

Final Phase 2 Design Report

Mississippi River Water Reintroduction Into Bayou Lafourche



Prepared for



March 2006

Prepared by



In association with:
T. Baker Smith, Inc.
FTN Associates, Ltd.
Eustis Engineering Company, Inc.
Jaymac Consultants
C-K Associates, Inc.

Final

Mississippi River Water Reintroduction Into Bayou Lafourche Phase 2 Design Report

Prepared for
Louisiana Department of Natural Resources

March 2006



CH2MHILL

In association with:

T. Baker Smith, Inc.
FTN Associates, Ltd.
Eustis Engineering Company, Inc.
Jaymac Consultants
C-K Associates, Inc.

Executive Summary

This Phase 2 Design Report documents the continued alternatives development for the Mississippi River Water Reintroduction Into Bayou Lafourche project. While issues related to the primary components of the project – pump station, conveyance and dredging – are complex in and of themselves, this effort also included the development of a complex hydrodynamic model to assess wetlands benefits for each alternative reviewed. The projects teams’ task was to analyze the seven remaining alternatives, and recommend a single preferred alternative that most efficiently met overall project objectives – to cost-effectively divert a minimum flow of 1,000 cubic feet per second (cfs) into Bayou Lafourche from the Mississippi River, while minimizing impacts and maximizing benefits. Similar to the approach used in the Phase 1 Design Report, criteria were used to describe and compare the alternatives, and to screen out those that were less effective at meeting project objectives. The evaluative criteria were based on information generated from continued engineering refinement of the alternative project components. Details on this refinement process are documented throughout this report and in the attached set of design drawings in Appendix P. Using quantitative and qualitative criteria, the remaining seven alternatives were evaluated through a comparative screening process that resulted in the selection of a recommended alternative. The comparison criteria included quantitative criteria such as cost, but also benefit quantification in terms of net average annual habitat units. Qualitative criteria addressed more subjective considerations such as, construction impacts, future project expandability and relative maintenance required.

The recommendation to select alternative 38 for continued refinement and engineering through the final design process was made only after an extremely thorough analysis that refined project information from prior evaluations including the Phase 1 Design Report and associated studies and data reports. Additionally, earlier evaluative efforts by others including the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers contributed significantly to the body of knowledge of the Bayou Lafourche project, and served as the foundation upon which the Phase 1 and 2 design efforts were built. Figure ES-1 illustrates the connection between the goals, tasks, and challenges of the project and how and where these challenges were evaluated, from the earlier U.S. Environmental Protection Agency work to this Phase 2 Design Report. The list is not comprehensive, but represents a “road map” of the key challenges and evaluations undertaken over the last several years.

This Phase 2 Design Report presents and documents the engineering and evaluative efforts to recommend a single preferred alternative to cost-effectively meet the goals of the Mississippi River Reintroduction Into Bayou Lafourche project. This effort built on earlier studies and evaluated the impacts, benefits, cost, and engineering requirements for the following major project components and issues:

- Diversion facility design requirements including site evaluation, intake, pump station, discharge and sedimentation control facilities
- Geotechnical evaluation including preliminary foundation recommendations

- Dredging and dredged material reuse
- Water level impacts to bayou-side properties
- Bank stabilization including slope stability and bulkheading requirements
- Impacts to vehicular and railroad bridges, and utilities crossing Bayou Lafourche
- Operation, monitoring and control of water levels during storm and contaminant spill operations
- Hydrodynamic modeling of diverted flows and affects
- Wetlands value assessment
- Alternatives comparison evaluation and screening
- Alternative cost estimating, cost allocation and financial analysis

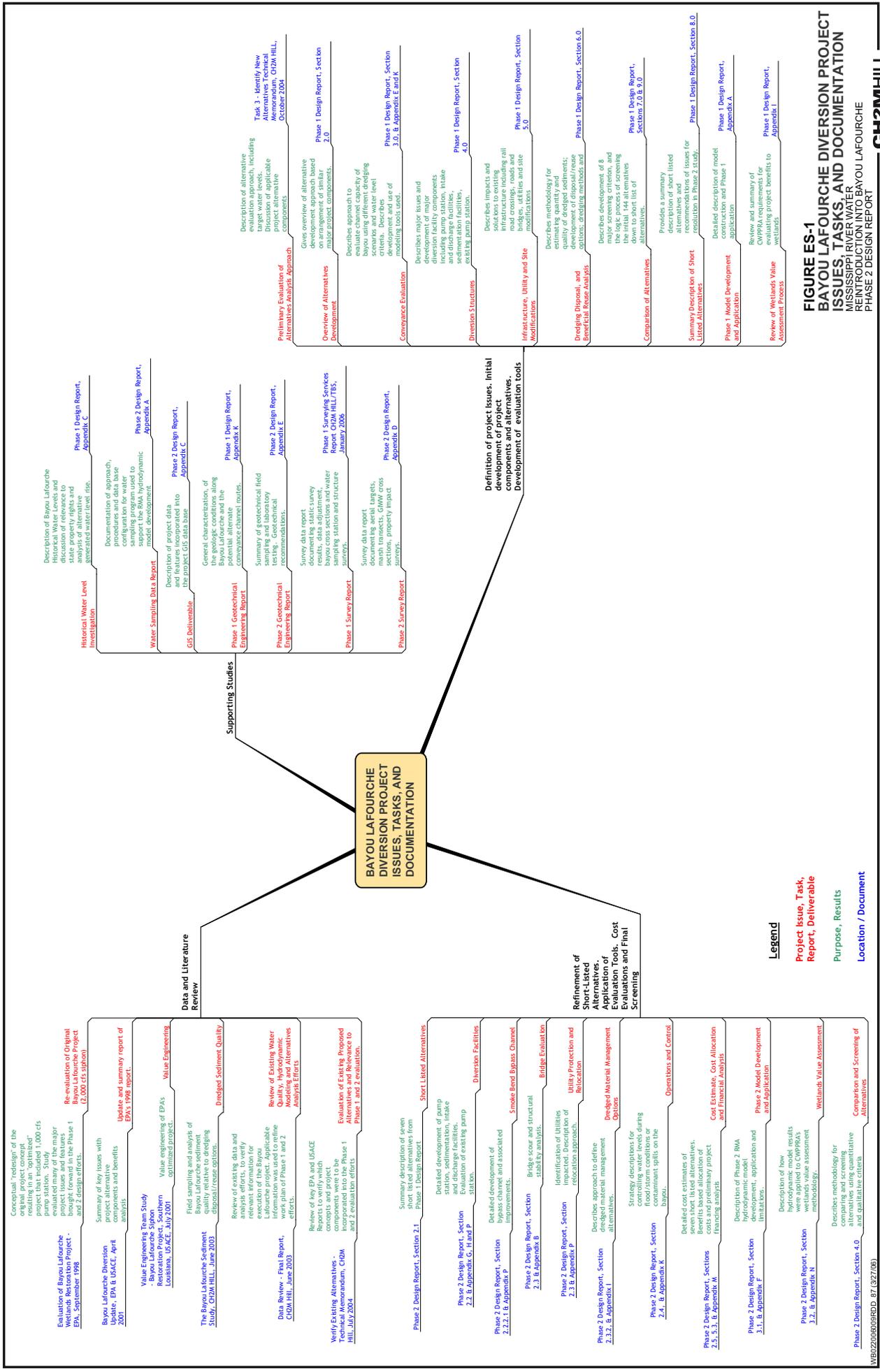
Table ES-1 presents the basic information that describes the recommended alternative 38. As noted in this report, several aspects of this alternative will continue to be refined through the final design process (e.g., the specific dredging plan).

