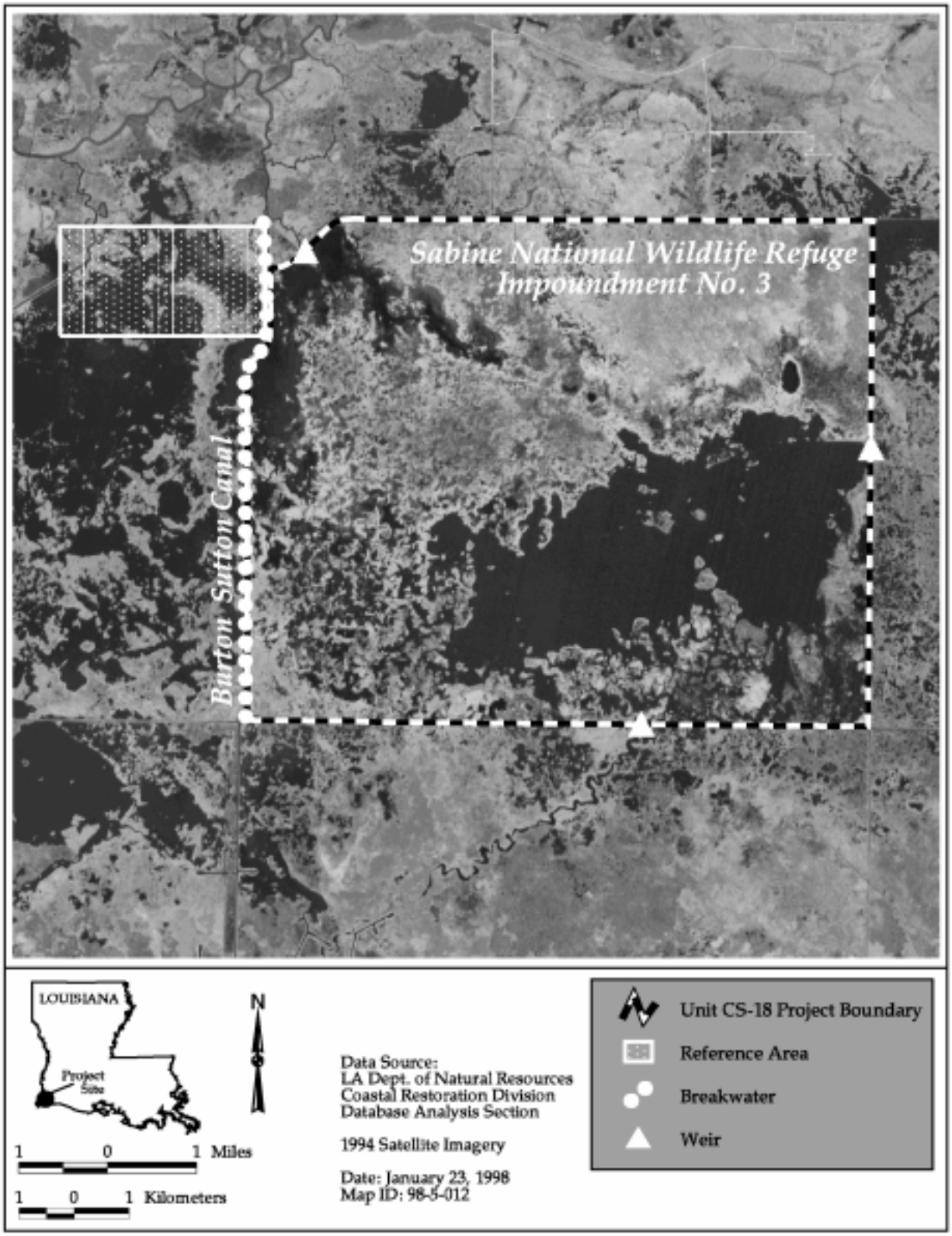


Figure 1. Sabine Refuge Protection (C/S-18) project area map.

further deterioration. Maintaining this impounded area as a freshwater marsh depends on an intact levee that encircles it.

Waves from passing vessels (boat wakes) cause erosion of navigation channel banks and damage to existing vegetation communities (Good et al. 1995). Water displaced from the channel by vessels may be pushed over the banks of channels into the adjacent wetland areas causing soil and vegetation scour and rapid changes in water level. In the more fragile interior wetlands erosion accelerates dramatically. Erosion of interior wetlands is exacerbated by "blowouts" where a connection is formed between a channel and an inland water body (Good et al. 1995).

Rock dikes have been designed to prevent boat wakes from eroding shorelines, but also to allow wave overtopping, resulting in sediment accretion behind the dike. A similar shoreline protection project along the GIWW at Cameron Prairie (Courville 1997) has resulted in some sediment buildup behind the rock dike. The Sabine Refuge Protection project (C/S-18) is designed to prevent further erosion of the Impoundment 3 west levee, and protect the existing freshwater wetlands from saltwater intrusion. Construction of approximately 5.5 linear mi (8.85 km) of free-standing, continuous rock dike was completed in January 1995. In addition, the levee was restored (using dredge material from the canal) where it was once degraded, and maintenance work will be undertaken at the three weir sites and at three alligator crossings along the east bank of the BSC (which forms the west bank of the impoundment).

The project objectives are to protect the existing freshwater vegetation within Impoundment 3 of SNWR adjacent to the BSC and to prevent the introduction of higher salinity water from the BSC into the impoundment. The specific goals needed to achieve these objectives are to:

1. Restore and protect the west levee of Impoundment 3 using dredge material and a free-standing rock breakwater.

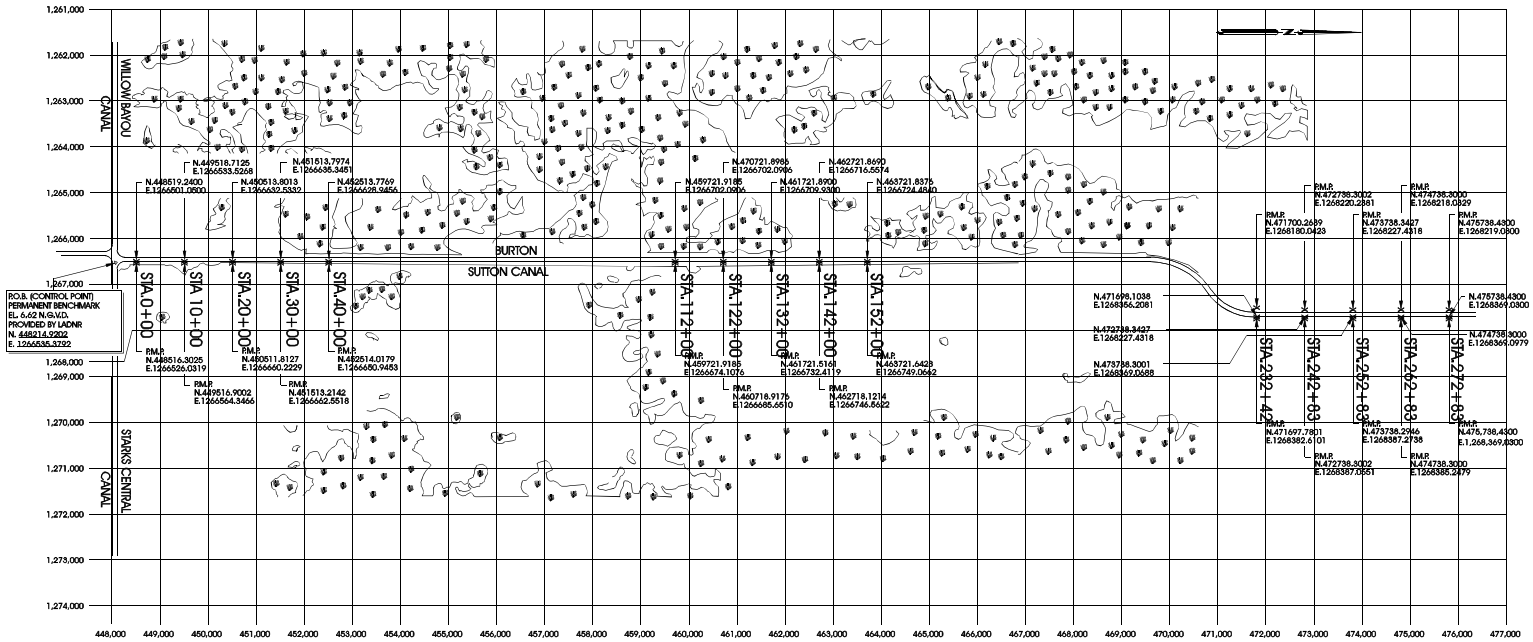
2. Protect existing freshwater vegetation in Impoundment 3 from saltwater intrusion via the Burton-Sutton Canal.

METHODS

Near-vertical color-infrared aerial photography (1:24,000 scale) was used to measure vegetated and non-vegetated areas for the project and reference areas. Aerial photography was scanned, mosaicked, and georectified by National Wetlands Research Center (NWRC) personnel according to the standard operating procedure described in the *Quality Management Plan for Coastal Wetlands Planning, Protection, and Restoration Act* (Steyer et al.1995). The photography was obtained in November 1993 prior to construction and in November 1779 post-construction.

To document shoreline movement, shoreline markers denoting the vegetated marsh edge were established at 1,000 ft (305 m) intervals along the east bank of the BSC adjacent to the northernmost, central, and southernmost portions of the rock dike (figure 2). Shoreline markers were also established along the west bank of the canal adjacent to the reference area. This baseline survey data will be compared to future data sets to evaluate project effectiveness. Shoreline position relative to the shoreline markers will be monitored by direct measurement at 5 yr intervals.

Additional data provided by SNWR personnel will be used to document the vegetated marsh to water ratio and vegetation composition in Impoundment 3. USFWS sampling was conducted December 3-10, 1996. Samples were taken at 0.5 mi (0.8 km) intervals on east-west and north-south transects. The east-west lines were labeled A-M, and the north-south lines were labeled 1-19. Data in this report are from the two westernmost sampling transects in the impoundment, rows 18 and 19 (figure 3 and appendix A). Sample locations were found using a hand held GPS unit. Data were collected from two 10 ft x 15 ft (3.05 x 4.57 m) sites at each location, one on the left side of the airboat and one on the right side. The following data were collected for each site: percent of marsh to water (=100), plant species, and percent of each for both the marsh and water portions of each site (percent species of percent vegetation and percent species of percent site). Each site was identified by the alphanumeric name and E, W, N, or S, depending on the orientation of the airboat. The following data were collected at each location from one of the sites: water depth, water turbidity, consistency of the bottom soil (hard or soft), and comments on wildlife observations. All data were dictated into a cassette recorder for later transcription and entry into Quattro Pro spreadsheets. The percent of each plant species (percent species of plot) was then calculated for each site (appendix B).



BURTON SUTTON CANAL - PLAN VIEW

SCALE: NTS

LEGEND

P.O.B. - POINT OF BEGINNING
P.M.P. - PERMANENT MARKER POLE
- MARSH

STATE OF LOUISIANA
DEPTARTMENT OF NATURAL RESOURCES
COASTAL RESTORATION DIVISION

PLAN VIEW
SABINE REFUGE PROTECTION
PROJECT (CS-18)

CAMERON PARISH, LOUISIANA

PREPARED BY: P.E.E.C., INC.
MODIFIED BY: Miller Engineers & Associates, Inc.
Engineers & Land Surveyors
700 Main St. (P.O. Box 223)
Franklin, La. 70538
318-828-1950

Figure 2. Plan view of the Sabine Refuge Protection (C/S-18) project rock dike along the Burton-Sutton Canal showing the location of the survey cross sections established to monitor shoreline movement.

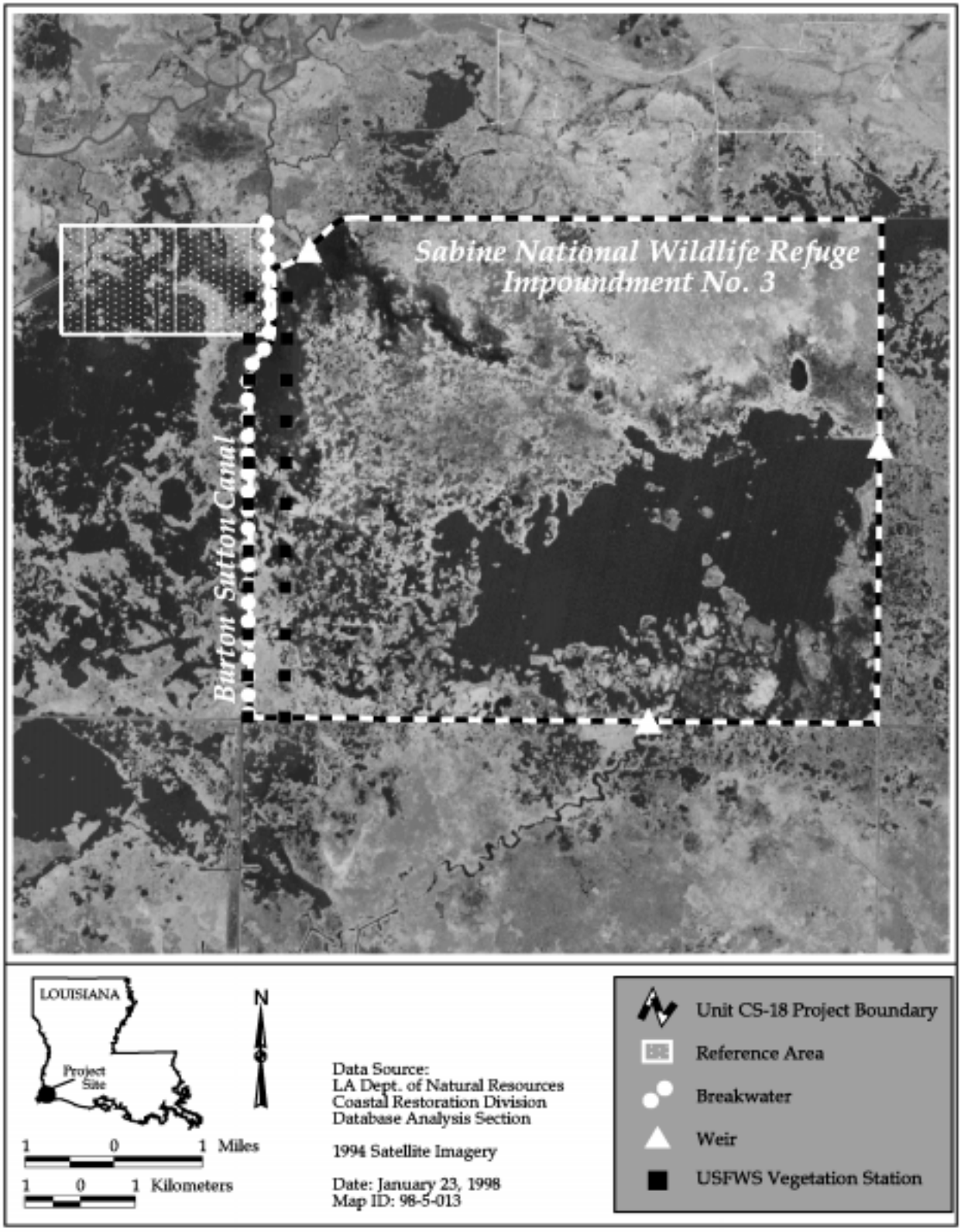


Figure 3. Selected USFWS Sabine Refuge vegetation sample stations.

