



State of Louisiana

**Coastal Protection and Restoration
Authority of Louisiana (CPRA)**

**2014/2015 Annual Inspection
Report**

for

**Replace Sabine Refuge Water
Control Structures at Headquarters
Canal, West Cove Canal, and Hog
Island Gully (CS-23)**

State Project Number CS-23
Priority Project List 3

November 12, 2014
Cameron Parish

Prepared by:

Dion Broussard, E.I.
Darrell J. Pontiff, P.E.
CPRA
Lafayette Field Office
635 Cajundome Blvd.
Lafayette, LA 70596



Table of Contents

I. Introduction.....	1
II. Inspection Purpose and Procedures	1
III. Project Description and History.....	2
IV. Summary of Past Operation and Maintenance Projects.....	3
V. Structure Operations.....	5
VI. Inspection Results	6
VII. Conclusions and Recommendations.....	6

Appendices

Appendix A	Project Features Map
Appendix B	Photographs
Appendix C	Three Year Budget Projections
Appendix D	Field Inspection Notes
Appendix E	Excerpts from Operational Plan

I. Introduction

The Replace Hog Island Gully, West Cove and Headquarters Canal Structures (CS-23) project area is located within the Sabine National Wildlife Refuge, approximately 9 mi (14.5 km) south of the town of Hackberry in Cameron Parish, Louisiana. Established on December 6, 1937, the Sabine Refuge is bound on the east by Calcasieu Lake, on the west by Sabine Lake, on the north by the North Line Canal, and on the south by the South Line Canal, pasture land and coastal ridges.

The Sabine Refuge Structure Replacement Project was authorized by Section 303(a) of Title III Public Law 101-646, the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) enacted on November 29, 1990 as amended and approved on the third Priority Project List. The Sabine Refuge Structure Replacement Project has a twenty – year (20 year) life, which began in February 2000 and ends in 2020. The USFWS is responsible for operations and minor maintenance.

II. Inspection Purpose and Procedures

The purpose of the annual inspection of the Sabine Refuge Structure Replacement Project (CS-23) is to evaluate the constructed project features to identify any deficiencies and prepare a report detailing the condition of project features and recommended corrective actions needed. Should it be determined that corrective actions are needed, CPRA shall provide, in the report, a detailed cost estimate for engineering, design, supervision, inspection, and construction contingencies, and an assessment of the urgency of such repairs (O&M Plan, 2002). The annual inspection report also contains a summary of maintenance activities which were completed since project completion and 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 C. A summary of past operation and maintenance projects completed since completion of the Sabine Refuge Protection Project are outlined in Section IV.

An inspection of the Sabine Refuge Structure Replacement Project (CS-23) was held on November 12, 2014 under cloudy skies and cold temperatures. In attendance were Dion Broussard of CPRA, Darryl Clark of USFWS, and Brandon Samson of NRCS for other inspections. The inspection began at the Hog Island Gully Structure at approximately 11:00 am and ended at the West Cove Structure at 12:00 pm.

The field inspection included an inspection of all three project sites. Staff gauge readings and existing temporary benchmarks where available were used to determine approximate elevations of water, rock embankments, concrete structures and other project features. Photographs were taken (see Appendix B) and Field Inspection notes were completed in the field to record measurements and deficiencies (see Appendix D).

III. Project Description and History

O'Neil (1949) characterized the project area wetlands as fresh to intermediate marshes dominated by *Cladium mariscus* (Jamaica sawgrass). The Black Lake area, located north of the project, experienced an 81% reduction in the acreage of emergent wetlands between 1952 and 1974 (Adams et al. 1978). By 1972, the Black Lake area was characterized as brackish marsh (Chabreck and Linscombe 1978). A number of factors such as salinity stress, erosion, subsidence, burning and hydrologic modification influenced this habitat change.

Since there are primarily three avenues for water passage (Hog Island Gully, West Cove Canal, and Headquarters Canal) in the area, water management by weirs and tainter gates was initiated by USFWS in the 1970's. By the 1990's, these structures had corroded with the continuous exposure to saline water to the extent that they were inoperable or almost inoperable.

Due to the detrimental impacts of excessive salinity on brackish and intermediate marshes, the ability to occasionally reduce or halt the inflow of saline water is critical. This level of control was not available with the original structures. The inability to manipulate gate structures jeopardized the integrity of thousands of acres of interior brackish and intermediate marshes which are lower in elevation and often occur in highly organic semifloating soils. The estimated subsidence rate in the project marshes ranges between 0.12 in/yr and 0.16 in/yr (0.32 and 0.42 cm/yr) (Penland et al. 1989).