TABLE ES-1
Alternative 38 Summary

Component/Feature	Value
Flow Capacity	
Nominal Diversion Capacity	1,000 cfs
Modeled Flow Capacity	970 cfs
Expandable Capacity	1,500 cfs
New Pump Station Location	Donaldsonville
Dredging	
Dredging Template	2 feet below existing invert from Donaldsonville to RM 29 (2-foot and 0-foot @ RM 29)
Dredging Quantity	2,900,000 cy
Union Pacific Railroad Bridge Status	Bridge replaced to eliminate hydraulic constriction
Bridge Modifications	Bracing required at Highway 998, Highway 403, and Highway 402
Utility Replacements/Relocation	40 assumed, size range 2 to 36 inches
Control Structures	3 – inflatable bladder with steel weir plate
Thibodaux Weir	Demolished
Water Level Rise	Approximately 1 foot to 1.5 feet between Donaldsonville and the Thibodaux weir Approximately 2.5 feet just downstream of the Thibodaux weir and decreases to 1 foot at Lockport.

Notes:

cy = cubic yards
RM = river mile



Contents

	Page
Executive Summary.....	iii
Acronyms and Abbreviations	xiii
Section	
1.0 Introduction.....	1-1
1.1 Background	1-1
1.2 Purpose and Scope of Phase 2 Design Report.....	1-6
1.3 Report Organization	1-7
2.0 Phase 2 Alternatives Development.....	2-1
2.1 Description of Remaining Alternatives.....	2-1
2.1.1 Alternative 15.....	2-2
2.1.2 Alternative 20.....	2-3
2.1.3 Alternative 32.....	2-4
2.1.4 Alternative 38.....	2-4
2.1.5 Alternative 44.....	2-11
2.1.6 Alternative 47.....	2-12
2.1.7 Least Rise Alternative.....	2-17
2.1.8 Grand Bayou Modifications.....	2-17
2.2 Detailed Description of Project Components and Issues.....	2-18
2.2.1 Diversion Facilities	2-18
2.2.2 Conveyance	2-38
2.2.3 Operations and Control.....	2-82
2.3 Estimates of Cost	2-88
2.3.1 Basis of Estimate	2-88
2.3.2 Detailed Cost Estimates.....	2-93
3.0 Modeling of Alternatives and Benefits Assessment	3-1
3.1 Phase 2 Model – Application and Results.....	3-1
3.1.1 Introduction	3-1
3.1.2 Model Description.....	3-1
3.1.3 Model Inputs.....	3-2
3.1.4 Model Testing and Sensitivity	3-2
3.1.5 Model Mesh Modification.....	3-2
3.1.6 Model Calibration and Verification	3-5
3.1.7 Model Application	3-5
3.1.8 Model Limitations and Suggestions for Improvement.....	3-11
3.1.9 Conclusions	3-11
3.2 Wetlands Value Assessment Methodology	3-12
3.2.1 Wetlands Value Assessment Habitat Models and Variables	3-12
3.2.2 Average Annual Habitat Units.....	3-15

Contents, Continued

	Page
3.2.3 RMA Hydrodynamic Model Data.....	3-16
3.2.4 Selection of Benefit Areas	3-16
3.2.5 Nutrient and Sediment Benefits.....	3-23
3.2.6 Salinity Reduction Benefits.....	3-23
3.3 Results.....	3-23
4.0 Comparison and Screening of Alternatives.....	4-1
4.1 Comparison Criteria	4-1
4.1.1 Quantitative Criteria.....	4-1
4.1.2 Qualitative Criteria	4-5
4.2 Alternative Evaluation	4-7
4.2.1 Quantitative Rankings.....	4-7
4.2.2 Qualitative Rankings	4-10
4.3 Preferred Alternative Recommendation.....	4-11
4.3.1 Review of Quantitative and Qualitative Rankings/Screening of Remaining Alternatives	4-11
4.3.2 Selection of Preferred Alternative	4-12
4.3.3 Future Design Refinements to Recommended Alternative	4-12
5.0 Implementation of Recommended Alternative	5-1
5.1 Agency and Public Coordination	5-1
5.1.1 Coastal Wetlands Planning, Protection, and Restoration Act Task Force/U.S. Army Corps of Engineers Coordination	5-1
5.1.2 National Environmental Policy Act Coordination.....	5-1
5.1.3 Permitting	5-2
5.1.4 Real Estate.....	5-2
5.1.5 Public Involvement and Outreach.....	5-3
5.2 Summary of Recommendations.....	5-7
5.2.1 Evaluation and Selection of Dredged Material Reuse Alternative	5-8
5.2.2 Drainage Evaluation.....	5-9
5.2.3 Conveyance Features.....	5-13
5.2.4 Pump Station	5-15
5.3 Funding	5-16
5.4 Schedule	5-16
6.0 References	6-1

Contents, Continued

Page

Appendices

A	Water Sampling Data Report
B	Bridge Evaluation
C	GIS Deliverable
D	Surveying Report
E	Geotechnical Report
F	Hydrodynamic Modeling Report
G	Diversion Facilities and Pump Station Evaluation
H	Pump Station Forebay and Sedimentation Basin Design
I	Dredged Material Management Options
J	Local Drainage Strategy, Planning, and Design Approach
K	Operations Strategy and Maintenance Plan
L	Construction Cost Estimate
M	Cost Allocation and Financial Analysis
N	Wetlands Value Assessment Methodology
O	Specifications List
P	Design Drawings