RESULTS

Color-infrared aerial photography of the preconstruction project area was obtained on November 1, 1993. The photography was checked for flight accuracy, color correctness, and clarity. The duplicate photography was prepared for scanning and analysis. The original film was archived.

A digital TIFF file with resolution of 300 pixels per inch (ppi) was created from the photography. Using PCI, an image processing software, the photography was mosaicked and used to generate a base map. Optimal global positioning system points were collected in the field to georeference the base map with the proper Universal Transverse Mercator coordinate system. The resulting preconstruction map (map i.d. #97-2-032) was then analyzed with ERDAS Imagine, a geographic information system (GIS). The unsupervised GIS classification (figure 4, map i.d. #97-2-072) determined that when the photography was taken, the project area consisted of approximately 16,075 ac (6,505 ha) of land and 10,264 ac (4,154 ha) of open water, a land to water ratio of 1.6. GIS analysis of the reference area (figure 5, map i.d. #97-2-073) showed approximately 716 ac (290 ha) of land and 1181 ac (478 ha) of open water, a land to water ratio of 0.6. These findings are summarized in table 1.

Table 1. Land/water analysis of the Sabine Refuge Protection (C/S-18) project and reference areas at preconstruction (November 1993).

	Land (acres)	**Water (acres)**	**Total (acres)**	**Land to Water Ratio**
Project Area	16,075	10,264	26,339	1.6
Reference Area	716	1,181	1,897	0.6
Total	16,791	11,445	28,236	

A second set of aerial photography (figure 6, map i.d. #97-2-074) was obtained in January 1997 at the request of SNWR. This photography has been scanned, converted to digital TIFF files with resolution of 300 ppi, and mosaicked. A GIS land-water analysis will be performed when rectification of the photomosaic is complete. Preliminary examination of this photography suggests that water levels are higher than prior to project construction.

In August 1995, Professional Engineering and Environmental Consultants of New Orleans completed a shoreline and cross-sectional survey of the BSC. Appendix A contains figures representing the 15 cross-sectional surveys and the location of the vegetated marsh edge at stations in the project and reference areas. This information will be used as the baseline vegetated shoreline location of project and reference areas. Subsequent surveys will determine any shoreline movement which will be documented in future progress reports.

Data provided by SNWR personnel indicate that the western portion of the impoundment, near the

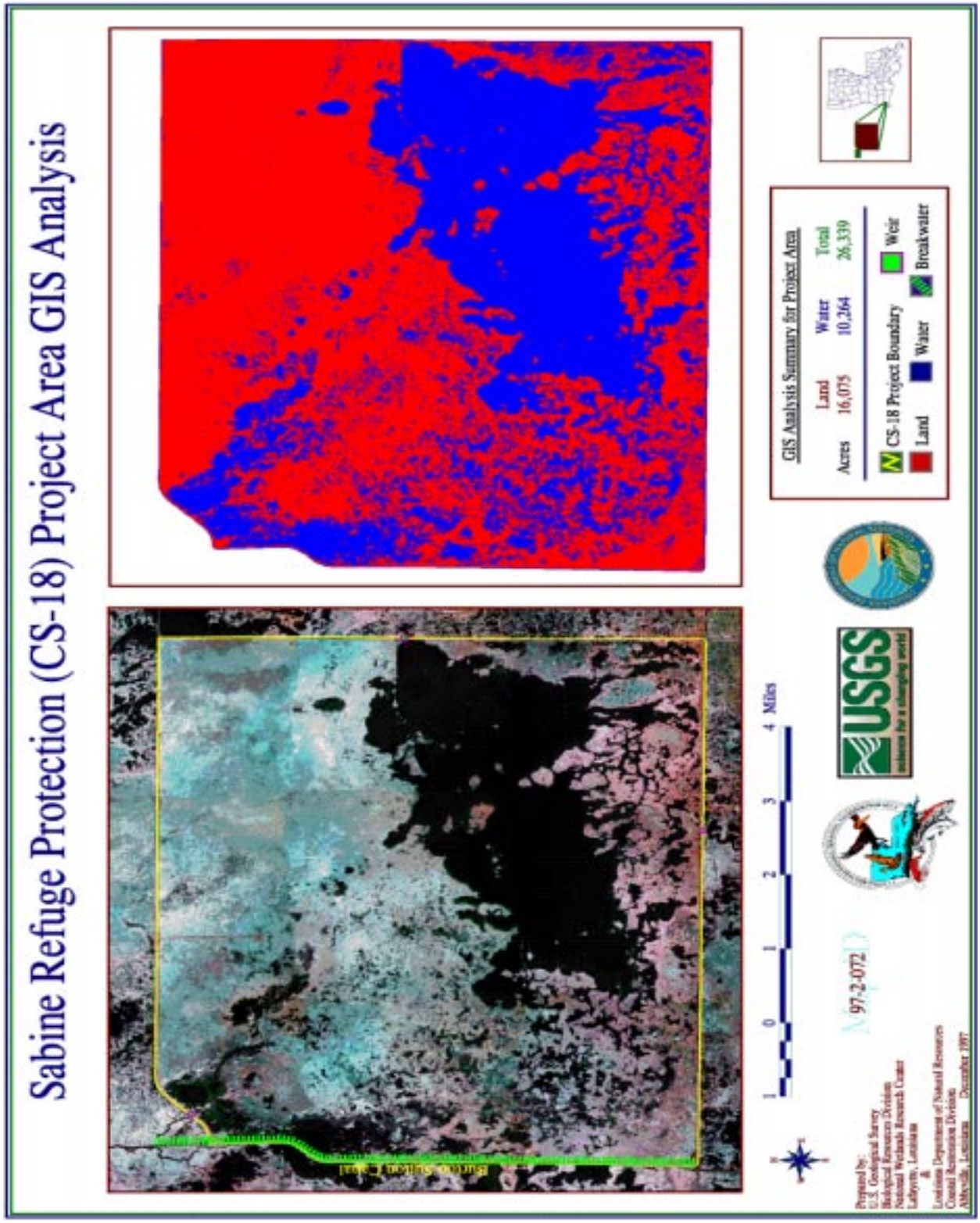


Figure 4. Sabine Refuge Protection (C/S-18) GIS analysis of project area preconstruction (November 1, 1993) aerial photography.

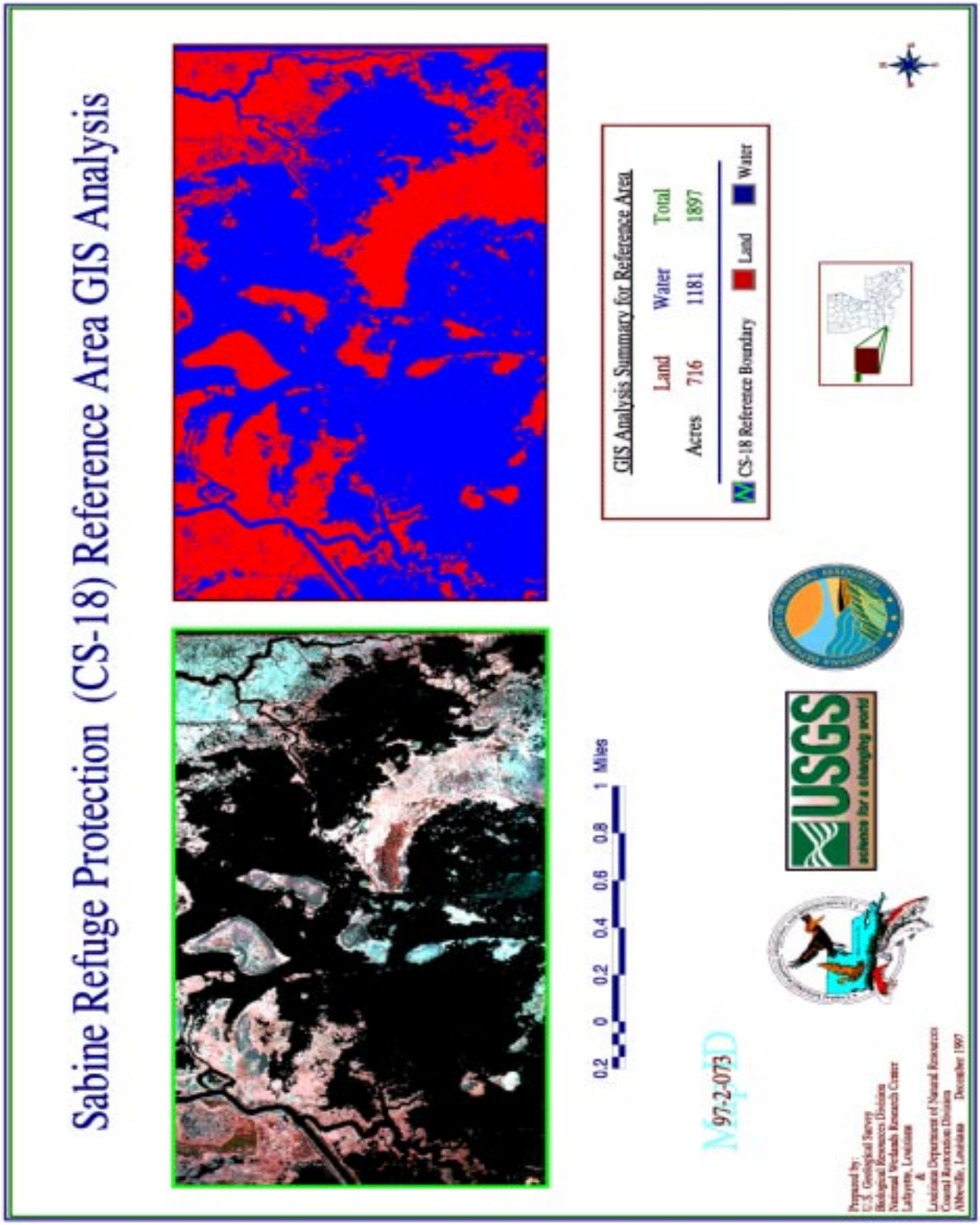


Figure 5. Sabine Refuge Protection (C/S-18) GIS analysis of reference area preconstruction (November 1, 1993) aerial photography.

Figure 6. 1997 aerial photography for Sabine Refuge Protection (C/S-18) project and reference areas.

protection levee, has remained fresh marsh since construction of the project. The area is dominated by taxa that are indicative of persistent freshwater conditions (i.e. *Typha* spp., *Hydrocotyle* spp., *S. lancifolia*) (appendix B). The ratio of vegetated marsh to water was variable among stations. Subsequent sample data will be used to complement aerial photography data to document any vegetated freshwater marsh loss.

Site inspection by Louisiana Department of Natural Resources (LDNR) monitoring personnel in December 1997 documented the composition of the reference area as brackish marsh dominated by *S. patens*. Parts of the western spoil bank of the BSC were also vegetated with stands of *P. australis* and *C. jamaicense*.

DISCUSSION

An exhaustive discussion is not possible at this time because postconstruction surveys will not begin until 2000 according to the monitoring plan. Examination of the engineers' first annual inspection report (October 1996) and inspection by LDNR monitoring personnel in December 1997 provided evidence that the Sabine Refuge Impoundment 3 levee and the protective rock dike are in good condition. The goals and objectives of the project apparently are being met. The BSC has not encroached into the impoundment and the freshwater vegetation in the impoundment has been preserved. Boat traffic on the BSC has not increased to anticipated levels and thus the threat of wave erosion is not imminent; however, at low water substantial erosion can be seen at the base of the protection levee. Large portions of exposed tree roots are visible. It is not known, however, the time period over which this erosion occurred or how long it would take for the erosion to compromise the levee.