Because of the restricted cross-sectional area of the pre-existing structures and culverts, the lower elevation interior marshes experienced longer periods of vegetative water logging stress than the marshes located east of Highway 27. The pre-existing structures afforded the primary avenues for drainage and were inadequate to provide sufficient discharge to evacuate excess water. Due to the project area not being fully enclosed, secondary drainage for the area could occur to the west through Sabine Lake via North, Central and South line canals.

In May 1999, the US Fish and Wildlife Service (USFWS) completed the environmental assessment (EA) addressing the Replacement of Water Control Structures at Hog Island Gully, West Cove Canal, and Headquarters Canal (CS-23). The environmental assessment called for the complete removal of the Hog Island Gully Structure, West Cove Canal Structure, and Headquarters Canal Structure and replacement with additional structures and culverts to provide larger cross sections for water removal and to minimize saltwater intrusion.

The replacement structures are operated to more effectively discharge excess water, increase cross sectional area for ingress and egress of estuarine dependent species and more effectively curtail saltwater intrusion into the interior marshes.

Replacement Structures:

Structure A-Hog Island Gully Canal

This structure has four 7.5 foot wide gates (HG1, HG2, HG5, and HG6) and two 3.0 foot wide gates (HG3 and HG 4) [306 ft² total area]. Each gate is 8 feet deep, assuming that water level is at marsh elevation (1.0' NGVD88). Each opening is equipped with slide gates that may be used to preclude all water flow. Of the four 7.5 foot wide gates, three have exterior flap gates, (HG1, HG2, and HG6).

Structure B- Headquarters Canal

This structure has three 5 foot wide diameter culverts (HQ1, HQ2, and HQ3) [59ft² total area]. The top of each culvert is at marsh level (1.0' NGVD). Each culvert is equipped with an exterior flap gate that may be raised and locked closed. The center culvert has a sluice gate.

Structure C – West Cove Canal

This structure has three 7.5 foot wide gates (WC1, WC3, and WC5) and two 3.0 foot wide gates (WC2 and WC4) [242 ft² total area]. Each gate is 8 feet deep, assuming that water level is at marsh elevation (1.0' NGVD). Each is equipped with slide gates that may be used to preclude all water flow. Two of the four 7.5 foot gates have exterior flap gates (WC1 and WC5).

Construction began in November 1999 and was completed on the Headquarters Canal, Hog Island Gully, West Cove structures in February 2000, August 2000, and June 2001, respectively. There were however operational issues after construction at the Hog Island Gully and West Cove structures due to electrical service problems and operating nut failures which prevented the structures from being operated as designed. Two hurricanes, Rita 2005 and Ike 2008, experienced in the area also exacerbated the damage to the structures. After various post-construction maintenance events and an extensive refurbishment that included the modification of the Hog Island and West Cove Canal water control structures, in April 2011, the Hog Island Gully and West Cove structures have been repaired and have been fully operational since 2011.

High saline waters can be precisely controlled, water discharge capacities have been increased, and vegetative stress through water logging has been minimized, thus enhancing emergent and submergent vegetative growth.

IV. Summary of Past Operation and Maintenance Projects

General Maintenance: Below is a summary of completed maintenance projects and operation tasks performed since February 2000, the construction completion date of Sabine Refuge Structure Replacement Project (CS-23).

- **June, 2005 – F. Miller & Sons, Inc.**

A maintenance event was performed to correct the following:

1. Install operating nut in gate 6A, Hog Island Gully.
2. Free gate 6b that is jammed, Hog Island Gully.
3. Replace operation nut in gate 3A, West Cove.
4. Replace batteries in all Rotork Actuators and re-calibrate.

Construction (Item Nos. 1, 2 & 3):	\$ 7,800.00
Construction (Item No. 4):	\$ 5,416.45

PROJECT TOTAL: \$13,216.45

- **June, 2006 – U.S. Fence & Gate, Inc.**

A maintenance event was performed to correct the following:

1. Remove existing fence and posts damaged by Hurricane RITA at both Hog Island Gully and West Cove Structures and replace with new chain link fence material and new posts.

Construction Cost:	\$8,360.00
Engineering Design and Construction Oversight:	In-House

PROJECT TOTAL: \$8,360.00

- **June – October, 2008 – Electrical Repairs by USFWS via Tennessee Valley Authority (TVA)**

The TVA, under contract with USFWS and post-Rita funds, replaced storm-damaged wiring, installed true 3-Phase power from Jeff Davis Electric Co-Op transformers at Highway 27 to the structures, relocated all controls to the top platform, removed the rotary phase converter, and wired the actuators using on-off control switches.

PROJECT TOTAL: \$232,979

- **2009 - Lonnie Harper & Associates - E&D of Repairs and Modifications to Structures**

Post-Rita FEMA funding was used for preparation of plans and specifications for structure repair and modifications.