Tables

2-1	Characteristics of Remaining Alternatives	2-2
2-2	Pump Station Capacities for the Seven Alternatives Selected for Further Analysis in Phase 2.....	2-35
2-3	Permitting and Consultation Requirements.....	2-51
2-4	Bridge Replacement Recommendations	2-65
2-5	Bayou Lafourche Utilities Relocation Data.....	2-71
2-6	Bulkhead Stability Results.....	2-81
3-1	Dredging and Operational Scenarios Modeled.....	3-9
3-2	Analysis of Distribution of Diversion Flows: Percent of Diversion Flows out of Central Terrebonne Basin	3-10
3-3	Analysis of Flows into Barataria Basin.....	3-11
3-4	Total AAHUs for each RMA Model Run Alternative for the Bayou Lafourche Diversion.....	3-24

Contents, Continued

	Page
3-5 Total Benefit Acres for the Bayou Lafourche Diversion – Salinity and Sediment/Nutrient Analysis.....	3-24
4-1 Costs of Alternatives.....	4-7
4-2 AAHU Ranking of Alternatives.....	4-7
4-3 Cost Per Flow Ranking of Alternatives.....	4-8
4-4 Cost Per Benefit Ranking of Alternatives	4-8
4-5 Project Efficiency Ranking of Alternatives.....	4-8
4-6 Water Level Impacts Ranking of Alternatives	4-9
4-7 Summary of Quantitative Values	4-9
4-8 Summary of Quantitative Rankings.....	4-9
4-9 Summary of Qualitative Scoring.....	4-10
4-10 Summary of Qualitative Rankings	4-10
4-11 Summary of Quantitative Rankings.....	4-12
4-12 Summary of Qualitative Rankings	4-12
4-13 Alternative 38 Phase 2 Design Criteria Summary	4-13
5-1 Additional Land Area Inundated and Structures Impacted by Alternative	5-7

Figures

1-1 Project Area.....	1-3
2-1 Water Surface Profile – Alternative 15.....	2-5
2-2 Water Surface Profile – Alternative 20.....	2-7
2-3 Water Surface Profile – Alternative 32.....	2-9
2-4 Water Surface Profile – Alternative 38.....	2-13
2-5 Water Surface Profile – Alternative 44.....	2-15
2-6 Water Surface Profile – Alternative 47.....	2-19
2-7 Water Surface Profile – Least Rise Alternative	2-21
2-8 Pump Station Renderings	2-23

Contents, Continued

	Page
2-9 Pump Station Wet Well	2-25
2-10 Pump Station Mid-Level Deck	2-27
2-11 Pump Station Section	2-29
2-12 Pump Station Main Deck.....	2-31
2-13 Electrical One-Line Diagram.....	2-33
2-14 Pump Station Site Renderings	2-39
2-15 Outlet Structure	2-41
2-16 Smoke Bend Bypass Alignment	2-45
2-17 Smoke Bend Bypass Channel Partial Plan and Typical Section.....	2-47
2-18 Highway 1 Under-Crossing and Bypass Channel Outlet.....	2-49
2-19 Potential Retention Ponds	2-57
2-20 Potential Wetlands	2-59
2-21 Timber Pile Retrofit Strategy	2-63
2-22 Utility Relocation Horizontal Directional Drill.....	2-69
2-23 Bank Stability Analysis Typical Cross Section 2-foot Dredging No Bulkhead.....	2-77
2-24 Bank Stability Analysis Typical Cross Section 2-foot Dredging Plus Bulkhead	2-79
2-25 Control Structure, Planned and Downstream Section View	2-83
2-26 Control Structure Cross-Section View	2-85
2-27 Early Warning Flood and Water Quality Monitoring System	2-89
2-28 SCADA System.....	2-91
2-29 Bayou Lafourche Cost Components	2-95
2-30 Cost Efficiency	2-97
3-1 Final Phase 2 Model Grid	3-3
3-2 Location of Data Collection Stations.....	3-7
3-3 Flow Distributions for Runs 5, 10, 12, and 14.....	3-13
3-4 Potential Areas of Wetlands Benefit for Run 5, using RMA Isohaline Regimes	3-17

Contents, Continued

	Page
3-5 Potential Areas of Wetlands Benefit for Run 10, using RMA Isohaline Regimes	3-19
3-6 Screened, Final Marsh Areas of Benefit by Habitat Type for RMA Run 10.....	3-21
3-7 Terrebonne Basin Nutrient and Sediment Based Benefit Areas.....	3-25
5-1 Typical Dredging Reach Access Corridors.....	5-5
5-2 Water Surface Profile - Alternative 38.....	5-11
5-3 Estimated Traditional Project Delivery Schedule.....	5-17

Acronyms and Abbreviations

1998 Summary Report	<i>Evaluation of Bayou Lafourche Wetlands Restoration Projects: Coastal Wetlands Planning, Protection and Restoration Act Project PBA-20</i>
AAHU	Average Annual Habitat Units
BLFWD	Bayou Lafourche Freshwater District
CEEC	Coastal Engineering and Environmental Consultants, Inc.
cfs	cubic foot/feet per second
CWA	Clean Water Act
CWPPRA	Coastal Wetlands Planning, Protection, and Restoration Act
cy	cubic yards
E&D	engineering and design
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
fps	foot/feet per second
FW	future-with-project
FWO	future-without-project
GIS	geographic information system
GIWW	Gulf Intracoastal Waterway
H:V	horizontal:vertical
HDD	horizontal directional drilling
HNC	Houma Navigation Canal
HSI	Habitat Suitability Index
HU	Habitat Units
LDEQ	Louisiana Department of Environmental Quality
LDNR	Louisiana Department of Natural Resources
LDNR-CMD	Coastal Management Division of the Louisiana Department of Natural Resources
LDOTD	Louisiana Department of Transportation and Development

mcy	million cubic yards
mm	millimeter
MP	mile post
NEPA	National Environmental Policy Act
ppt	parts per thousand
psf	pounds per square foot
psi	pounds per square inch
RM	river mile
ROW	right-of-way
SCADA	supervisory control and data acquisition
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WRDA	Water Resources Development Act
WVA	Wetlands Value Assessment

Introduction

The Task Force for the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) approved Phase 1 Engineering and Design (E&D) for the Mississippi River Water Reintroduction into Bayou Lafourche project in 2001. Funding for the effort came equally between CWPPRA and the State of Louisiana. The U.S. Environmental Protection Agency (EPA) is leading the task force agency and the Louisiana Department of Natural Resources (LDNR) is leading this initial phase of the project.