Habitat mapping of the project and reference areas was complicated by two factors. First, an ARC/INFO coverage of the reference area boundary was unavailable at the time of land-water analysis. Consequently, the boundary was digitized at the NWRC based on the boundary illustrated by the project and reference area map included in Sabine Refuge Protection Progress Report No. 4 (Vincent 1997). Because this boundary might differ slightly from the original reference area boundary, total acreage may not agree with previous estimates. Second, the project area included both floating and submerged aquatic vegetation and mudflats which were classified as land by the GIS software. Similarly, land areas shadowed by trees were sometimes incorrectly classified as water. After these problem areas had been identified and reclassified, an accuracy assessment was performed. By comparing 256 randomly selected pixels with aerial photography, the accuracy assessment calculated an overall classification accuracy of 96.1% (± 5%).

CONCLUSION

According to available information the project appears to be effective at protecting the west levee of Impoundment 3 and the existing freshwater vegetation within the impoundment. The baseline shoreline survey has been completed and the vegetation composition of the impoundment has been documented. The goals and objectives of the monitoring plan appear to have been met thus far. New information and data will be collected in the future according to the monitoring plan and will be used to evaluate project effectiveness at that time

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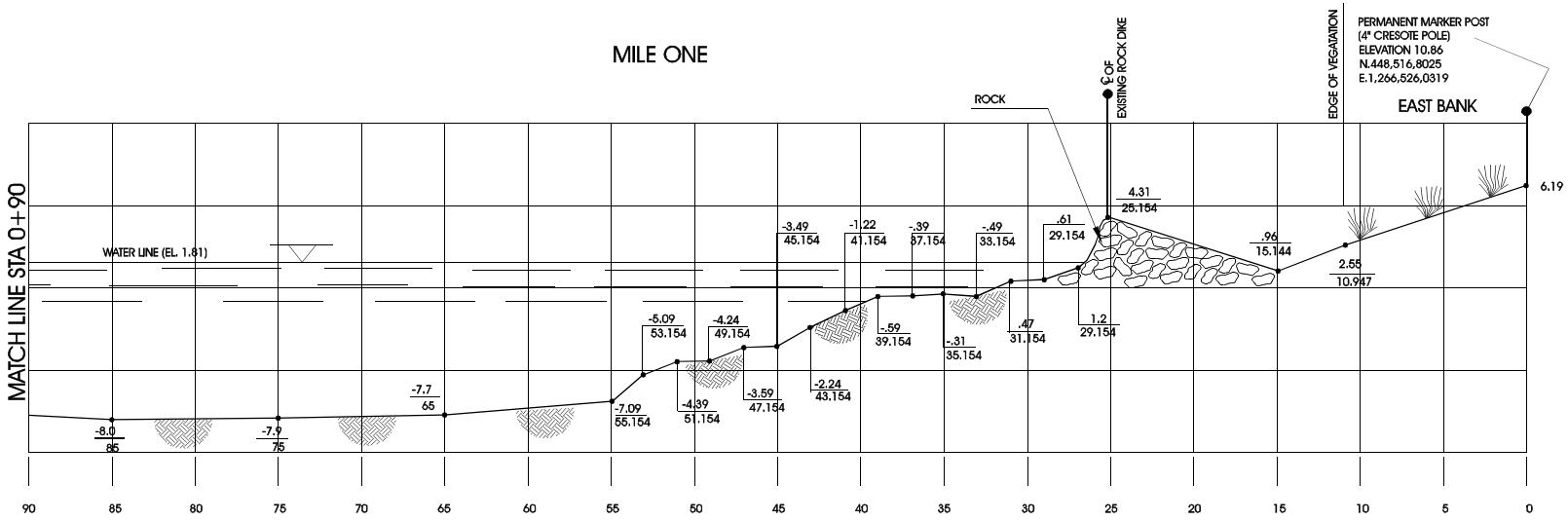
APPENDIX A

Sabine Refuge Protection (C/S-18) cross section drawings of project and reference stations

NOTE:

ALL ELEVATIONS SHOWN ARE IN N.G.V.D. BASED ON AN ASSUMED ELEVATION OF 6.62 N.G.V.D. PROVIDED BY L.A.D.N.R. AT A PERMANENT BENCHMARK DESIGNATED AS P.O.B.



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DATE: 8/22/95

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DEPARTMENT OF NATURAL RESOURCES
COASTAL RESTORATION DIVISION

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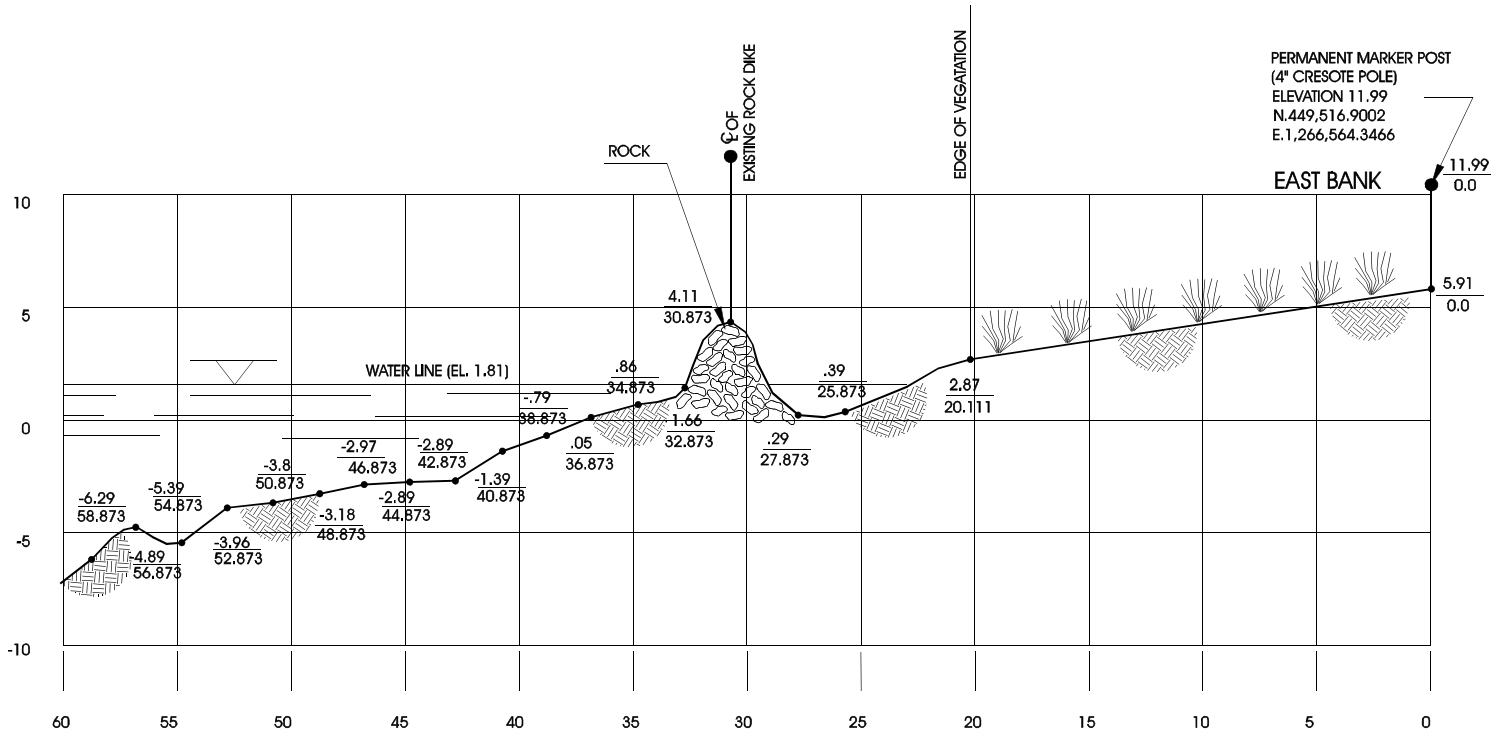

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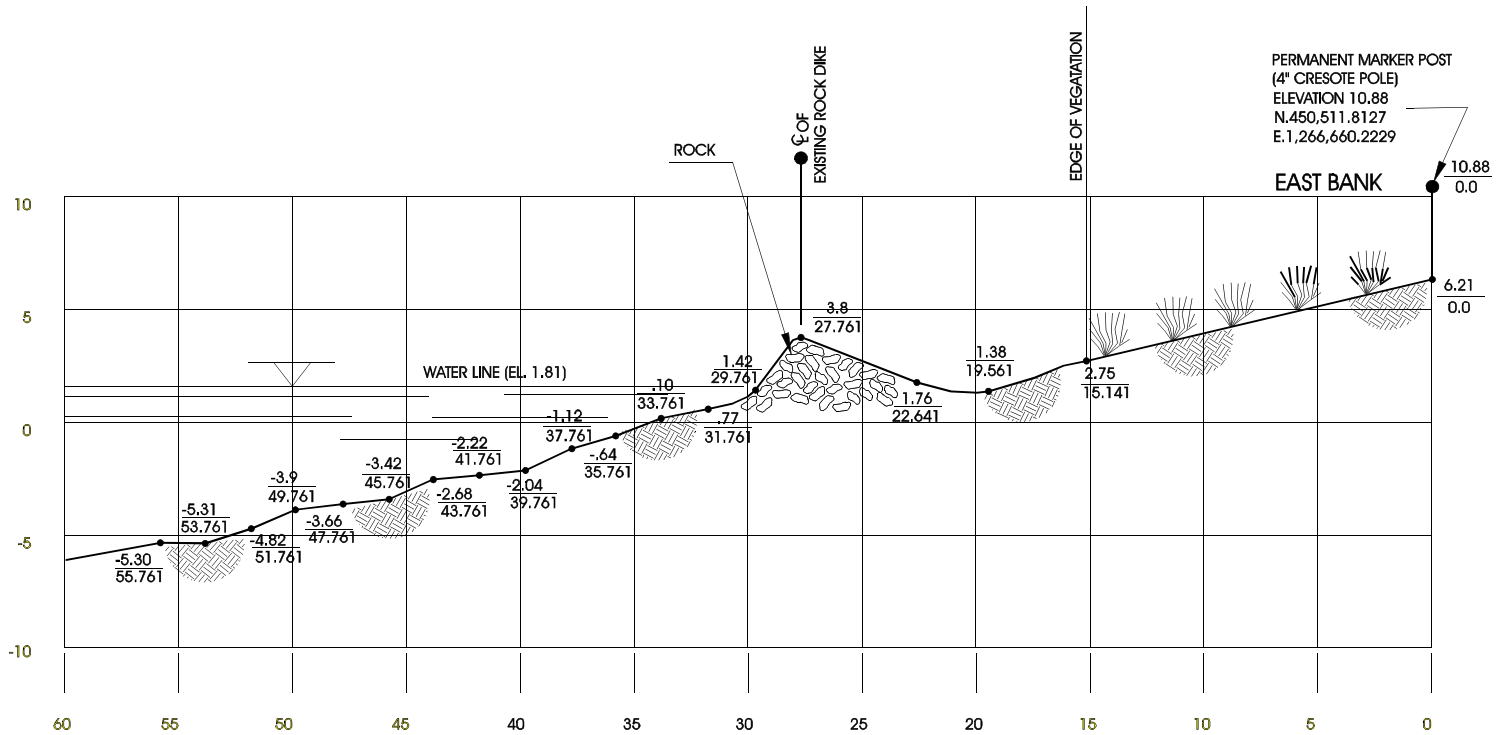

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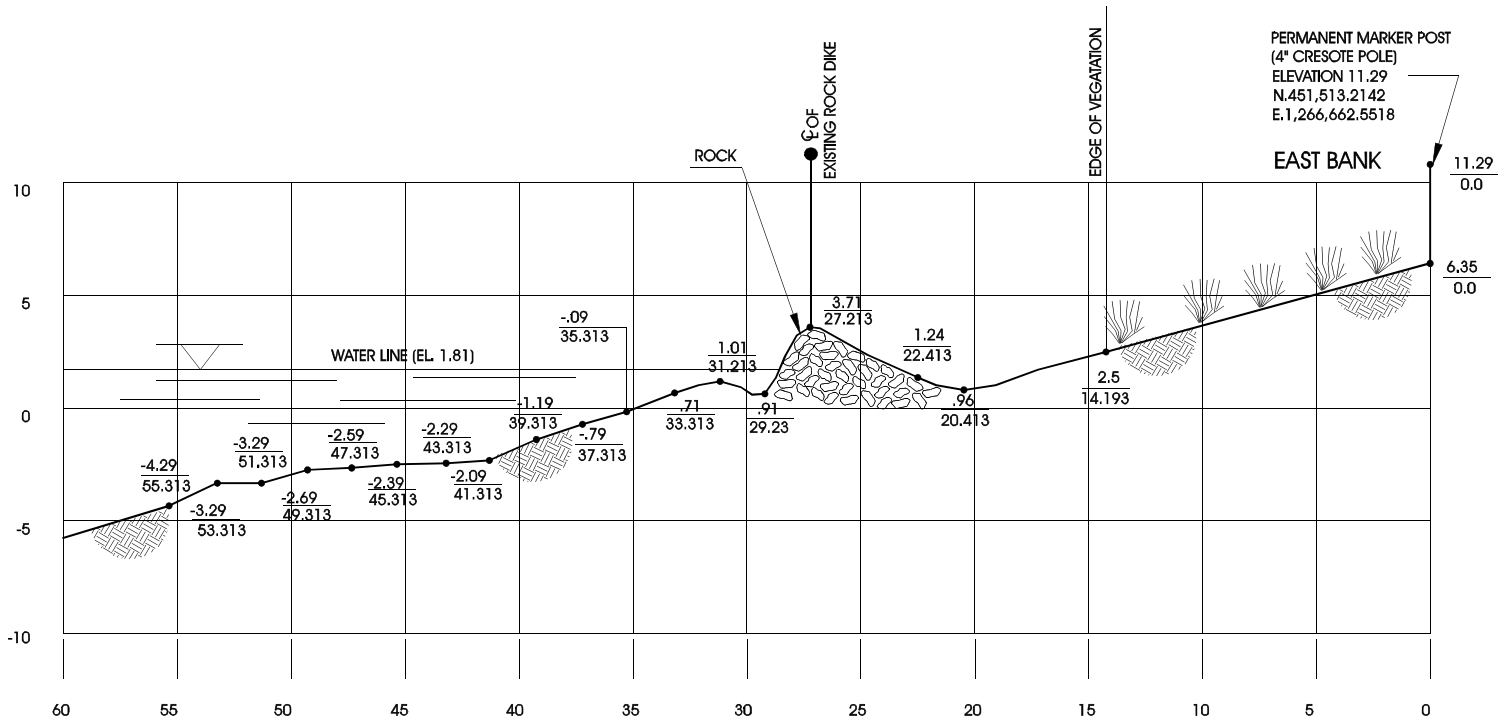