FEMA ALLOWANCE: \$144,185

- **September, 2009 – A-1 American Fence, Inc.**

A maintenance event was performed to correct the following:

1. Remove existing fence and posts damaged by Hurricane Ike at both Hog Island Gully and West Cove Structures and replace with new chain link fence material and new posts.

Construction Cost:	\$ 5,500.00
Engineering Design and Construction Oversight:	\$18,566.93

PROJECT TOTAL: \$24,066.93

- **April, 2011 – L.S. Womack, Inc.**

A maintenance event was performed to correct the following:

1. Dismantling of Hog Island Gully and West Cove structures.
2. Cleaning and performing modifications to all gates at both Hog Island Gully and West Cove structures.
3. Refurbishing gear drives and actuators for gates where 3” stems were to be replaced with 2.5” stems.
4. Refurbishing the gear drive and actuator at Headquarters.
5. Structural modifications to the 7’-6” gates at both Hog Island Gully and West Cove structures included modifying the stem attachments to accommodate a dual stem configuration.
6. Removal of the leak proof gasket, modify structural steel platforms at Hog Island Gully and West Cove structures to accompany new gate connection and stems.
7. Reworking of all electrical connections to provide complete operation of all three structures.
8. During construction, it was determined that the gates required structural repairs to maintain the integrity of the gates. 193 stitch welds were performed on 22 gates, to repair broken welds and strengthen the integrity of the gates.

Construction Cost:	\$1,288,934.82
Engineering Design and Construction Oversight:	\$ 64,077.11

PROJECT TOTAL: \$1,353,011.93

V. Structure Operations

Normal Operation:

The structures are operated based on salinity and water level data. The target levels are defined in the permitted Operational Plan (see Appendix E). Water exchange is provided through open bays having approximately the same cross-sectional area as that provided by the old structures' fully open gates [182 ft² total area]. The slide/slucice gates of the flapgated bays may be adjusted by the refuge manager at his discretion, except for the middle Headquarters' Canal Structure culvert (HQ2) which will remain 50 percent open.

The Hog Island Gully and West Cove structures were not fully operational prior to Hurricane Rita due to an electrical service problem as well as gate alignment problems.

Note: USFWS is responsible for structure operations and minor maintenance (up to \$2,000/year). Actual operation data may be obtained from the Sabine Refuge Headquarters Office at 337-762-3816 or the LA Ecological Services Office 337-292-3111.

VI. Inspection Results

Structure A - Hog Island Gully Canal

The structure is in fully operational condition as a result of the 2011 maintenance event. The conversion from single to dual stems appears to have helped with the operation of the gates. (Photos: Appendix B, Photos 1 - 2)

Structure B - Headquarters' Canal

The structure is in fully operational condition as a result of the 2011 maintenance event. (Photos: Appendix B, Photos 3-4).

Structure C - West Cove Canal

Gate 2A is not working due to a problem with the actuator motor. A quote was obtained from Custom Actuation and CPRA is in the process of developing a purchase order for repair. (Photos: Appendix B, Photos 5-6).