In November 2005, the first portion of Phase 1 E&D was presented in the Final Phase 1 Design Report. The Phase 1 report documented the alternatives assessment and the resulting seven alternatives to be taken into the next phase of evaluation, to selection of a preferred alternative. This second portion of the E&D evaluation, represented by this report, is referred to as Phase 2. After completion of Phase 2, the selected alternative will move into final design and efforts will be undertaken with the CWPPRA Task Force and state to secure willing cost-share partners to construct the project.

This Phase 2 Design Report is the foundation document for making the decision to move forward with final design. It contains further refinement of the alternatives that were brought forward from Phase 1 and the resulting recommended preferred alternative.

1.1 Background

Bayou Lafourche was cut off from the flow of the Mississippi River at Donaldsonville, Louisiana, in 1903 by a dam and subsequent levee improvements. Historically, the river counteracted subsidence in the area by introducing freshwater, sediments, and nutrients. Without the supply from Bayou Lafourche, adjacent marshes were cut off from one of the major distributaries in the area. In addition, numerous oil field canals, the Gulf Intracoastal Waterway (GIWW), and the Houma Navigation Canal (HNC) have altered the natural hydrology of the area. These alterations affected the freshwater flows to area marshes, and saltwater intrusion impacted drinking water quality. The bayou was partially reconnected to the river in the 1950s with the installation of a pump/siphon station that supplies an average of approximately 200 cubic feet per second (cfs) for consumption and water quality maintenance. The project area is shown on Figure 1-1.

A conceptual project was identified in the *Louisiana Coastal Wetlands Restoration Plan* (CWPPRA, 1993) to divert larger quantities of freshwater down Bayou Lafourche to benefit the marshes of the Terrebonne and Barataria Basins. In 1995, EPA and the Bayou Lafourche Freshwater District (BLFWD) developed a more specific proposal, which was selected for inclusion in the CWPPRA Fifth Priority List. This project, designated PBA-20, was further refined through additional evaluations initiated by EPA in 1996.

The original project proposed the diversion of 2,000 cfs of water from the Mississippi River into Bayou Lafourche at Donaldsonville to promote environmental benefits and meet the needs of downstream freshwater supply withdrawals. The original concept was that the

2,000 cfs would be diverted via siphons, and only operated during periods when the difference between river and bayou stage was to create a siphon (January to June in normal water years). Outside the siphon operation period, diversions would be reduced to those quantities that could be supplied using the existing pump station.

The original project met with substantial public resistance, primarily because of concerns over the negative impacts of increased water levels. The water levels rise would primarily affect bank stability and drainage on residential properties adjacent to the bayou. No provision was included in the original project to address property inundation or drainage issues. Because of the anticipated increase in costs to address property and legal issues, the CWPPRA Task Force sought to develop alternatives that would limit the impacts to bayou property owners and regional drainage.

In April 1997, Coastal Engineering and Environmental Consultants, Inc. (CEEC), conducted an alternatives analysis to increase the conveyance capacity of Bayou Lafourche to accommodate the 2,000 cfs without raising water levels above a reference water surface profile. CEEC performed preliminary analyses on the following two alternatives:

- The first alternative was to increase the conveyance capacity by dredging the bayou from Donaldsonville to Thibodaux to a greater extent than was originally proposed. Deployable weirs and extensive bulkheading were included in this alternative to maintain water levels in the bayou when the siphons were not in operation.
- The second alternative included the introduction of freshwater into Bayou Lafourche by additional drainage from marshes on the eastern side of the bayou.

Subsequent to the original project goals and the resulting public concerns, EPA conducted a conceptual redesign of the proposal and additional alternatives were evaluated. The outcome of this process was the selection of a new project alternative in 1998 based on expected impacts, benefits, and cost-effectiveness in the *Evaluation of Bayou Lafourche Wetlands Restoration Projects: Coastal Wetlands Planning Protection and Restoration Act Project PBA-20* (1998 Summary Report) (EPA, 1998).

Results of the conceptual redesign of the Bayou Lafourche diversion project are presented in the 1998 Summary Report. The 1998 Summary Report evaluated the original PBA-20 project alternatives and several other alternatives. In contrast to the original project, the following three features were consistently identified in the alternatives considered:

- Additional pumping capacity was included to provide consistent flows year-round and to maximize freshwater supplies, particularly in the fall when salinity problems are greatest.
- All alternatives were reduced in overall size to reduce impacts and costs (for example, total Mississippi River diversion reduced to 1,000 cfs or less).
- Alternatives incorporated channel improvements and management structures to minimize or control potential adverse effects on water levels in the bayou and bank stability.

As part of the evaluation, EPA developed a specific project concept referred to as the “optimized project.” The optimized project is a 1,000 cfs diversion project that incorporated the features listed above. This project was the focal point of the alternatives that were evaluated. Features, costs, benefits, and impacts were developed to the greatest degree for the optimized project, but remained conceptual in nature. Other project “alternatives” evaluated were primarily modifications of the optimized project, including value engineering revisions to parts of this project (e.g., vinyl sheet piling as opposed to steel sheet piling).

Lingering uncertainties related to project costs and benefits resulted in the project being deferred. In October 2001, the State of Louisiana committed to share the cost of the Phase 1 E&D effort equally with CWPPRA. In agreeing to accept the state’s proposal, CWPPRA requested that an allocation of costs be calculated for any forthcoming recommended alternative and proposed project benefit areas take into consideration operation of other diversion projects (i.e., Davis Pond).

In October 2001, the Breaux Act Task Force agreed to proceed with Phase 1 E&D for the Bayou Lafourche Project, subject to, among others, the following stipulations:

The 30 percent design review will address the costs and benefits of alternative means of achieving the wetland conservation goal of the Bayou Lafourche project via additional Mississippi River flows.

The design report will include the following updated estimates of costs and benefits of the project and alternative designs and approaches for accomplishing the project conservation goals:

- An assessment of the effects of existing and planned water control and freshwater diversion projects in the basin on the benefits of the Bayou Lafourche Project.
- Allocation of costs between beneficiaries.

In December 2005, the project purpose was modified as follows:

The purpose of the project is to nourish and protect the marshes of the Barataria and Terrebonne Basins through the reintroduction of freshwater, sediments, and nutrients from the Mississippi River. The proposed project has the added benefits of ensuring long-term freshwater supply to the communities and industries served by the Lafourche Freshwater District, by limiting saltwater intrusion and enhancing water supply.

The overall environmental goal of the project is to introduce more Mississippi River water into Bayou Lafourche to benefit coastal marshes in the bayou’s historical overflow area. The project’s targeted marshes are south of Thibodaux in Lake Fields and Lake Long (both fed by Company Canal), Grand Bayou, Bayou Terrebonne, HNC, Delta Farms, and Bayous Perot and Rigolets areas.