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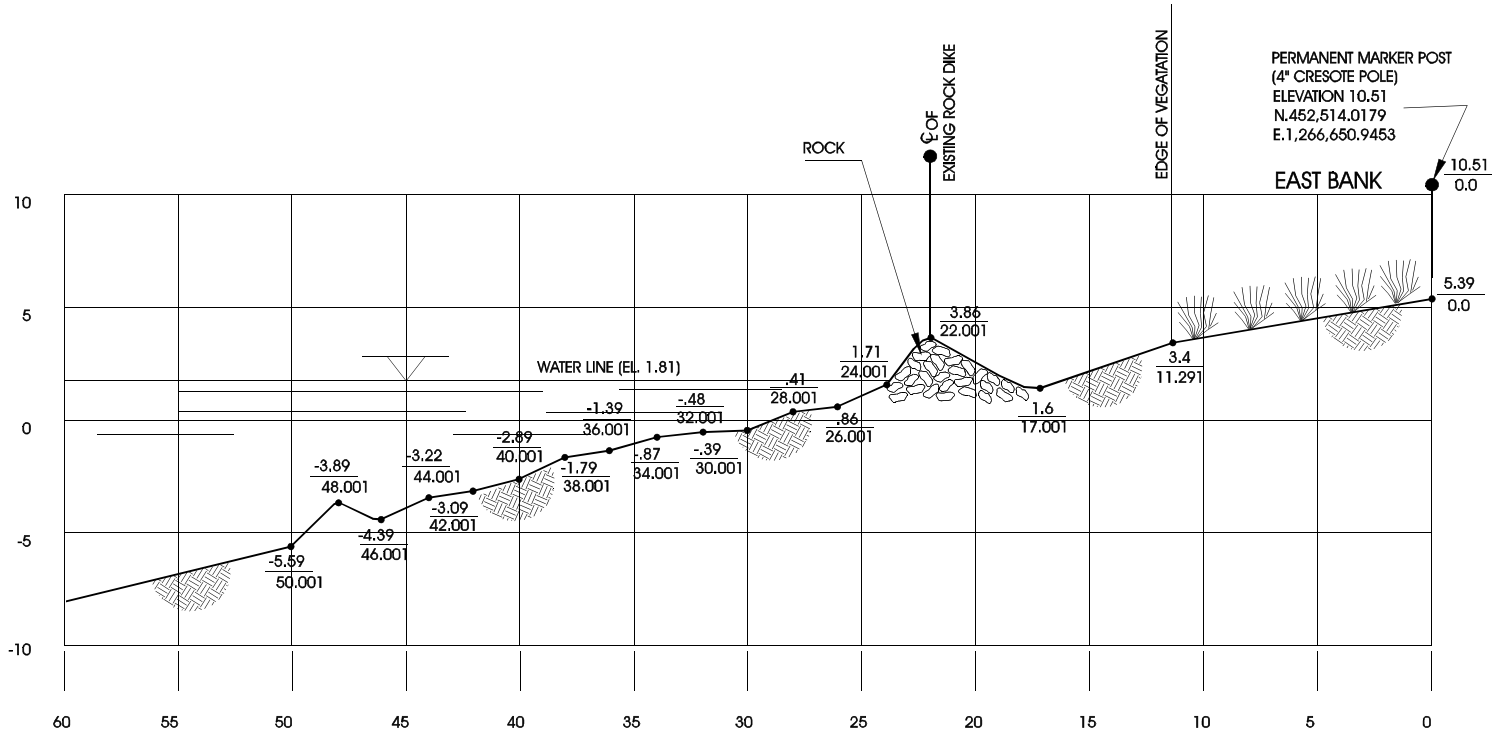
SCALE: NTS
NOTE: TIDE 1.81 N.G.V.D.
FIELD BOOK,#0006
DATE: 8/22/95

STATE OF LOUISIANA
DEPARTMENT OF NATURAL RESOURCES
COASTAL RESTORATION DIVISION

CROSS SECTION @ STA. 30+00
SABINE REFUGE PROTECTION
PROJECT (CS-18)

CAMERON PARISH, LOUISIANA

PREPARED BY: P.E.E.C.,INC.
MODIFIED BY: Miller Engineers & Associates, Inc.
700 Main St. (P.O. Box 223)
Franklin, La. 70538
318-828-1950



CROSS SECTION @ STA. 40+00

SCALE: NTS
NOTE: TIDE 1.81 N.G.V.D.
FIELD BOOK,#0006
DATE: 8/22/95

STATE OF LOUISIANA
DEPARTMENT OF NATURAL RESOURCES
COASTAL RESTORATION DIVISION

CROSS SECTION @ STA. 40+00
SABINE REFUGE PROTECTION
PROJECT (CS-18)

CAMERON PARISH, LOUISIANA

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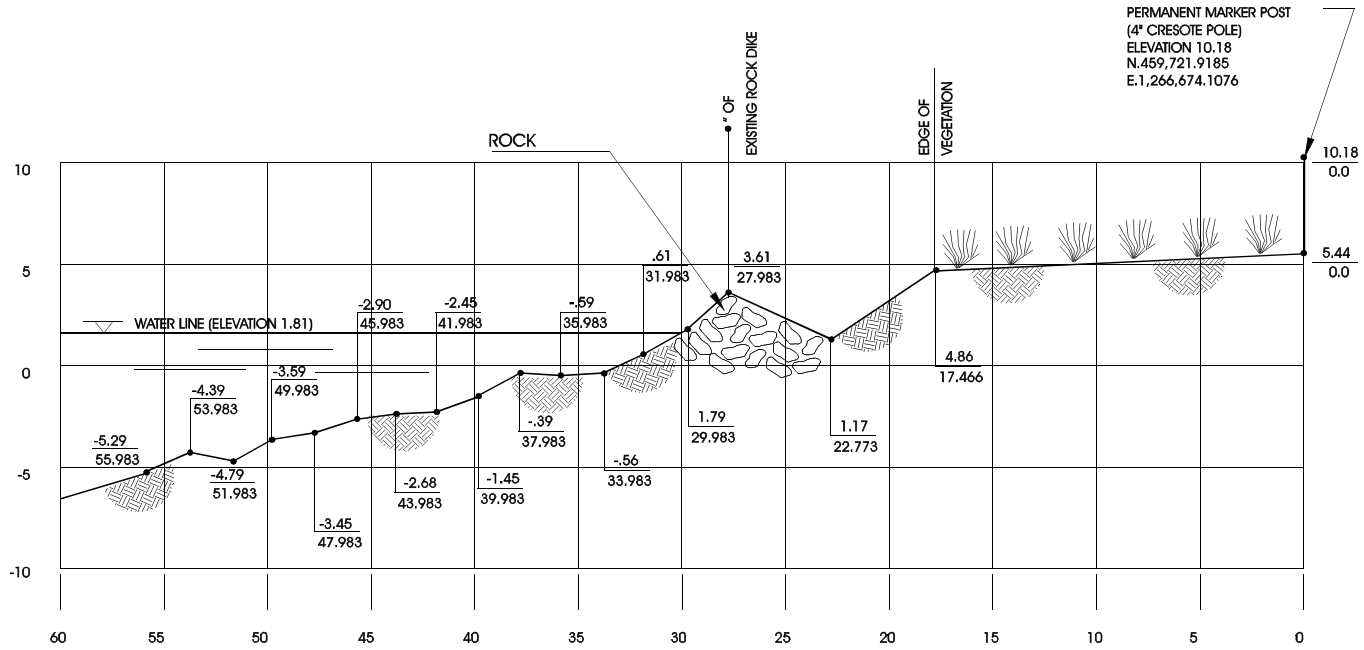
318-828-1950



CROSS SECTION @ STA. 112+00

SCALE: NTS
NOTE: TIDE 1.81 N.G.V.D.
FIELD BOOK.#0006
DATE: 8/22/95

STATE OF LOUISIANA
DEPARTMENT OF NATURAL RESOURCES
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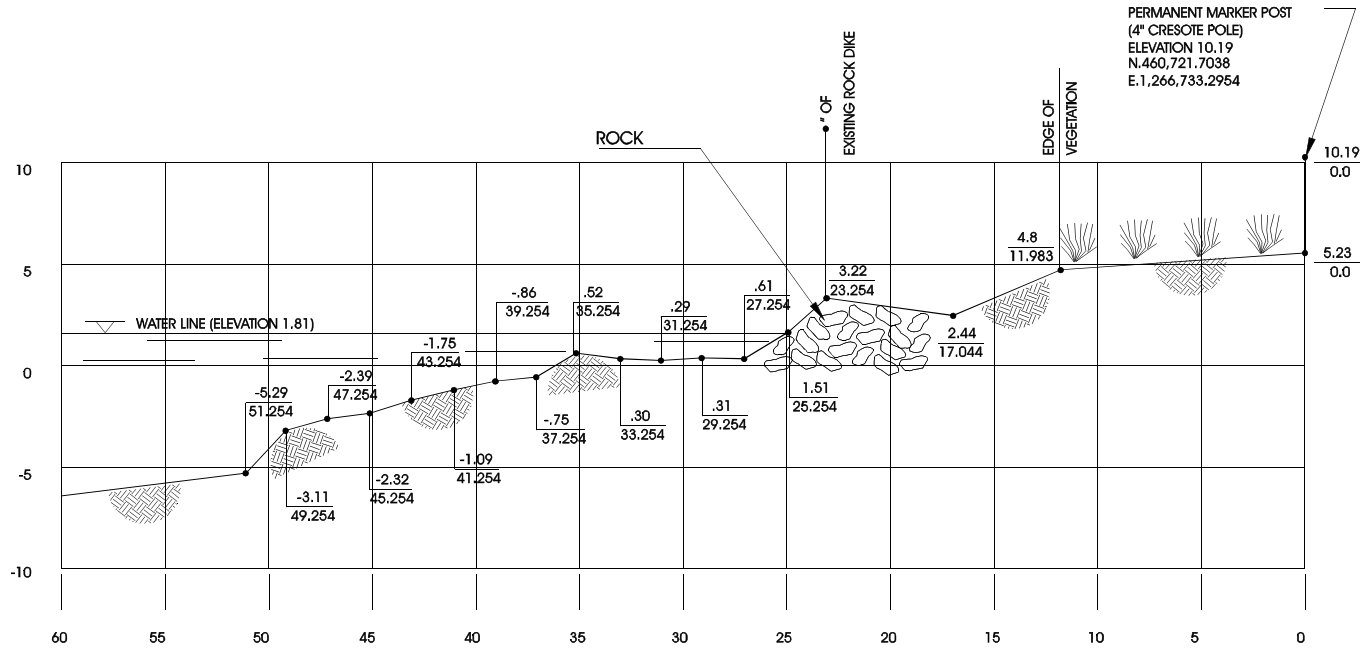

CROSS SECTION @ STA. 122+00

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NOTE: TIDE 1.81 N.G.V.D.
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DATE: 8/22/95