VII. Conclusions and Recommendations

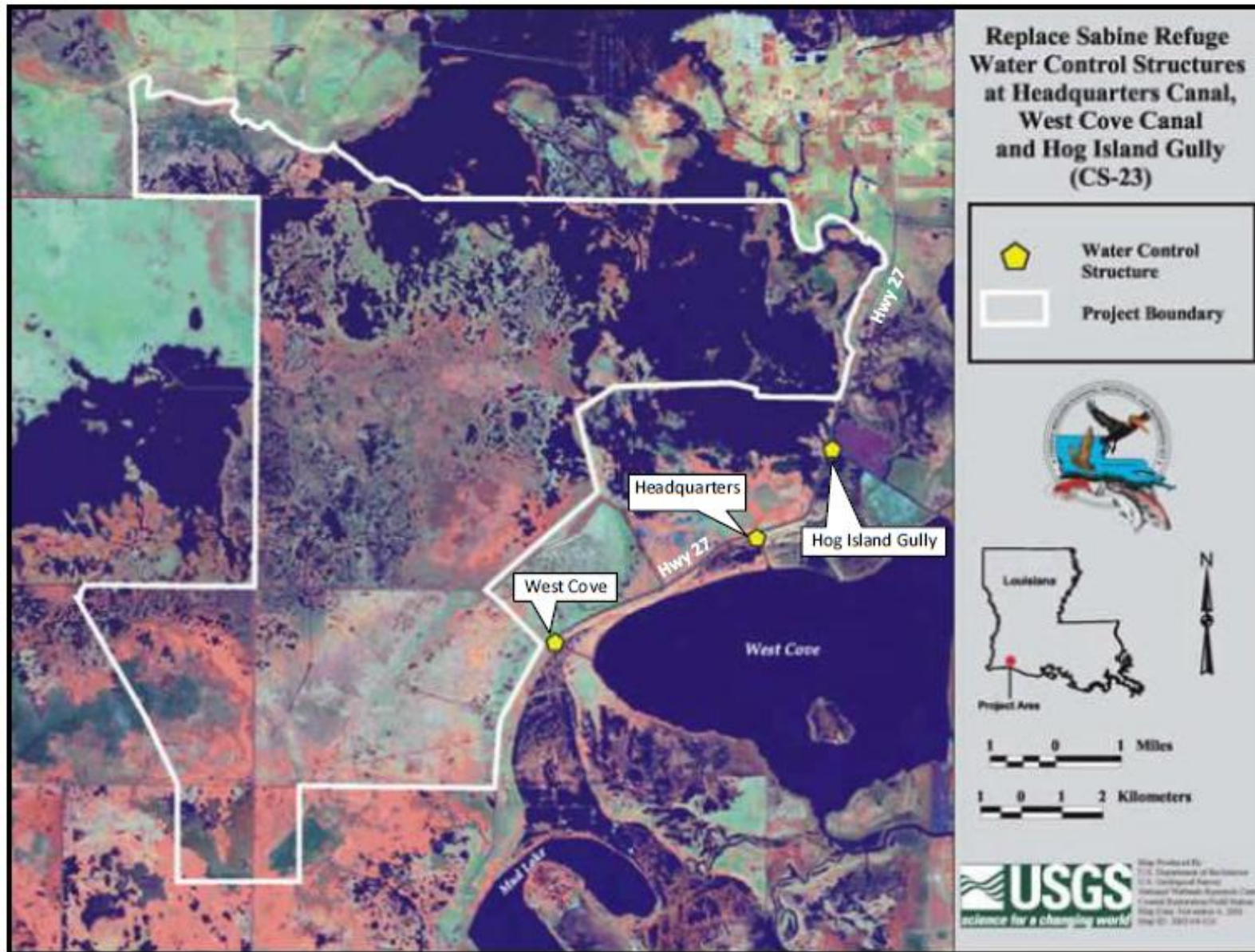
The Gate 2A actuator (motor) at West Cove will be replaced upon the issuance of a purchase order. The Sabine Refuge Structure replacement project structures are operating well with occasional minor repair issues on a few gates needing periodic maintenance.

Annual Inspection Report
SABINE REFUGE STRUCTURE
REPLACEMENT
State Project No. CS-23

Appendix A

Project Features Map

Annual Inspection Report
SABINE REFUGE STRUCTURE
REPLACEMENT
State Project No. CS-23



Annual Inspection Report
SABINE REFUGE STRUCTURE
REPLACEMENT
State Project No. CS-23

Appendix B

Photographs

Annual Inspection Report
SABINE REFUGE STRUCTURE
REPLACEMENT
State Project No. CS-23



Photo No. 1, Hog Island Gully Structure looking from the Hwy 27 side



Photo No. 2, Hog Island Gully Structure from the Calcasieu Lake side– gates being exercised and in open position

Annual Inspection Report
SABINE REFUGE STRUCTURE
REPLACEMENT
State Project No. CS-23



Photo No. 3, Headquarters Structure with outside flapgates flapping



Photo No. 4, Headquarters Structure marsh side culverts with riprap

Annual Inspection Report
SABINE REFUGE STRUCTURE
REPLACEMENT
State Project No. CS-23



Photo No. 5, West Cove Canal Calcasieu Lake side of structure with flapgate flapping



Photo No. 6, West Cove Canal from Hwy 27 side – gates being exercised and in open position

Annual Inspection Report
SABINE REFUGE STRUCTURE
REPLACEMENT
State Project No. CS-23

Appendix C

Three Year Budget Projection

Annual Inspection Report
 SABINE REFUGE STRUCTURE
 REPLACEMENT
 State Project No. CS-23

SNWR STRUCTURES/ CS-23 / PPL 3
Three-Year Operations & Maintenance Budgets 07/01/2015 - 06/30/2018

Project Manager <i>Darrell Pontiff</i>	O & M Manager <i>Dion Broussard</i>	Federal Sponsor <i>USFWS</i>	Prepared By <i>Dion Broussard</i>
---	--	---------------------------------	--------------------------------------

	2015/2016 (-16)	2016/2017 (-17)	2017/2018 (-18)
<i>Maintenance Inspection</i>	\$ 6,851.00	\$ 7,057.00	\$ 7,269.00
<i>Structure Operation</i>	\$ 5,000.00	\$ 5,000.00	\$ 5,000.00
<i>State Administration</i>			\$ -
<i>Federal Administration</i>			\$ -

Maintenance/Rehabilitation

15/16 Description:

<i>E&D</i>	\$ -
<i>Construction</i>	
<i>Construction Oversight</i>	
<i>Sub Total - Maint. And Rehab.</i>	\$ -

16/17 Description:

<i>E&D</i>	
<i>Construction</i>	
<i>Construction Oversight</i>	
<i>Sub Total - Maint. And Rehab.</i>	\$ -

17/18 Description:

<i>E&D</i>	\$ -
<i>Construction</i>	\$ -
<i>Construction Oversight</i>	\$ -
<i>Sub Total - Maint. And Rehab.</i>	\$ -

	2015/2016 (-16)	2016/2017 (-17)	2017/2018 (-18)
<u>Total O&M Budgets</u>	\$ 11,851.00	\$ 12,057.00	\$ 12,269.00

<u>O & M Budget (3 yr Total)</u>	\$ 36,177.00
<u>Unexpended O & M Budget</u>	\$ 487,005.00
<u>Remaining O & M Budget (Projected)</u>	\$ 450,828.00

Annual Inspection Report
SABINE REFUGE STRUCTURE
REPLACEMENT
State Project No. CS-23

Appendix D

Field Inspection Form

Annual Inspection Report
 SABINE REFUGE STRUCTURE
 REPLACEMENT
 State Project No. CS-23

MAINTENANCE INSPECTION REPORT CHECK SHEET			
Project No. / Name: CS-23 Sabine Refuge Structure Replacement		Inspector(s): Dion Broussard (CPRA) Daryl Clark (USFWS) Brandon Samson (NRCS) for other inspections	
Structure No.: West Cove Canal		Water Level Inside: N/A Outside: N/A	
Structure Description: Control Structure		Weather Conditions: Cloudy skies and cold temperatures	
Type of Inspection: Annual			

Item	Condition	Physical Damage	Corrosion	Photo #	Observations and Remarks
Steel Bulkhead / Caps	N/A				
Steel Grating	Good				
Gates	Good			5 & 6	
Electrical	Good				
Hardware/Stairs	Good			5	
Fencing	Good				
Timber Piles	Good				
Timber Wales	N/A				
Actuators	Good			5	
Cables	Good				
Signage / Supports	Good				
Rip Rap	Good			5 & 6	
Earthen Embankment	N/A				

What are the conditions of the existing levees?
 Are there any noticeable breaches?
 Settlement of rock plugs and rock weirs?
 Position of stoplogs at the time of the inspection?
 Are there any signs of vandalism?

Annual Inspection Report
SABINE REFUGE STRUCTURE
REPLACEMENT
State Project No. CS-23

Appendix E

Excerpts from Operational Plan

**Excerpts from the "Replace Sabine Structures Operation Plan" from
Environmental Assessment 1999**

V. DESCRIPTION OF WATER MANAGEMENT PLAN

Operation Goals of the New Water Control Structures. The proposed replacement structures were designed to increase management capabilities and provide greater water discharge capability than the existing structures (Table 1). The operational plan for the new structures has been developed to maintain the existing marsh types and provide the following goals:

- 1) To increase water discharge capacity and reduce adverse impacts from excessive rainfall and storm surges which push excessive saline water into the area,
- 2) To curtail saltwater intrusion into interior low-salinity marshes, and
- 3) To provide greater cross-sectional area for improved estuarine-dependent fish and shellfish access.

The water management plan for each new structure provides for unimpeded water exchange through a cross-sectional area approximately equivalent to that of the existing structure when fully open. Additional water exchange would be allowed, upon the refuge manager's discretion, for the purpose of discharging excess water, introducing fresh water or water of lower salinity, improving ingress and egress of estuarine-dependent fishes and shellfishes, and discharging anoxic water or to remediate other water quality problems.

The operational plan would also allow the new structures to restrict or halt saltwater inflow to protect intermediate marshes from saltwater damage. The intermediate marsh areas occur primarily within the northwestern and southwestern portions of the project area. Intermediate marshes also occur beyond the western project area boundary along Central Canal. Saltwater intrusion into these areas occurs primarily through Central Canal and through the open water area of the northeastern project area adjacent to Sabine NWR Management Unit 1. Two data collection platforms (Stations' BC and BN) have been established along each of these two saltwater routes to monitor the rate and extent of saltwater penetration into project area intermediate marshes (Figure 2).

Because Station BC is located at a site from which saltwater readily enters intermediate marshes to the south, west, and north, it was determined to be a critical salinity monitoring station. Station BN is in an intermediate marsh area, hence it was also determined to be a critical monitoring station.