In the first major evaluation, Phase 1 alternatives were systematically screened, both qualitatively and quantitatively, and presented in the Phase 1 Design Report for state and EPA review. Following their guidance, seven project alternatives were carried into the Phase 2 design.

In Phase 2, comparison criteria were developed to facilitate a side-by-side comparison and ranking of certain attributes in support of selecting a preferred alternative. As in Phase 1, both qualitative and quantitative criteria were used in the selection process. For example, quantitative criteria were developed for those attributes that could be defined numerically, such as the following:

- Construction costs
- Benefits to wetlands
- Cost effectiveness
- Project efficiency
- Water level impacts

Qualitative criteria were more subjective in nature and associated with long- and short-term benefits, impacts, and public perception. These criteria included consideration of the following:

- Maintenance of project alternatives
- Impacts to the public from construction activities
- Impacts to residents and overall project costs from the magnitude of project dredging
- Flexibility to expand an alternative in the future to accommodate greater flow volumes
- Potential to provide better stormwater control and management
- Diversion flow magnitude for future restoration efforts
- Permitting, right-of-way (ROW), and environmental difficulties associated with each alternative

Quantitative and qualitative criteria were used to evaluate the alternatives so that the preferred alternative would be a high value, effective solution. By applying these criteria and ranking the remaining alternatives, a recommended preferred alternative was selected at the completion of Phase 2 design.

1.2 Purpose and Scope of Phase 2 Design Report

The Phase 2 Design Report presents the final alternatives analysis and recommended preferred alternative for consideration by the CWPPRA Task Force and the State of Louisiana in determining whether to proceed with final design and how to do it cost effectively.

This report documents the Phase 2 evaluation of alternatives and recommendation of a preferred alternative to take into final design for the Mississippi River Water Reintroduction into Bayou Lafourche project. The project was organized into the following five major tasks:

- Task 1: Project Initiation and Management
- Task 2: Collect, Inventory, and Review Existing Data and Current Conditions
- Task 3: Formulate Viable Alternative Plans
- Task 4: Alternatives Investigation/Development
- Task 5: Final Alternatives Analysis

This report and its associated appendices also document the completion of the following subtasks under Task 4 and Task 5:

- Task 4.2: Water Sampling
- Task 4.3: Bridge Evaluation
- Task 4.4: Mapping/Geographic Information System (GIS) Development
- Task 4.5: Phase 2 Design Evaluation
- Task 4.6: Quality Assurance/Quality Control (for Tasks 4.2, 4.3, 4.4, and 4.5)
- Task 5.1: Benefit Quantification
- Task 5.2: Wetlands Benefits Analysis
- Task 5.3: Final Alternatives Screening
- Task 5.4: Recommend Alternative for Final Design
- Task 5.5: Prepare Final Report

1.3 Report Organization

This Phase 2 Design Report provides an analysis of the remaining alternatives under consideration at the end of Phase 1 and the recommended preferred alternative. The report is organized into the following sections and supporting appendices:

- Section 1 – Introduction
- Section 2 – Phase 2 Alternatives Development
- Section 3 – Modeling of Alternatives and Benefits Assessment
- Section 4 – Comparison and Screening of Alternatives
- Section 5 – Implementation of Recommended Alternative
- Section 6 – References
- Appendix A – Water Sampling Data Report
- Appendix B – Bridge Evaluation
- Appendix C – GIS Deliverable
- Appendix D – Surveying Report
- Appendix E – Geotechnical Report
- Appendix F – Hydrodynamic Modeling Report
- Appendix G – Diversion Facilities and Pump Station Evaluation
- Appendix H – Pump Station Forebay and Sedimentation Basin Design
- Appendix I – Dredged Material Management Options
- Appendix J – Local Drainage Strategy, Planning, and Design Approach
- Appendix K – Operations Strategy and Maintenance Plan
- Appendix L – Construction Cost Estimate
- Appendix M – Cost Allocation and Financial Analysis
- Appendix N – Wetland Value Assessment Methodology
- Appendix O – Specifications List
- Appendix P – Design Drawings

Phase 2 Alternatives Development

Phase 1 resulted in seven alternatives, which were carried into the Phase 2 design effort. Each of these alternatives included specific features of the project that were common to every alternative. The features varied in size, length, capacity, and location based on the alternative makeup. The alternatives included a combination of attributes for water level rise, diversion capacity, and dredging quantity and location that separated the seven potential projects and influenced both cost and benefits.

The primary goals of Phase 2 were to develop the alternative features to a higher level of engineering, to prepare a more detailed cost estimate, and to compare the alternative costs with the associated benefits. The following major project features were refined for each of the seven remaining alternatives:

- Conveyance channel dredging and dredged material management
- Pump station and intake forebay
- Sedimentation basins
- Control structures
- Bridge bracing and replacement
- Utility relocation
- Bulkheads
- Smoke Bend bypass channel

The following descriptions outline the major project components and characteristics of the seven remaining alternatives evaluated in Phase 2.

2.1 Description of Remaining Alternatives

Each of the seven alternatives remaining from Phase 1 can be described in terms of project attributes such as alignment, diversion capacity, dredging template, and approximate water level rise. In the Phase 2 design, the project features were further investigated and refined to greater detail to better estimate the costs of each alternative. The Design Drawings (Volume of 8 of this Phase 2 Design Report) present specific features of each of the alternatives. Drawing G-3, Index To Drawings By Alternative, indicates which design features and associated drawings are included for each of the alternatives in Phase 2.

Table 2-1 provides an overview of some of the main features of the project alternatives. Additionally, features, pros, and cons (irrespective of detailed costs) are summarized in the subsections following the table.

TABLE 2-1
 Characteristics of Remaining Alternatives

Alternative Number	Alignment/ Pump Station Location	Diversion Flow Capacity (cfs)	UPRR Bridge	Water Level Rise (feet) Donaldsonville	Water Level Rise (feet) Thibodaux	Dredging Template and Quantity (mcy)
15	Donaldsonville	1,000	No Replacement	1.5 to 3.0	1.0 to 3.0	2-foot and 0-foot @ RM 29 (2.9)
20	Donaldsonville	1,000	Replacement	<1.0	1.0 to 2.0	2-foot All (4.8)
32	Donaldsonville	1,500	Replacement	1.0 to 1.5	1.0 to 2.5	8-foot and 2-foot @ RM 29 (6.7)
38	Donaldsonville	1,000	Replacement	1.0 to 1.5	1.0 to 2.5	2-foot and 0-foot @ RM 29 (2.9)
Least Rise	Donaldsonville	1,000	Replacement	No Rise	1.0 to 1.5	8-foot All (8.6)
44	Smoke Bend	1,500	No Replacement	1.0 to 1.5	1.5 to 2.5	2-foot All (4.6)
47	Smoke Bend	2,000	No Replacement	1.0 to 1.5	1.5 to 2.5	8-foot All (8.2)