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CROSS SECTION @ STA. 122+00
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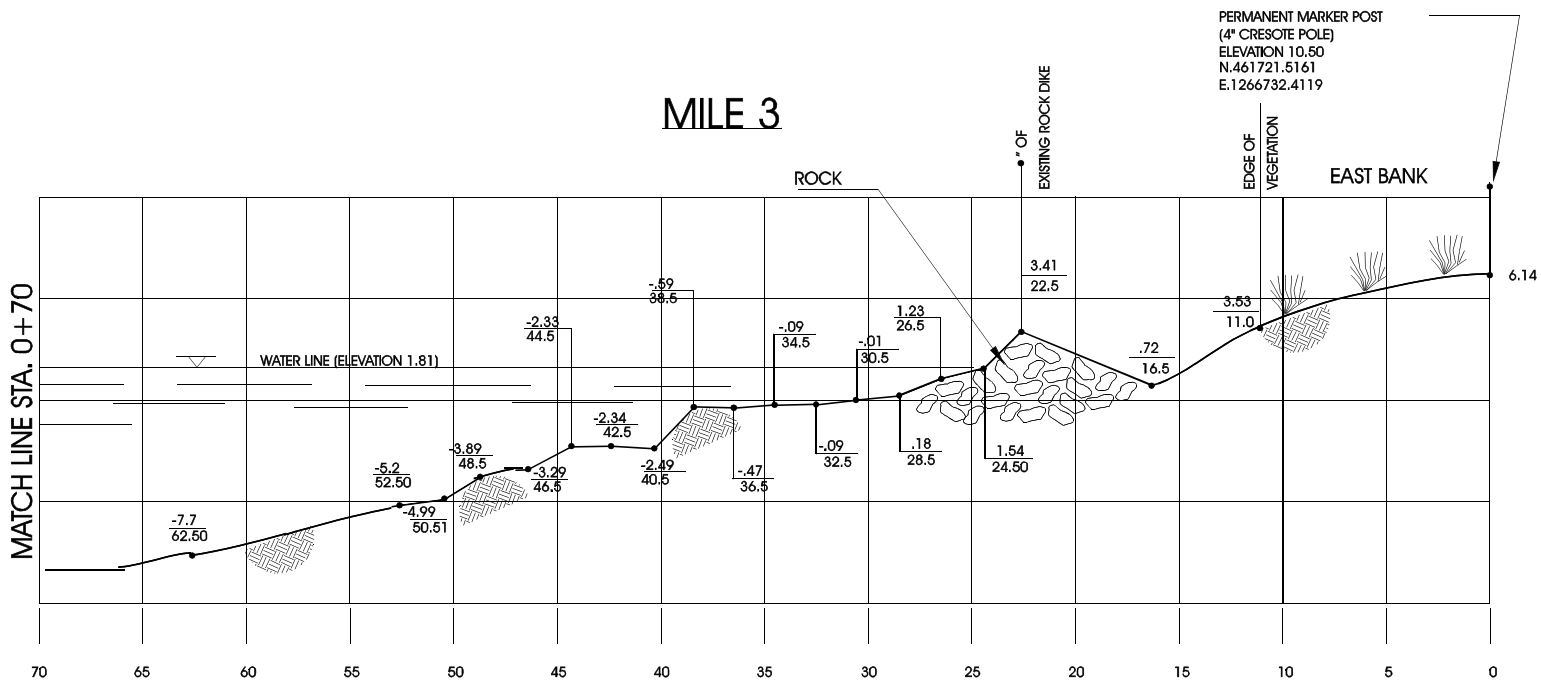

CROSS SECTION @ STA. 132+00

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PROJECT (CS-18)

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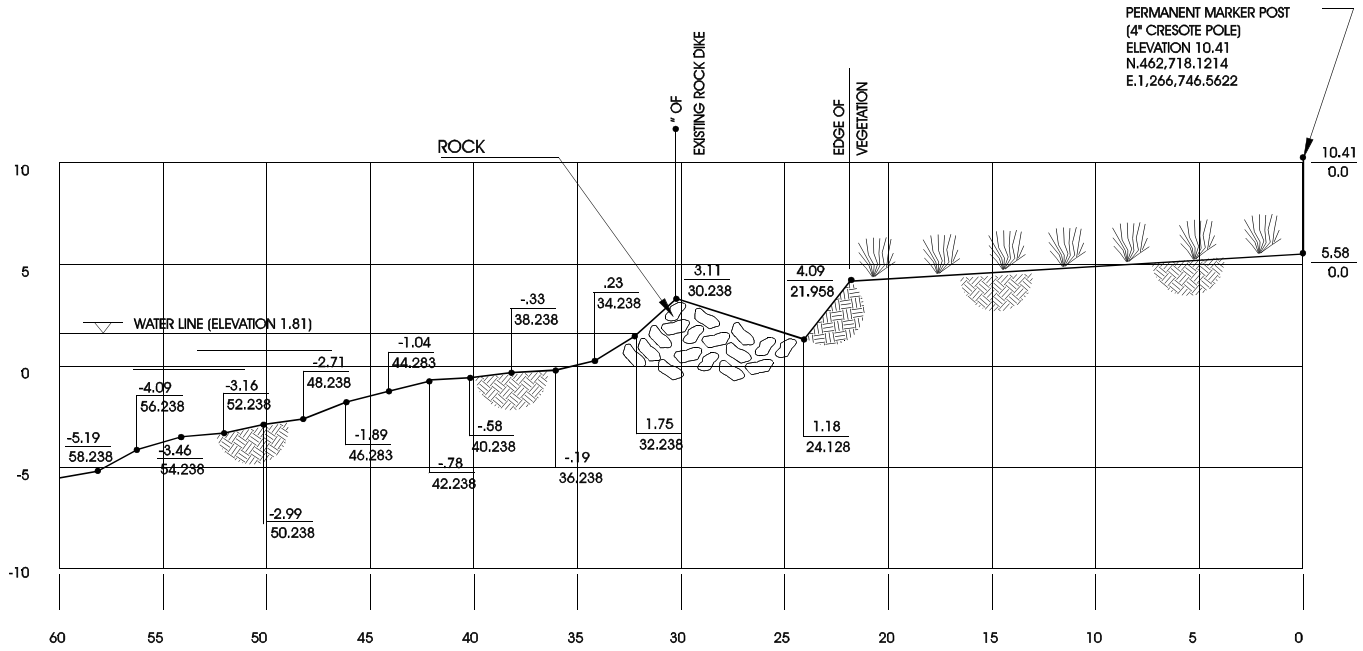

CROSS SECTION @ STA. 142+00

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NOTE: TIDE 1.81 N.G.V.D.
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DATE: 8/22/95

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DEPARTMENT OF NATURAL RESOURCES
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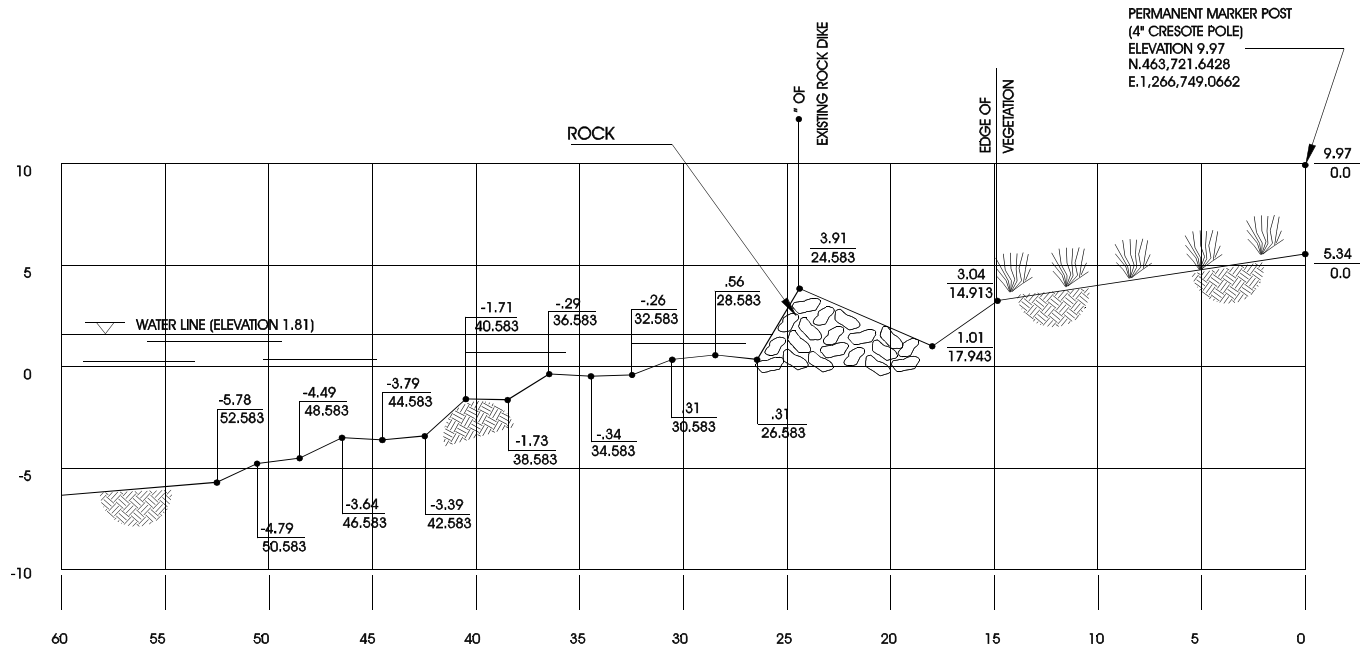

CROSS SECTION @ STA. 152+00

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NOTE: TIDE 1.81 N.G.V.D.
FIELD BOOK.#0006
DATE: 8/22/95

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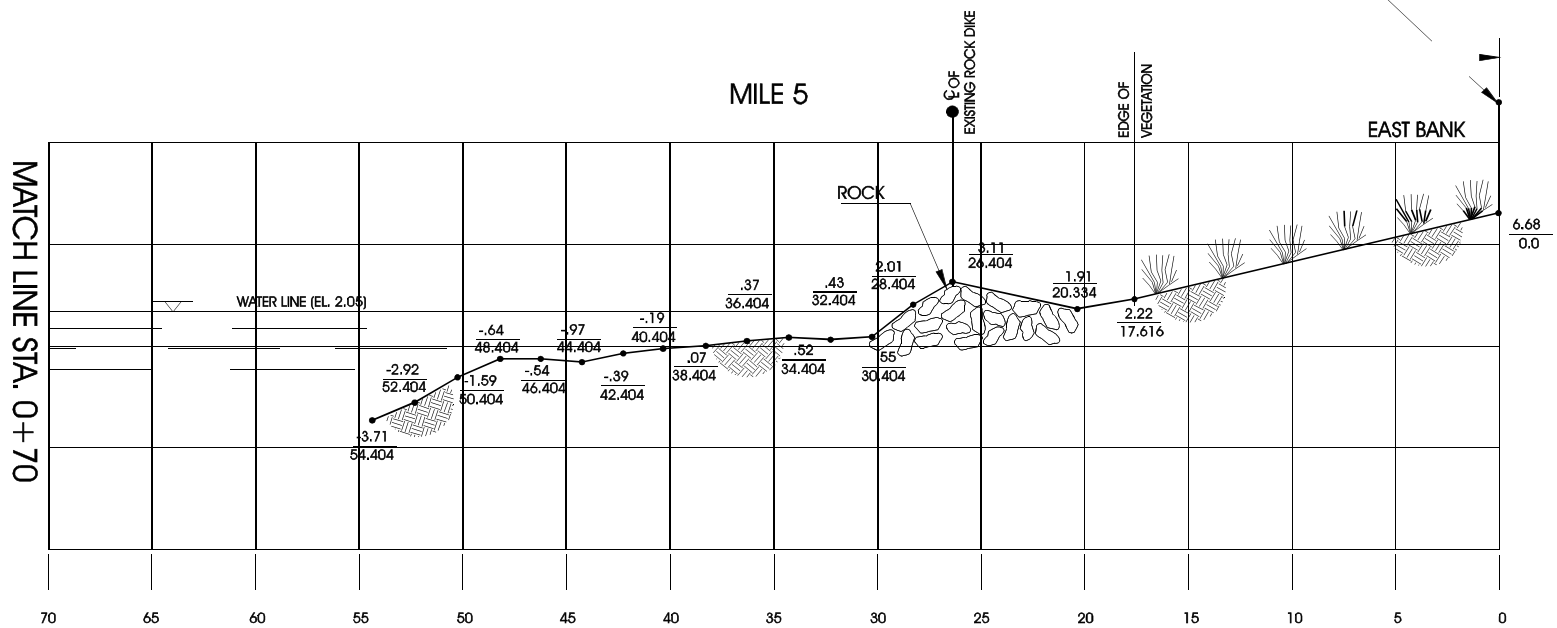

CROSS SECTION @ STA. 232+83

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SCALE: NTS
NOTE: TIDE 1.81 N.G.V.D.
FIELD BOOK,#0006
DATE: 8/22/95

STATE OF LOUISIANA
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CROSS SECTION @ STA. 232+83
SABINE REFUGE PROTECTION
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CAMERON PARISH, LOUISIANA

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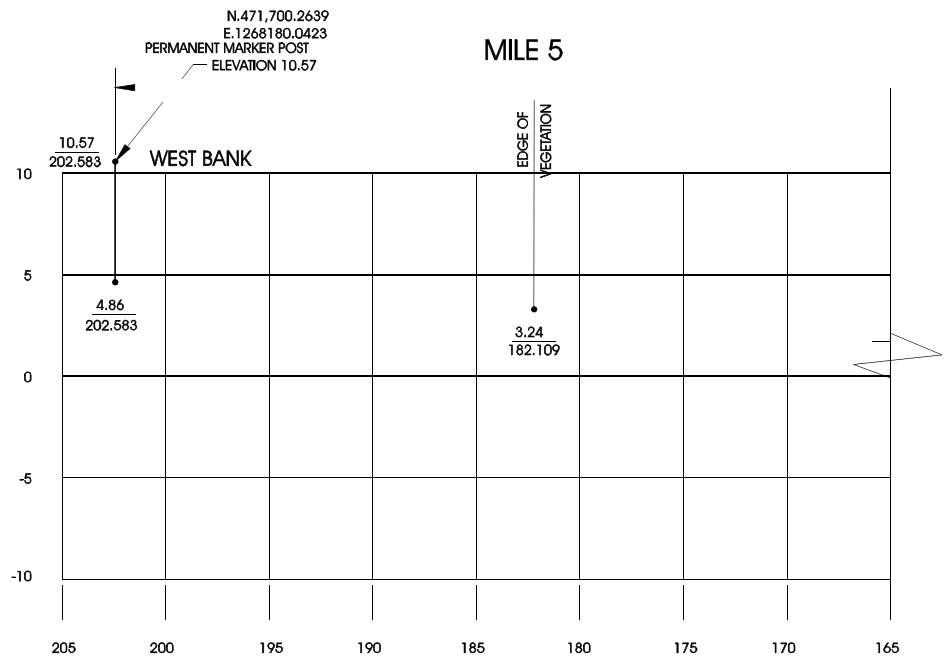