Station BN and Station 5R Structure Operation Criteria. Salinity data compiled for stations BN and BC reveal that the period 1984 through 1988 was the most saline on record, and the period 1989 through 1993 was the freshest on record. Mean monthly salinities were plotted for both the 1984-1988 and 1989-1993 periods (Figures 3 and 4). To maintain existing intermediate marsh vegetation, it was assumed that maintenance of an appropriate salinity range would be most critical during the beginning and middle portions of the growing season from March through August. The new structures will be operated to maintain growing season salinities at Station BN between that of the 1984-88 and 1989-93 extremes. Hence, 3 parts per thousand (ppt) was established as the Station BN structure closure criteria (Water Control Structure Operational Plan-Attachment 1). Given that high salinity events occur with greater frequency from September through February, the Station BN closure criterion during this period was established at 5 ppt (the lower range of the monthly maximum values).

Saltwater may reach Station BN by either flowing northward up Beach Canal from the West Cove Canal Structure, or it may flow across open water areas in Unit 1 from the Hog Island Gully Structure. Station 5R was established to monitor the influence of saltwater inflows through the Hog Island Gully Structure on Unit 1 open water areas. Salinity criteria were established for Station 5R to restrict saltwater inflows and reduce the potential that east or southeast winds will push high salinity waters across Unit 1 and exceed closure criteria at Station BN. To establish those inflow restriction criteria at Station 5R, four years of simultaneous readings from Stations BN and 5R were compared. Those data revealed that Station 5R salinities averaged 2.4 ppt higher than those at Station BN. For this reason, inflow restriction salinity criteria at Station 5R were established 2 ppt higher than closure criteria at Station BN.

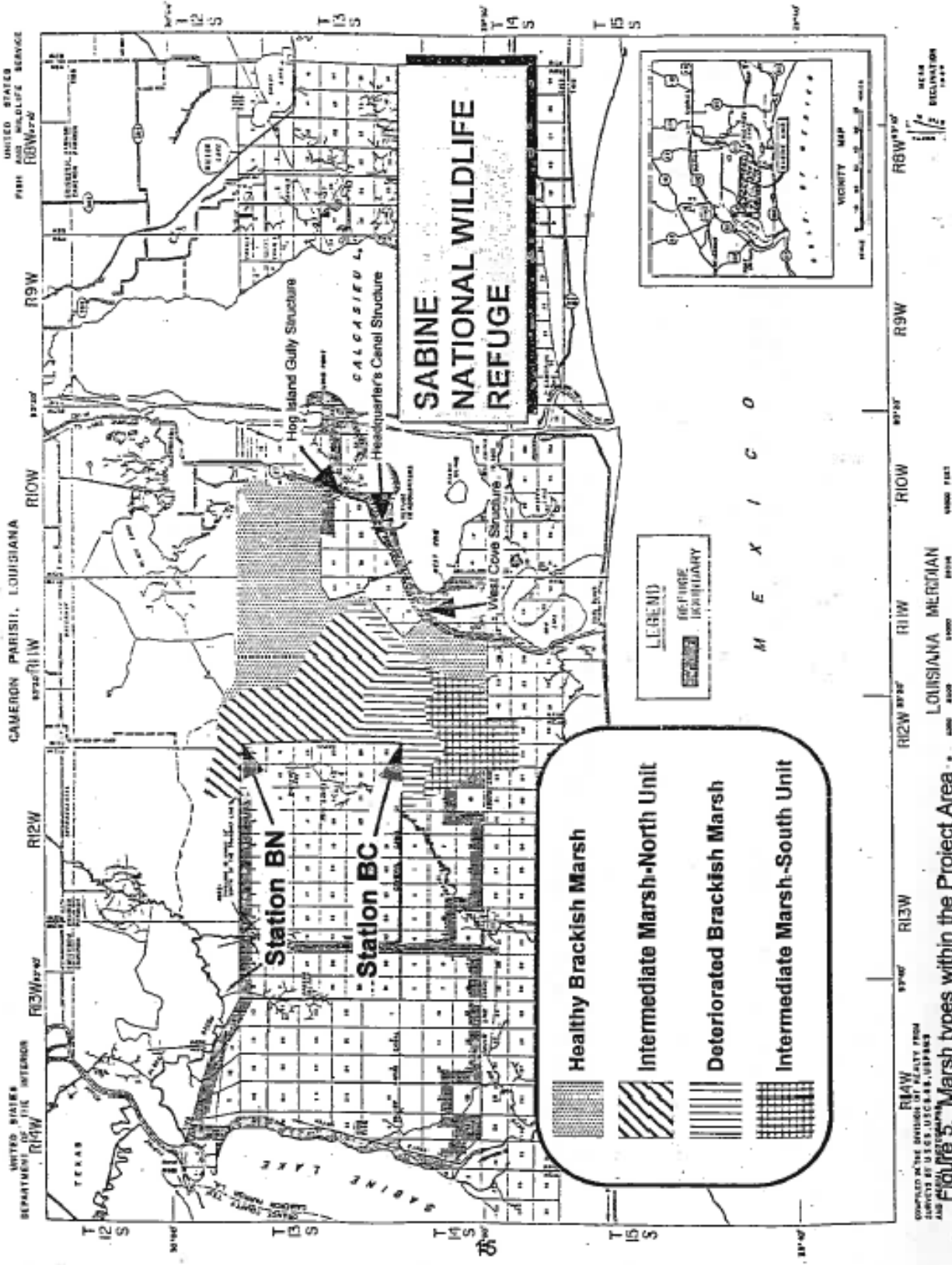
Saltwater inflow restrictions to protect intermediate marshes in the vicinity of Station BN would also be triggered when salinities at Station BN reached levels 1 ppt less than the closure criteria. When salinities at Station BN reach the inflow restriction criteria, refuge personnel will utilize other salinity data, precipitation, wind direction,