Notes:

In all of the Phase 2 alternatives, the Thibodaux weir would be removed.

mcy = million cubic yards

UPRR = Union Pacific Railroad

RM = river mile

2.1.1 Alternative 15

Alternative 15 uses the Donaldsonville diversion site and alignment with the following project features:

- A new pump station at Donaldsonville with a capacity of 1,000 cfs.
- 2-foot of dredging from Donaldsonville to mile post (MP) 29 (5 miles upstream of the Thibodaux weir). No dredging downstream of MP 29.
- Dredging quantity of 2.9 mcy.
- No replacement of the UPRR Bridge.
- Water level control structures near the Palo Alto Bridge, in Napoleonville, and in Thibodaux (three structures total).
- Water level rise is approximately 3 feet upstream of UPRR Bridge, and between 0.5 foot and 1.5 feet from the UPRR Bridge to the Thibodaux weir.

- Water level rise is approximately 3 feet just downstream of the Thibodaux weir and decreases to 1 foot at Lockport.
- No bridges have been identified for replacement.

The positive attributes of this alternative include the following:

- Least amount of dredging required (cost savings, less construction impact on public)
- UPRR Bridge not removed (cost savings, less construction impact on public)

The shortcomings of this alternative include the following:

- The highest water level rise of all seven remaining alternatives

Figure 2-1 presents the water surface profile for alternative 15, compared with the existing water surface elevations, from Donaldsonville to Lockport.

2.1.2 Alternative 20

Alternative 20 uses the Donaldsonville diversion site and alignment with the following project features:

- A new pump station at Donaldsonville with a capacity of 1,000 cfs.
- 2 feet of dredging, continuous, from Donaldsonville to Lockport.
- Dredging quantity of approximately 4.8 mcy.
- Replace the UPRR Bridge.
- Water level control structures near the Palo Alto Bridge, in Napoleonville, and in Thibodaux (three structures total).
- Water level rise is less than 1 foot between Donaldsonville and the Thibodaux weir.
- Water level rise is approximately 2 feet just downstream of the Thibodaux weir and decreases to 1 foot at Lockport.
- No bridges have been identified for replacement.

The positive attributes of this alternative include the following:

- Low water level rise relative to remaining alternatives considered
- A medium amount of dredging is required

The shortcomings of this alternative include the following:

- More dredging than other alternatives (more expense and construction impacts)
- Replacement of UPRR Bridge required (cost and construction impacts)

Figure 2-2 presents the water surface profile for alternative 20, compared with the existing water surface elevations, from Donaldsonville to Lockport.

2.1.3 Alternative 32

Alternative 32 uses the Donaldsonville diversion site and alignment with the following project features:

- A new pump station at Donaldsonville with a capacity of approximately 1,500 cfs.
- 8 feet of dredging from Donaldsonville to MP 29 (5 miles upstream of the Thibodaux weir), and 2 feet of dredging from MP 29 to Lockport.
- Dredging quantity of approximately 6.7 mcy.
- Replace the UPRR Bridge.
- Water level control structures near the Palo Alto Bridge, in Napoleonville, and in Thibodaux (three structures total).
- Water level rise is approximately 1 foot to 1.5 feet between Donaldsonville and the Thibodaux weir.
- Water level rise is approximately 2.5 feet just downstream of the Thibodaux weir and decreases to 1 foot at Lockport.
- Four bridges have been identified for replacement.

The positive attributes of this alternative include the following:

- A higher diversion flow of 1,500 cfs
- Deeper dredging through RM 29 for increased stormwater management flexibility
- A medium level of water level rise relative to the seven remaining alternative considered

The shortcomings of this alternative include the following:

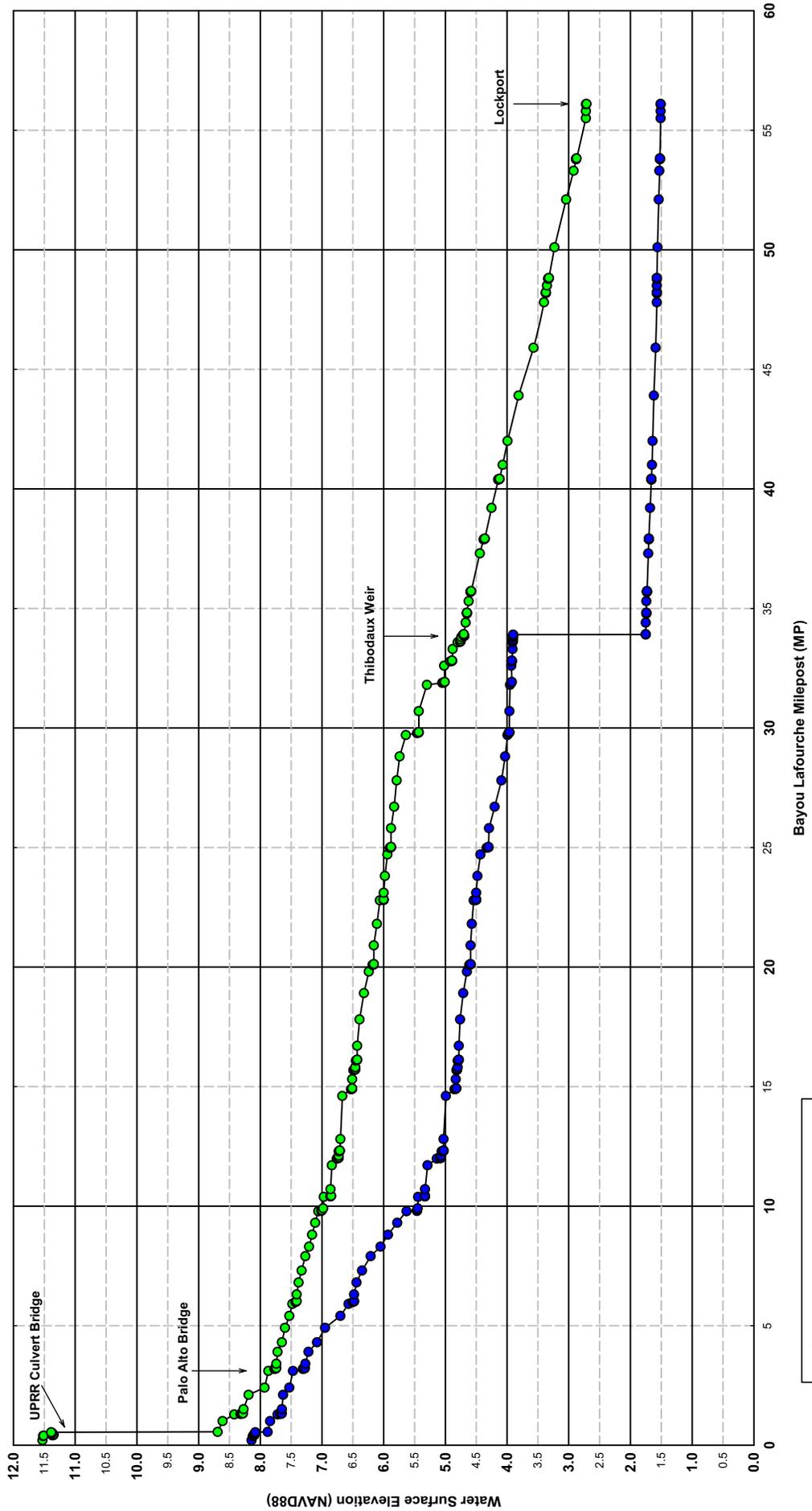
- More dredging than other alternatives (more expense and construction impacts)
- Replacement of UPRR Bridge required (more expense and construction impacts)
- Multiple bridges require replacement/bracing