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CROSS SECTION @ STA. 232+83

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FIELD BOOK, #0006
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DEPARTMENT OF NATURAL RESOURCES
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CROSS SECTION @ STA. 232+83
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PROJECT (CS-18)

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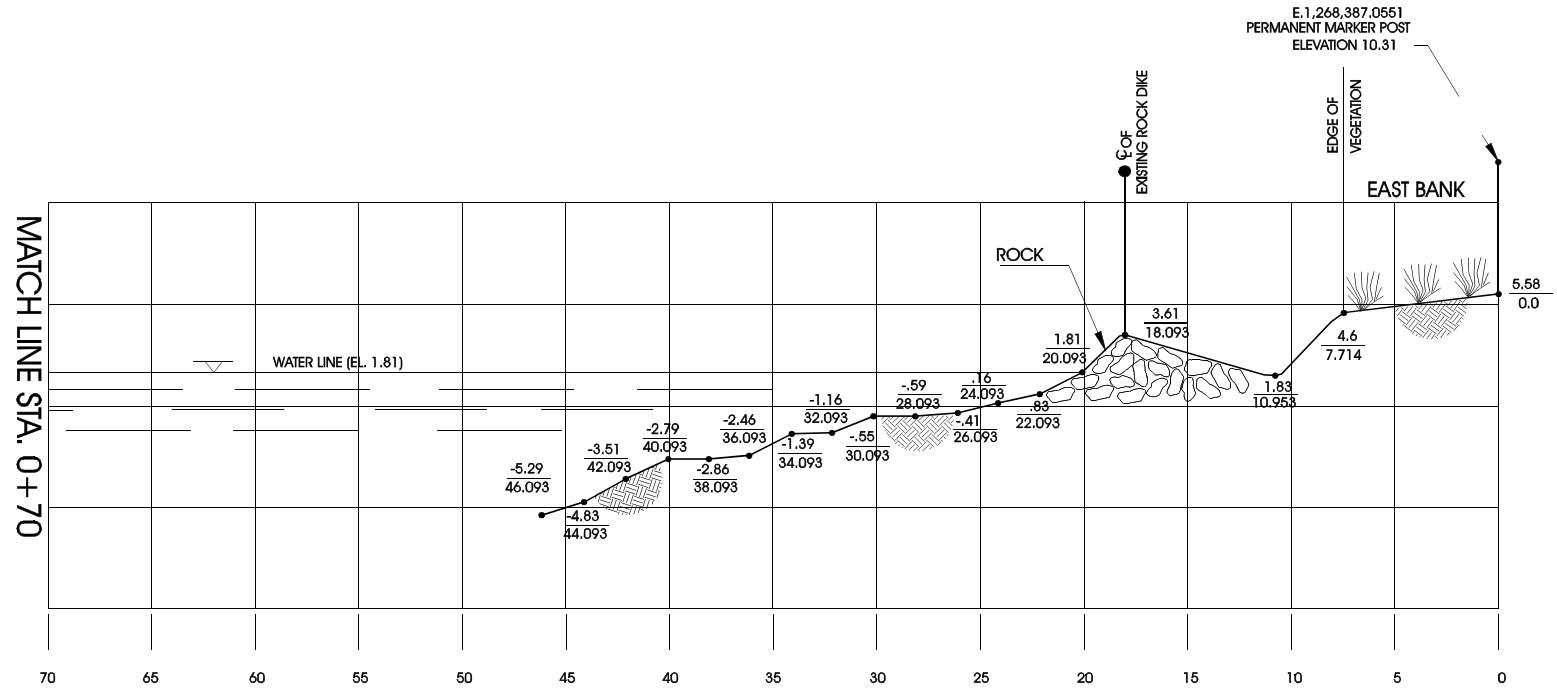

CROSS SECTION @ STA. 242+83

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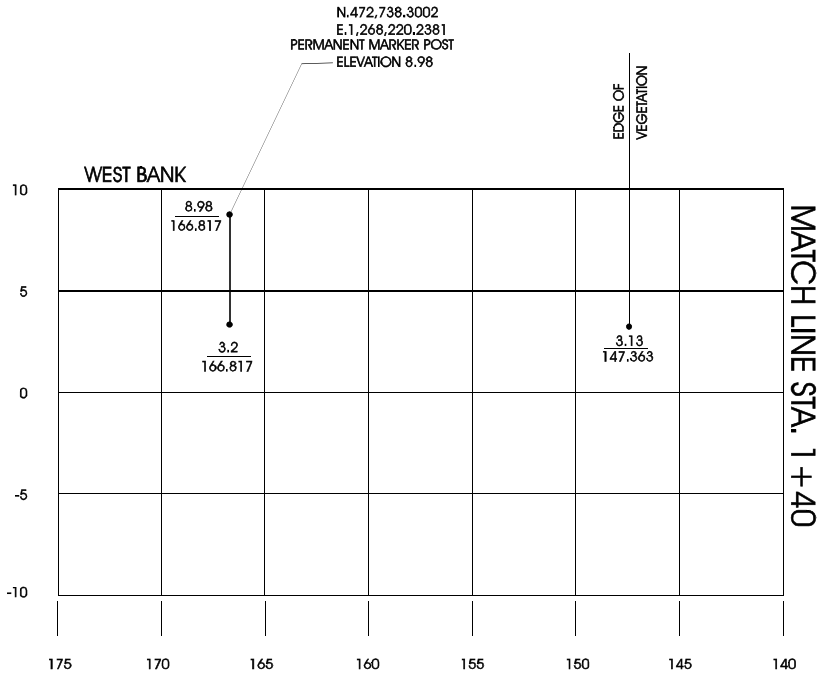

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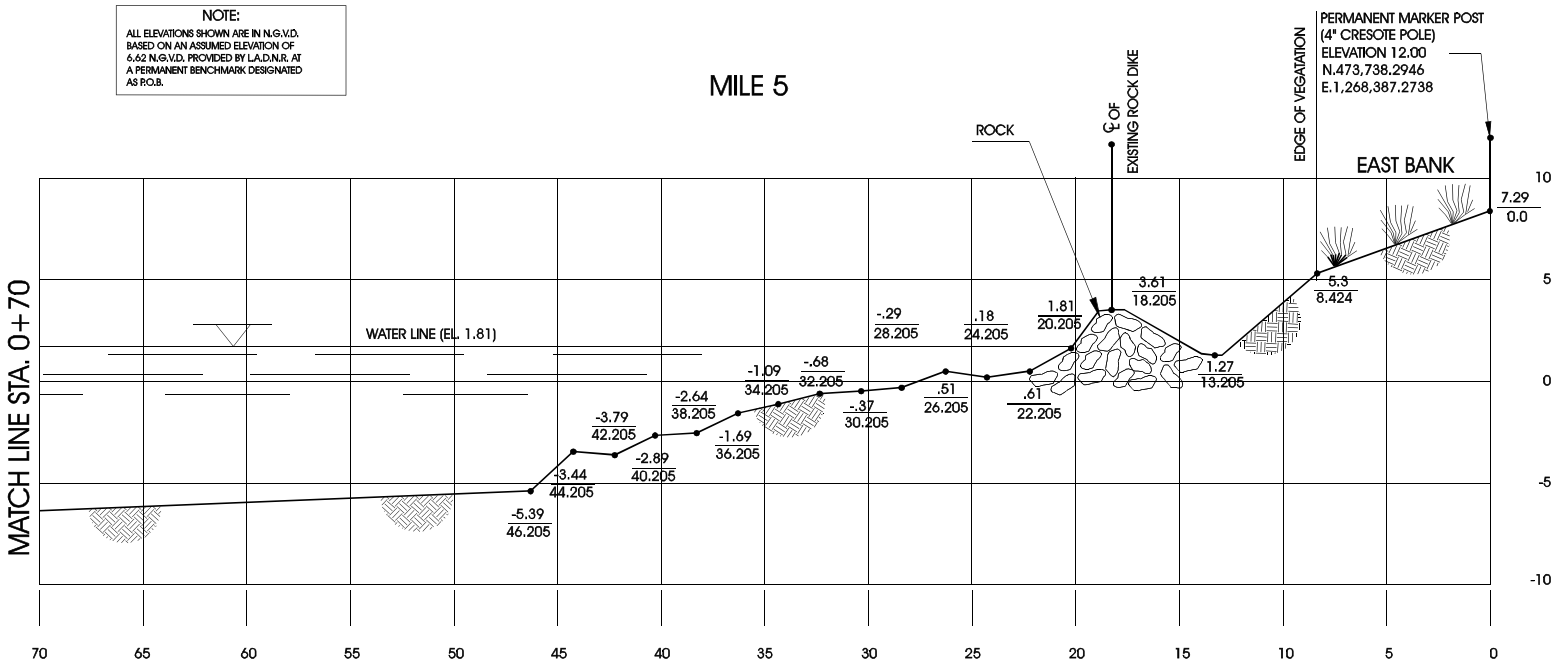

CROSS SECTION @ STA. 252+83

SCALE: NTS
NOTE: TIDE 1.81 N.G.V.D.
FIELD BOOK,#0006
DATE: 8/22/95

STATE OF LOUISIANA
DEPARTMENT OF NATURAL RESOURCES
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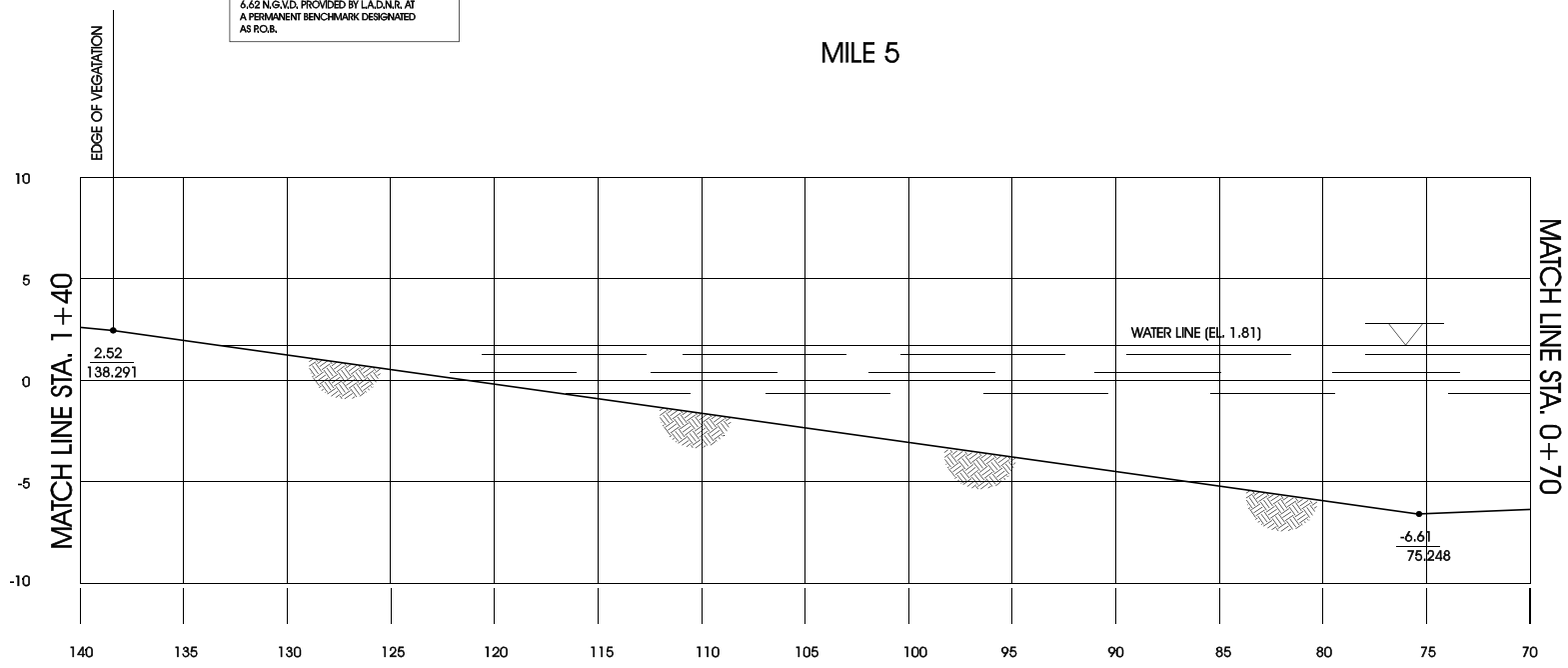

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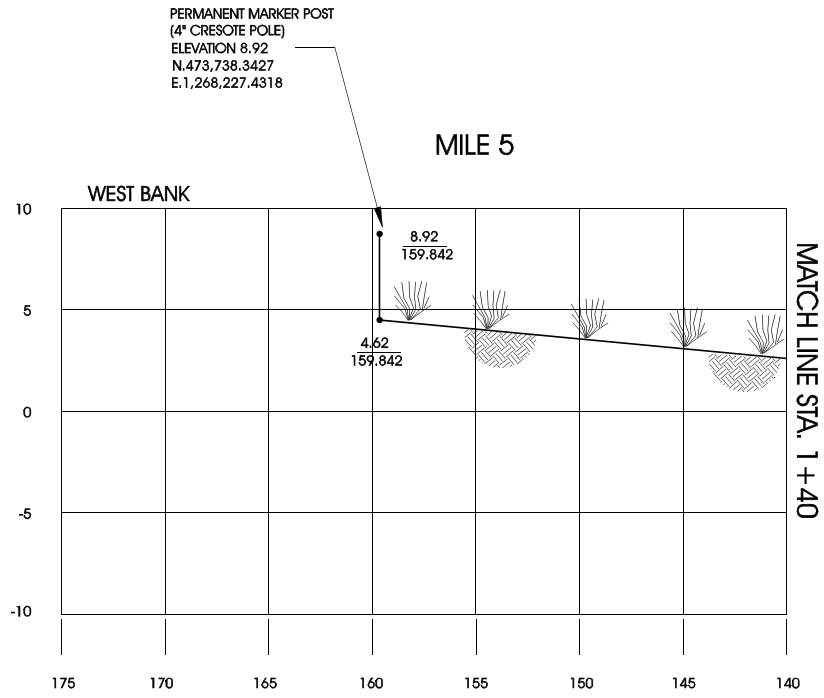