wind speed, east Unit 3 spillway operations and other factors to determine whether the saltwater came from the Hog Island Gully Structure or from the West Cove Canal Structure. Only those refuge structure(s) determined to have caused the high salinity conditions will be closed or restricted. Should refuge personnel determine that the saltwater came from both the West Cove and Hog Island Gully Structures, then both structures will be closed. Additional safeguards against saltwater intrusion from the south via Beach Canal will be provided by the criteria at monitoring Stations C and BC.

Station BC and Station C Structure Operation Criteria. Station BC is located in a deteriorated brackish marsh area (Figure 5). This station will monitor salinity inflows primarily from the West Cove Canal and Headquarters's Canal structures prior to the dispersal of those flows to the south, west, or north. Because of the salinity fluctuations at Station BC, mean salinities during 1984-88 and 1989-93 (Figure 4) were used less than the unaveraged data presented in Tables 2 and 3. Based upon that data, gate closure criteria were chosen between the extremely high salinity conditions of 1984-88 and the low salinity conditions of 1989-93. The March-August salinity criteria for gate closure was determined to be 6 ppt, and the September-March salinity closure criteria was determined to be 10 ppt (Water Control Structure Operational Plan-Attachment 1).

To protect intermediate marshes located to the north, west, and south, of Station BC, and to reduce the extent of complete gate closures triggered by those high salinities, Station C was established to monitor saltwater inflows heading for Station BC. Salinity values at Station C, which trigger inflow restrictions through the West Cove Canal and Headquarters Canal Structures, were determined by readings from July 1990 through August 1998. During this period, Station C salinities averaged 2.1 ppt higher than those at Station BC. Therefore, the growing season inflow restriction criteria at Station C were set 2 ppt higher than the Station BC structure closure criteria. Given that saltwater inflows here are contained within canals, the non-growing season inflow restriction criteria at Station C was set at the same value as Station BC closure criteria to ensure that intermediate marshes are not impacted. Hence Station C inflow restriction criteria are 8 ppt during the growing season and 10 ppt during the non-growing season (Water Control Structure Operational Plan-Attachment 1). Additionally, should Station BC salinities reach or exceed 4 ppt during the growing season, or 8 ppt during the non-growing season (that is 80 percent of closure criteria values), then the Headquarters' Canal and West Cove Canal Structures may be operated to restrict saltwater inflows.

Annual Inspection Report
 SABINE REFUGE STRUCTURE
 REPLACEMENT
 State Project No. CS-23



Station BS Structure Operation Criteria. Salinity monitoring conducted at Station BS (located at the intersection of Beach Canal and Southline Canal) will ensure that saltwater does not adversely impact intermediate marshes south of the project area. Saltwater reaching this station would likely come from the West Cove Canal Structure via Central Canal. However, it might also come via the East Mud Lake area through South Line Canal, or from high tides overtopping the beach rim. Station BS salinity criteria for restricting saltwater inflow and closing structures will be the same as those at Station BC (6‰-growing season; 10‰-non-growing season). When those criteria are met, refuge personnel will evaluate other salinity data, tides, precipitation, wind speed and direction, plus other factors to determine the source of saltwater. If refuge personnel determine that salinities came from Central Canal, then the Headquarters Canal and West Cove Canal structures will be closed or restricted as appropriate. If the saltwater at Station BS is determined to have come over the beach rim, then, pending refuge manager discretion and conditions elsewhere, refuge structures will likely be left open to discharge that water.

Inflow Restriction Criteria Summary and Structure Operations. When the salinities reach or exceed any of the salinity criteria specified below (see Table 4), the refuge manager will determine the source of high salinity water causing the criteria to be reached or exceeded. Only those refuge structure(s) determined to be admitting the saltwater will then be operated to restrict future saltwater inflows. During inflow restriction operations and all periods when water level safety provisions are not in affect, the refuge manager may use his discretion to configure the flapgates and/or other gates to discharge water as desired. When the salinity levels at the station(s) prompting inflow restrictions fall below the inflow restriction criteria, then normal water exchange will be resumed.