Figure 2-3 presents the water surface profile for alternative 32, compared with the existing water surface elevations, from Donaldsonville to Lockport.

2.1.4 Alternative 38

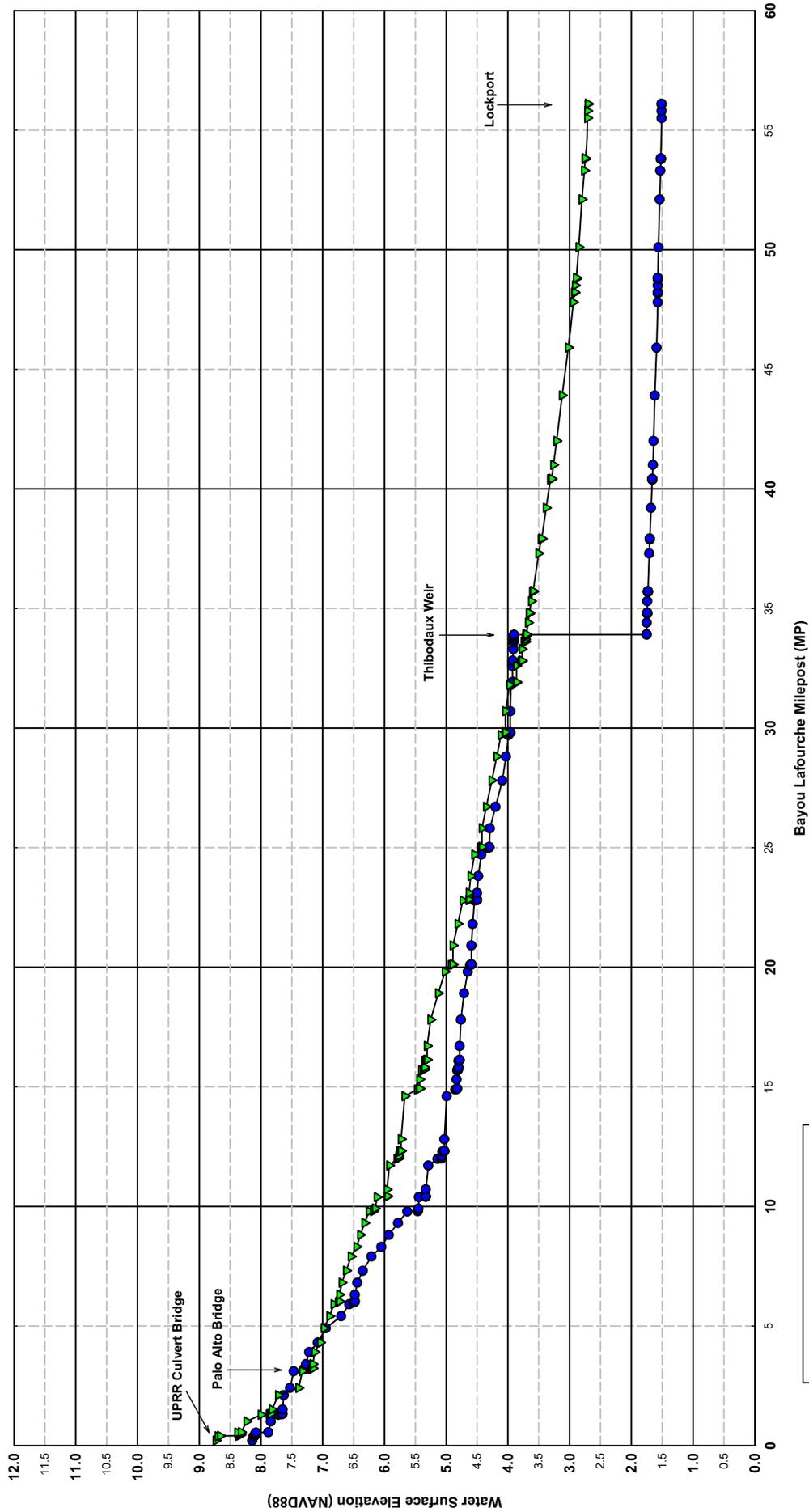
Alternative 38 uses the Donaldsonville diversion site and alignment with the following project features:

- A new pump station at Donaldsonville with a capacity of approximately 1,000 cfs.
- 2 feet of dredging from Donaldsonville to MP 29 (5 miles upstream of the Thibodaux weir). No dredging downstream of MP 29.
- Dredging quantity of approximately 2.9 mcy.