CROSS SECTION @ STA. 252+83

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CAMERON PARISH, LOUISIANA

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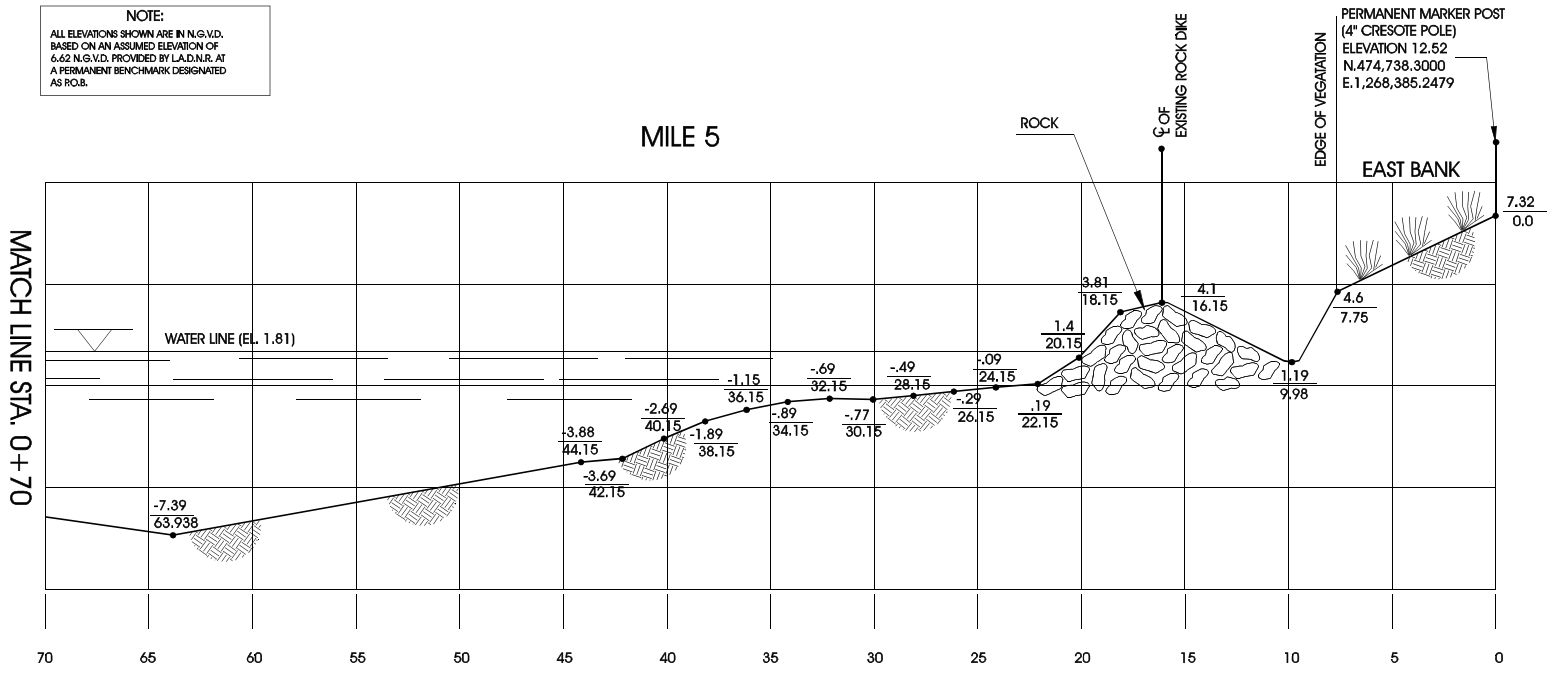

CROSS SECTION @ STA. 262+83

SCALE: NTS
NOTE: TIDE 1.81 N.G.V.D.
FIELD BOOK,#0006
DATE: 8/22/95

STATE OF LOUISIANA
DEPARTMENT OF NATURAL RESOURCES
COASTAL RESTORATION DIVISION

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SABINE REFUGE PROTECTION
PROJECT (CS-18)

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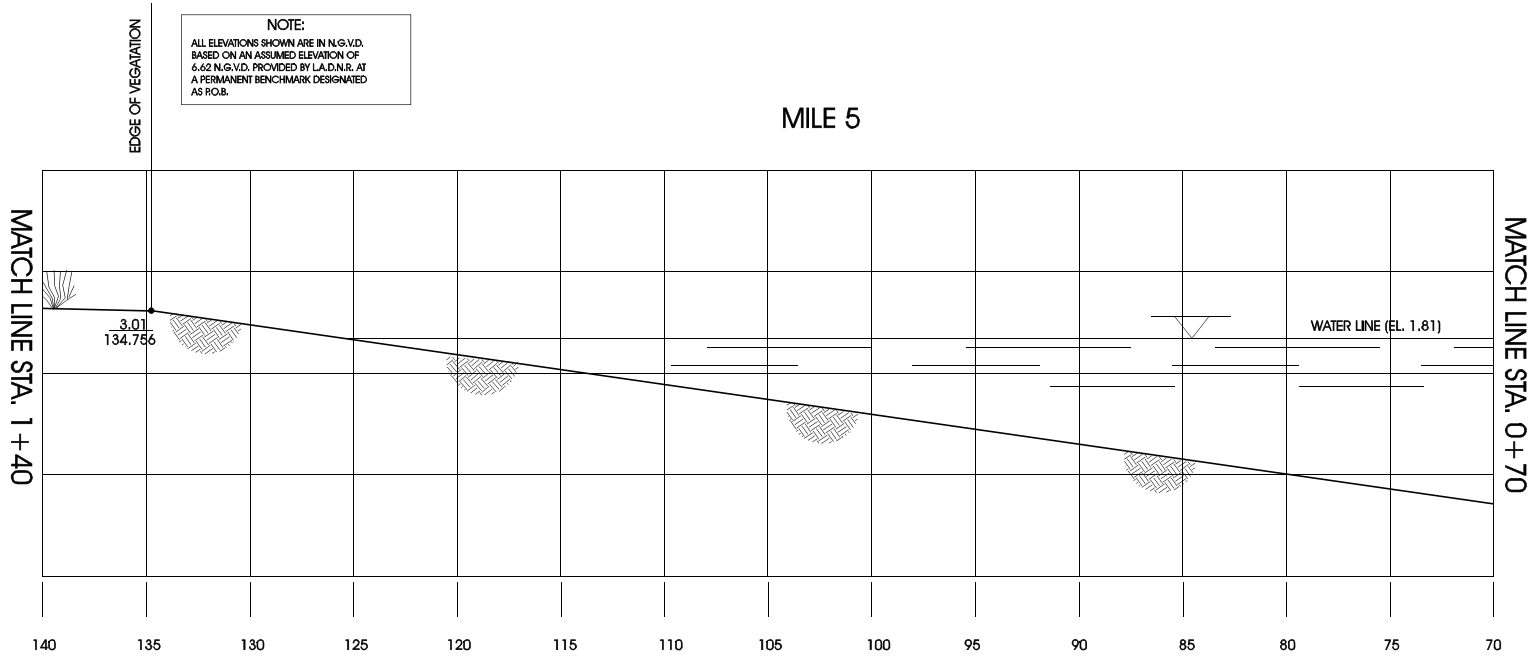

CROSS SECTION @ STA. 262+83

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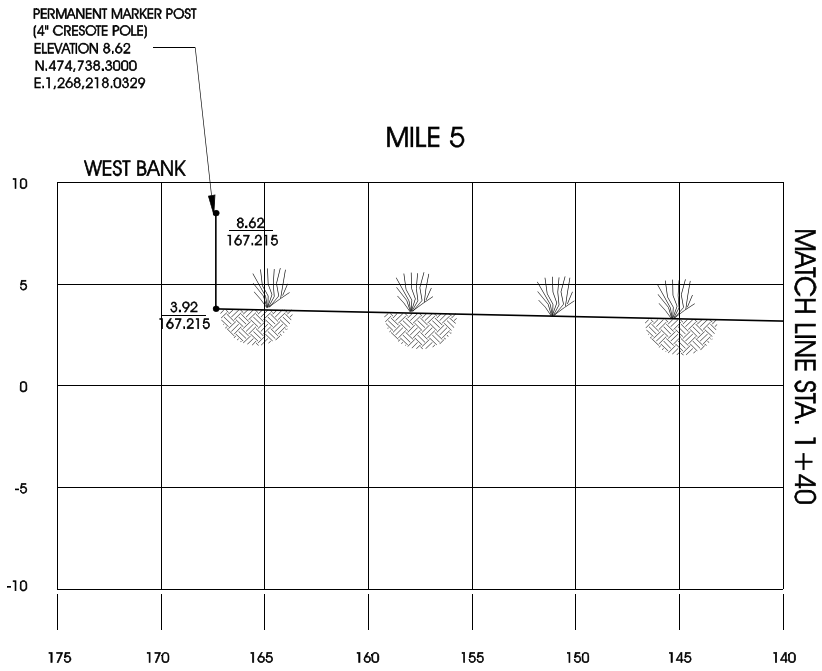

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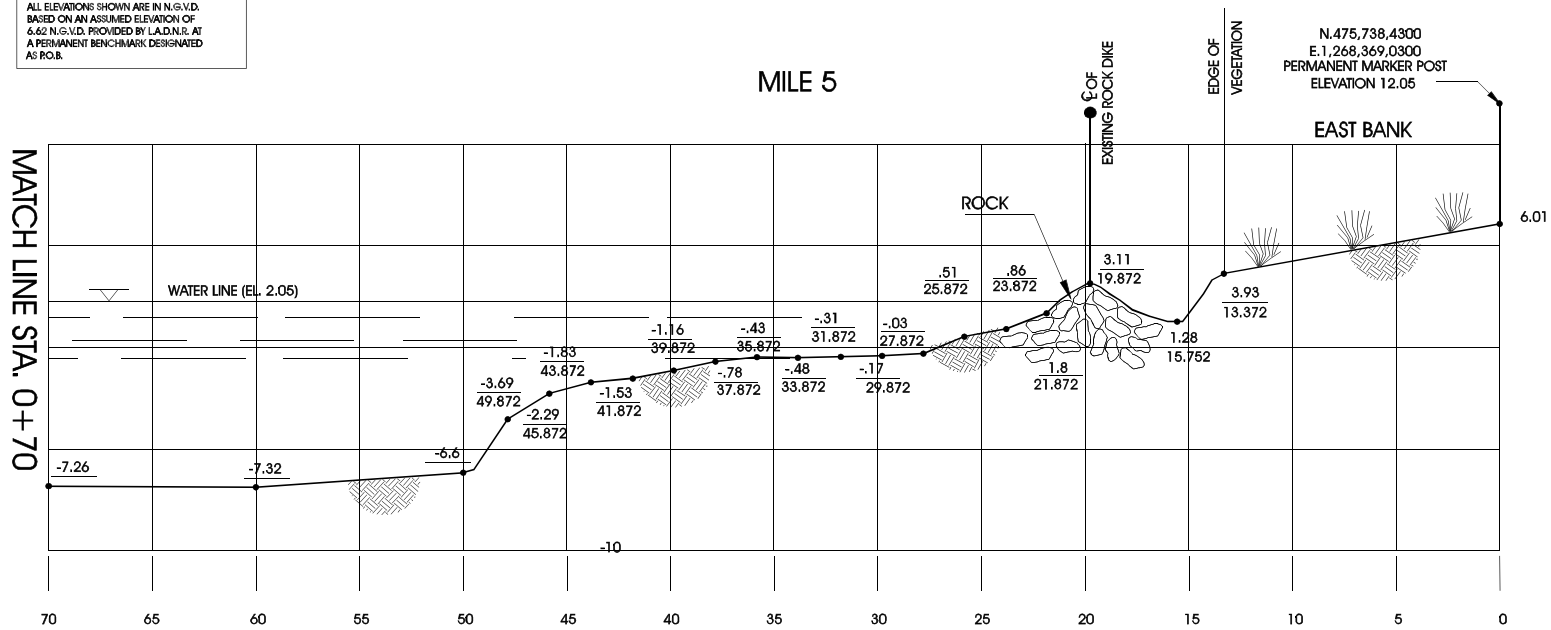

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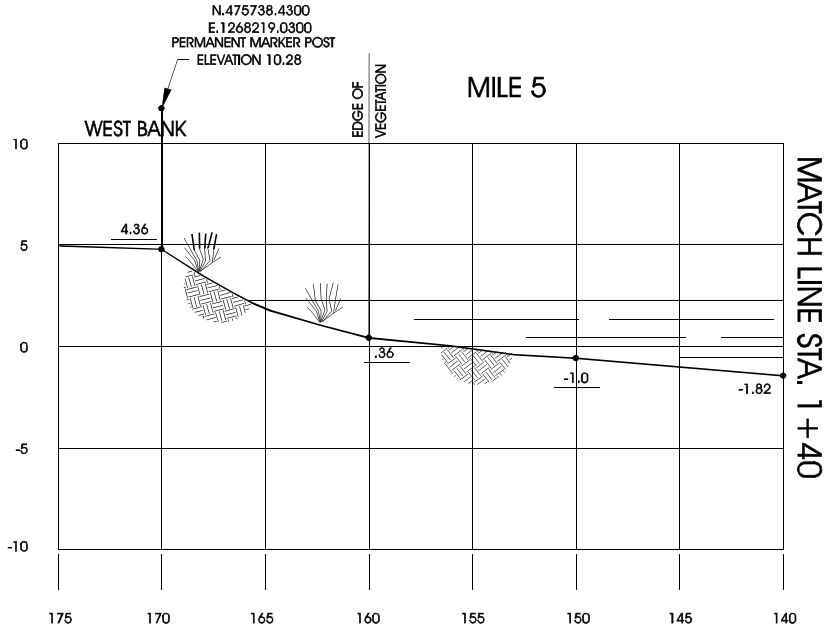

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APPENDIX B

Sabine NWR-Management Unit 3 vegetation data-December 1996

SABINE NWR -MANAGEMENT UNIT 3 VEGETATION DATA-DECEMBER 1996

Lines 18 and 19.