Restricted inflow through the Hog Island Gully Structure will be achieved by allowing inflow through only one, fully open, 3-foot-wide gate (22% of normal cross-section). Restricted inflow through the West Cove Canal Structure will be achieved by completely closing the Headquarters' Canal structure to all inflow and by restricting inflow at the West Cove Canal Structure to only one, fully open, 3-foot-wide gate (20% of normal combined cross-section), or, by completely closing the West Cove Canal Structure and allowing exchange through one Headquarters Canal culvert opened 75 percent.

Table 4. Salinity criteria (ppt) for restricting saltwater inflows

Season	Months	Monitoring Station				
		C	BC	BS	5R	BN
Growing	Mar. - Aug.	8	4	4	5	2
Non-growing	Sep. - Feb.	10	8	8	7	4

Gate Closure Criteria Summary and Structure Operations. When the salinities reach or exceed any of the salinity criteria specified below (see Table 5), the refuge manager will determine the source of that saltwater. Only those refuge structure(s) determined to be admitting the saltwater will then be operated to preclude further saltwater inflow. During periods of gate closures and all periods when water level safety provisions are not in affect, the refuge manager may use his discretion to configure the flapgates and/or other gates to discharge water as desired. When the salinity levels at the station(s) prompting gate closures fall below the closure criteria, then normal or restricted inflow operations will be resumed depending on area salinities.

Table 5. Salinity criteria (ppt) for halting all saltwater inflows

Season	Months	Monitoring Station				
		C	BC	BS	5R	BN
Growing	Mar. - Aug.	-	6	6	-	3
Non-growing	Sep. - Feb.	-	10	10	-	5

Special Gate Openings for Marine Organism Ingress and Egress. When salinity criteria (Table 5) provide for complete elimination of inflows, short-term special gate openings will be conducted to provide ingress and egress as follows:

- a) **March 1st through April 15th.** During this critical brown shrimp ingress period, one 3-foot-wide gate will be completely open, during incoming tides, at night

- only, for 3 to 6 hours per day, for 3 consecutive nights each week. Those openings should be targeted for post-dusk or pre-dawn periods, to the degree possible.
- b) **May 15th through June 14th**. During this critical brown shrimp egress period, a minimum of one 3-foot-wide gate should be fully opened during outgoing tides, for a 6-8 hour period, once a week. Those openings should be conducted during periods of darkness to the greatest degree possible.
- c) **June 15th through July 31st**. During this critical white shrimp ingress period, one 3-foot-wide gate will be completely open, during incoming tides, at night only, for 3 to 6 hours per day, for 3 consecutive nights each week. Those openings should be targeted for post-dusk or pre-dawn periods, to the degree possible.
- d) **Opening of white shrimp season through Nov. 31st**. During this white shrimp egress period, special openings should be conducted during outgoing tides, in conjunction with the opening of white shrimp season. Following that, openings should be conducted 3 to 4 times a month, and/or associated with the passage of cold fronts.
- e) **September 1st through September 30th**. During this ingress period for red drum, one 3-foot-wide gate will be completely open, during incoming tides, at night only, for 3 to 6 hours per day, for 3 consecutive nights each week. Those openings should be targeted for post-dusk or pre-dawn periods, to the degree possible.

Structure Operations During Periods of High Water Levels. Marsh elevation will be determined and staff gauges installed to provide information on project area water levels (Figure 6). Water level data from those staff gauges and from project area DCP's will be used to trigger special gate openings to facilitate discharge of excess water. Generally, if interior marsh water levels exceed the marsh surface [defined as the surface of the marsh sediment at the base of marsh vegetation at the juncture of the marsh plant shoots and marsh floor (or mud/detritus surface)] by two inches for two weeks, then sluice gates on each flapgated bay will be raised to discharge excess water. Under such conditions, all inflow through non-flapgated bays will be halted until project area water levels are dropping and at or below two inches above marsh level. At that time, normal exchange will be resumed. During periods of normal water levels, the refuge manager, may allow discharge through flapgated bays according to his discretion.

Structure Operations During Tropical Storms. Prior to a storm's approach, flapgated bays may be readied in advance for later discharge of excess water by raising the interior sluice gates of those bays equipped with flapgates. Prior to a storm's approach, refuge personnel may restrict or close non flapgated bays to reduce exposure of interior marshes to saltwater tidal surges. Following a storm, normal or restricted water exchange operations shall be resumed on non-flapgated bays in accordance with the established salinity and water level provisions and criteria.