Site	%site veg	% spp of % veg	%spp of plot	Vegetation	Vegetation	% site water	% spp of % site water	% spp of plot	Spp within H2O	Spp within H2O
				Common name	Scientific name				Common name	Scientific name
A19-N	20	80	16	Bulltongue	Sagitaria lancifolia	80				
sw unit 3	20	10	2	Bagscale	Sacciolepsis striata					
	20	10	2	Marshmallow	Hibiscus spp.					
			20							
A19-S	20	70	14	Bulltongue	Sagitaria lancifolia	80				
	20	15	3	Alligatorweed	Althernanthera philoxeroides					
	20	10	2	Tallow tree	Sapium sebiferum					
	20	4	0.8	Pennywort	Hydrocotyle spp					
	20	1	0.2	Marshmallow	Hibiscus spp.					
			20							
B19-S	50	50	25	Bagscale	Sacciolepsis striata	50	40	20	Mud-midget	Wolfiella lingulata
	50	25	12.5	Cattail	Typha spp.					
	50	23	11.5	Fourchette	Bidens laevis					
	50	1	0.5	Pennywort	Hydrocotyle spp					
	50	1	0.5	Smartweed	Polygonum spp					
			50							
B19-N	35	60	21	Cattails	Typha spp.	65	50	32.5	Mud-midget	Wolfiella lingulata
	35	25	8.75	Bagscale	Sacciolepsis striata	65	1	0.65	Pennywort	Hydrocotyle spp
	35	10	3.5	Fourchette	Bidens laevis					
	35	5	1.75	Smartweed	Polygonum spp					
			35					33.15		
C19-S	20	80	16	Fourchette	Bidens laevis	80	10	8	Mud-midget	Wolfiella lingulata
	20	10	2	Bagscale	Sacciolepsis striata					
	20	10	2	Flatsedge	Cyperus spp					
			20							
C19-N	30	80	24	Bagscale	Sacciolepsis striata	70	10	7	Mud-midget	Wolfiella lingulata
	30	15	4.5	Fourchette	Bidens laevis					
	30	4	1.2	Dog fennel	Eupatorium perfoliatum					
	30	1	0.3	Carolina waterhyssop	Bacopa caroliniana					
			30							
D19-S	70	80	56	Bagscale	Sacciolepsis striata	30	5	1.5	Duckweed	Lemna spp.
	70	18	12.6	Dog fennel	Eupatorium perfoliatum	30	3	0.9	Mud-midget	Wolfiella lingulata
	70	2	1.4	Giant foxtail	Setaria magna					
			70					2.4		
D19-N	50	75	37.5	Dog fennel	Eupatorium perfoliatum	50	5	2.5	Duckweed	Lemna spp.
	50	15	7.5	Pennywort	Hydrocotyle spp	50	5	2.5	Mud-midget	Wolfiella lingulata
	50	9	4.5	Spike rush	Eleocharis spp					
	50	1	0.5	Marsh-fleabane	Pluchea odorata					
			50					5		
E19-N	75	50	37.5	Bagscale	Sacciolepsis striata	25				
	75	10	7.5	Fourchette	Bidens laevis					
	75	30	22.5	Alligatorweed	Althernanthera philoxeroides					
	75	5	3.75	Pennywort	Hydrocotyle spp					
	75	5	3.75	Climbing hempweed	Mikania scandens					
			75							
E19-S	85	60	51	Bagscale	Sacciolepsis striata	15				
	85	35	29.75	Alligatorweed	Althernanthera philoxeroides					
	85	5	4.25	Fourchette	Bidens laevis					
			85							

F19-E	35	80	28	Bagscale	Sacciolepsis striata	65				
	35	15	5.25	Flatsedge	Cyperus spp					
	35	5	1.75	Marsh-fleabane	Pluchea odorata					
			35							
F19-W	20	90	18	Bagscale	Sacciolepsis striata	80	2	1.6	Green algae	
	20	8	1.6	Flatsedge	Cyperus spp					
	20	1	0.2	Marsh-fleabane	Pluchea odorata					
	20	1	0.2	Willow tree	Salix spp.					
			20							
G19-S	75	30	22.5	Bulltongue	Sagitaria lancifolia	25				
	75	30	22.5	Bagscale	Sacciolepsis striata					
	75	30	22.5	Marsh-fleabane	Pluchea odorata					
	75	5	3.75	Dog fennel	Eupatorium perfoliatum					
	75	5	3.75	Coffeeweed	Sesbania macrocarpa					
			75							
G19-N	80	30	24	Bulltongue	Sagitaria lancifolia	20				
	80	30	24	Bagscale	Sacciolepsis striata					
	80	20	16	Marsh-fleabane	Pluchea odorata					
	80	20	16	Coffeeweed	Sesbania macrocarpa					
			80							
H19-N	15	100	15	Marsh-fleabane	Pluchea odorata	85	5	4.25	Waterhyssop-dead	Bacopa spp.
H19-S	25	90	22.5	Marsh-fleabane	Pluchea odorata	75	20	15	Waterhyssop-dead	Bacopa spp.
	25	5	1.25	Primrose-willow	Ludwigia leptocarpa					
	25	3	0.75	Bagscale	Sacciolepsis striata					
	25	2	0.5	Flatsedge	Cyperus spp					
			25							
I19-W	10	60	6	Marsh-fleabane	Pluchea odorata	90				
	10	20	2	Smartweed	Polygonum spp					
	10	10	1	Primrose-willow	Ludwigia leptocarpa					
	10	10	1	Bagscale	Sacciolepsis striata					
			10							
I19-E	15	55	8.25	Bullwhip	Scirpus californicus	85				
	15	20	3	Primrose-willow	Ludwigia leptocarpa					
	15	20	3	Marsh-fleabane	Pluchea odorata					
	15	3	0.45	Smartweed	Polygonum spp					
	15	2	0.3	Bagscale	Sacciolepsis striata					
			15							
A18-S	20	45	9	dead Dog fennel	Eupatorium perfoliatum	80				
	20	25	5	Pennywort	Hydrocotyle spp					
	20	10	2	Tallow tree	Sapium sebiferum					
	20	10	2	Coffeeweed	Sesbania macrocarpa					
	20	10	2	Bagscale	Sacciolepsis striata					
			20							
A18-N	70	75	52.5	Bagscale	Sacciolepsis striata	30				
	70	24	16.8	Dog fennel	Eupatorium perfoliatum					
	70	1	0.7	Pennywort	Hydrocotyle spp					
			70							

B18-S	20	55	11	Marsh-fleabane	Pluchea odorata	80				
	20	25	5	Fourchette	Bidens laevis					
	20	10	2	Dog fennel	Eupatorium perfoliatum					
	20	10	2	Bagscale	Sacciolepsis striata					
			20							
B18-N	35	60	21	Bagscale	Sacciolepsis striata	65				
	35	30	10.5	Fourchette	Bidens laevis					
	35	8	2.8	Marsh-fleabane	Pluchea odorata					
	35	2	0.7	Dog fennel	Eupatorium perfoliatum					
C18-W	85	95	80.75	Bagscale	Sacciolepsis striata	15				
	85	2.5	2.125	Pennywort	Hydrocotyle spp					
	85	2.5	2.125	Carolina waterhyssop	Bacopa caroliniana					
			85							
C18-E	85	96	81.6	Bagscale	Sacciolepsis striata	15				
	85	2	1.7	Smartweed	Polygonum spp					
	85	2	1.7	Carolina waterhyssop	Bacopa caroliniana					
			85							
D18-S	10	50	5	Giant cutgrass	Zizaniopsis miliacea	90				
	10	50	5	Primrose-willow	Ludwigia leptocarpa					
			10							
D18-N	40	80	32	Giant cutgrass	Zizaniopsis miliacea	60				
	40	10	4	Primrose-willow	Ludwigia leptocarpa					
	40	10	4	Marsh-fleabane	Pluchea odorata					
			40							
E18-N	10	60	6	Bagscale	Sacciolepsis striata	90	30	27	Giant cutgrass	Zizaniopsis miliacea
	10	15	1.5	Marsh-fleabane	Pluchea odorata					
	10	10	1	Bullwhip	Scirpus californicus					
	10	10	1	Primrose-willow	Ludwigia leptocarpa					
	10	5	0.5	Pennywort	Hydrocotyle spp					
			10							
E18-S	10	85	8.5	Bullwhip	Scirpus californicus	90	20	18	Giant cutgrass	Zizaniopsis miliacea
	10	15	1.5	Primrose-willow	Ludwigia leptocarpa					
			10							
F18-S	65	65	42.25	Bulltongue	Sagitaria lancifolia	35				
	65	55	35.75	Bagscale	Sacciolepsis striata					
			78							
F18-N	65	50	32.5	Bulltongue	Sagitaria lancifolia	35				
	65	50	32.5	Bagscale	Sacciolepsis striata					
			65							
G18-S	30	75	22.5	Bulltongue	Sagitaria lancifolia	70	5	3.5	Waterhyssop	Bacopa spp.
	30	20	6	Bagscale	Sacciolepsis striata	70	1	0.7	Green algae	
	30	5	1.5	Marsh-fleabane	Pluchea odorata	70	1	0.7	Duckweed	Lemna spp.
			30					4.9		
G18-N	5	98	4.9	Bagscale	Sacciolepsis striata	95	1	0.95	Waterhyssop	Bacopa spp.
	5	1	0.05	Bulltongue	Sagitaria lancifolia	95	1	0.95	Bladderwort	Utricularia spp.
	5	1	0.05	Marsh-fleabane	Pluchea odorata					
			5					1.9		
H18-E	0		0			100	50	50	Waterlily	Nymphaea spp.

						100	10	10	Bladderwort	Utricularia spp.
								60		
H18-W	5	100	5	Bulltongue	Sagitaria lineolata	95	30	28.5	Bladderwort	Utricularia spp.
						95	30	28.5	Waterlily	
								57		
I18-S	0		0			100	20	20	Bladderwort	Utricularia spp.
						100	4	4	Waterlily	Nymphaea spp.
								24		
I18-N	0		0			100	30	30	Bladderwort	Utricularia spp.
						100	2	2	Waterlily	Nymphaea spp.
								32		
J18-N	20	90	18	Giant cutgrass	Zizaniopsis miliacea	80	1	0.8	Waterhyssop	Bacopa spp.
	20	5	1	Bullwhip	Scirpus californicus					
	20	5	1	Marsh-fleabane	Pluchea odorata					
			20							
J18-S	5	60	3	Marsh-fleabane	Pluchea odorata	95	10	9.5	Waterlily	Nymphaea spp.
	5	20	1	Primrose-willow	Ludwigia leptocarpa	95	5	4.75	Bladderwort	Utricularia spp.
	5	20	1	Bullwhip	Scirpus californicus					
			5					14.25		
K18-E	0		0			100	50	50	Water-celery	Vallisneria americana
ditch						100	35	35	Pondweed	Potomogetan spp.
								85		
K18-W	0		0			100	35	35	Pondweed	Potomogetan spp.
						100	30	30	Water-celery	Vallisneria americana
								65		

Site	H20 Depth	Bottom subtrate	COMMENTS
A19-N	12"		This station was off from map we wrote down the new point.
sw unit 3			
A19-S			
B19-S	11"		
B19-N			
C19-S	6"	hard	
C19-N			
D19-S	7"	firm	
D19-N			
E19-N	7"		alligatorweed nutria eat-out
E19-S			

F19-E	15"	hard	
F19-W			
G19-S	4"	firm	
G19-N			
H19-N	15"	firm	live bacopa coming up from the bottom-difficult to estimate amount
H19-S			live bacopa coming up from the bottom-difficult to estimate amount
I19-W			
			dead cyperus under the water. This was a drought stimuated plant andd was coverd by water when we got rain--good for ducks
I19-E			
			lots of nutria activity here and lots of seeds laying up on top of the water.
A18-S	8"		
A18-N			

B18-S			Cyperus spp made up quite a bit of the dead biomass under the waters surface.
B18-N			Nutria mounds in the area had a trace of pennywort.
C18-W	6"	hard	shallow marsh, hummock
C18-E			
D18-S	9"	firm	
D18-N			Nutria eat out area.
E18-N	11"	soft	
E18-S			
F18-S	6"	hard	both sides here there are chewed up plants and many signs of nutria activity including beds in the plot.
F18-N			
G18-S	17"	firm	bottom of plots covered in bacopa- rake.
G18-N			
H18-E	16"	firm	open pond east of channel

H18-W			
I18-S			
I18-N			
	25"	hard	
J18-N			
J18-S			
	15"	hard	lots of dead cyperus under the water on both plots-difficult to estimate down there.
K18-E	26"	hard	
ditch			
K18-W			