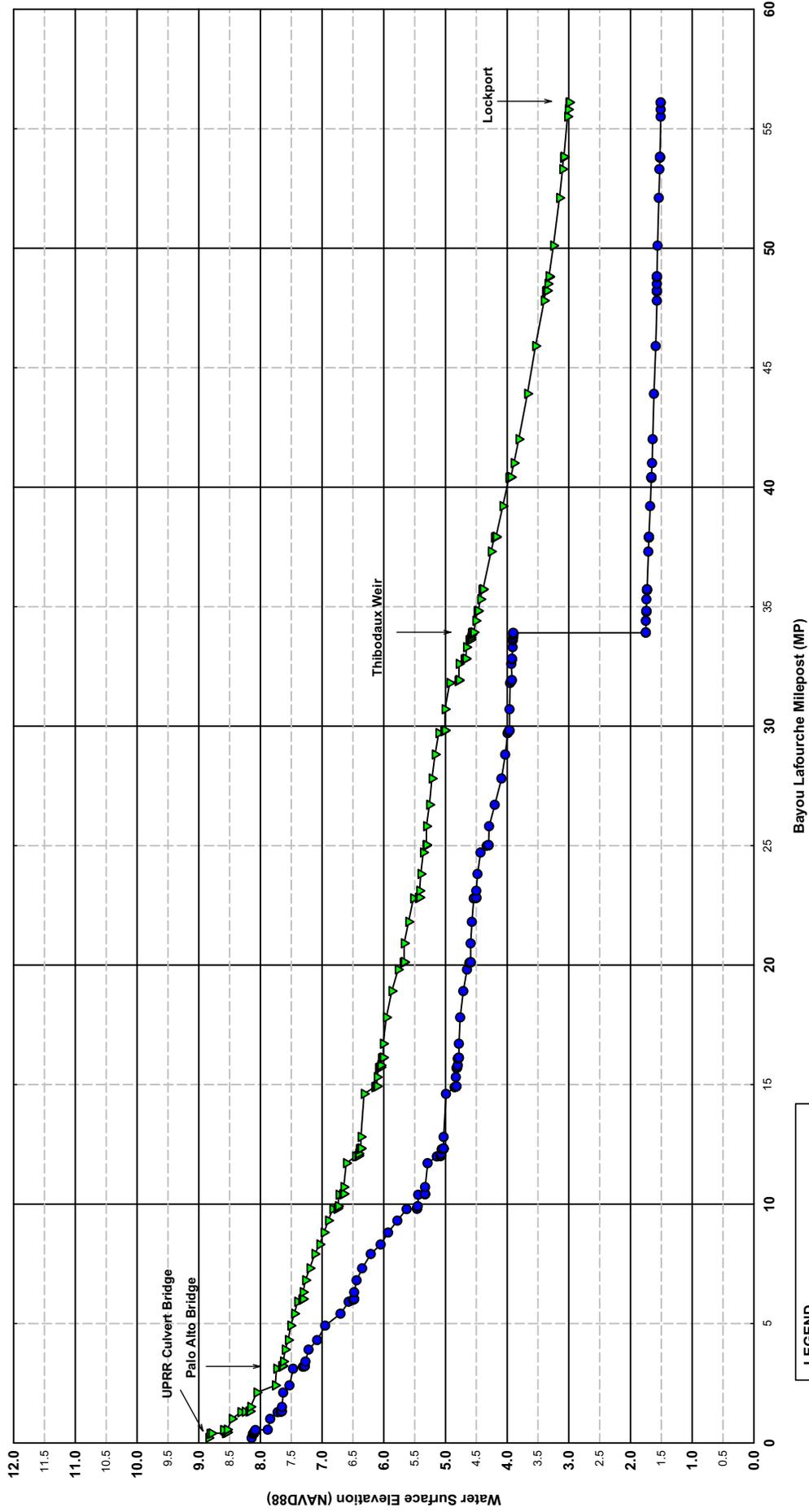
LEGEND
 ● EXISTING
 ● ALTERN. #15, 2'-0" RM29, 1,025 cfs

FIGURE 2-1
WATER SURFACE PROFILE -
ALTERNATIVE 15
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



LEGEND
 ● EXISTING
 ▲ ALTERN. #20, 2'- ALL, 1,020 cfs

FIGURE 2-2
WATER SURFACE PROFILE -
ALTERNATIVE 20
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



LEGEND
 ● EXISTING
 ▲ ALTERN. #32, 8'-2' RM29,1,530 cfs

FIGURE 2-3
WATER SURFACE PROFILE -
ALTERNATIVE 32
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

- Replace the UPRR Bridge.
- Water level control structures near the Palo Alto Bridge, in Napoleonville, and in Thibodaux (three structures total).
- Water level rise is approximately 1 to 1.5 feet between Donaldsonville and the Thibodaux weir.
- Water level rise is approximately 2.5 feet just downstream of the Thibodaux weir and decreases to 1 foot at Lockport.
- No bridges have been identified for replacement.

The positive attributes of this alternative include the following:

- A low amount of dredging required
- A medium level of water level rise relative to the seven remaining alternative considered

The shortcomings of this alternative include the following:

- Replacement of UPRR Bridge required (more expense and construction impacts)

Figure 2-4 presents the water surface profile for alternative 38, compared with the existing water surface elevations, from Donaldsonville to Lockport.

2.1.5 Alternative 44

Alternative 44 uses the Smoke Bend diversion site and the bypass channel alignment with the following project features:

- A new pump station at Smoke Bend with a capacity of approximately 1,500 cfs.
- 2 feet of dredging, continuous, from Donaldsonville to Lockport.
- Dredging quantity of approximately 4.6 mcy.
- No replacement of the UPRR Bridge.
- Bypass channel, cross-drainage facilities, and Highway 1 undercrossing.
- Water level control structures near the Palo Alto Bridge, in Napoleonville, and in Thibodaux (three structures total).
- Water level rise is approximately 1 to 1.5 feet between Donaldsonville and the Thibodaux weir.
- Water level rise is approximately 2.5 feet just downstream of the Thibodaux weir and decreases to 1.5 feet at Lockport.
- No bridges have been identified for replacement.

The positive attributes of this alternative include the following:

- A higher diversion flow of 1,500 cfs
- Future expandability to 2,000 cfs

- Construction of diversion facilities outside of Donaldsonville (less construction impacts)
- UPRR Bridge not removed (cost savings, less construction impact on public)
- A medium level of water level rise relative to the seven remaining alternative considered

The shortcomings of this alternative include the following:

- Land acquisition required for Smoke Bend diversion facilities and bypass channel

Figure 2-5 presents the water surface profile for alternative 44, compared with the existing water surface elevations, from Donaldsonville to Lockport.

2.1.6 Alternative 47

Alternative 47 uses the Smoke Bend diversion site and the bypass channel alignment with the following project features:

- A new pump station at Smoke Bend with a capacity of approximately 2,000 cfs.
- 8 feet dredging, continuous, from Donaldsonville to Lockport.
- Dredging quantity of approximately 8.2 mcy.
- No replacement of the UPRR Bridge.
- Bypass channel, cross-drainage facilities, and Highway 1 undercrossing.
- Water level control structures near the Palo Alto Bridge, in Napoleonville, and in Thibodaux (three structures total).
- Water level rise is approximately 1 to 1.5 feet between Donaldsonville and the Thibodaux weir.
- Water level rise is approximately 2.5 feet just downstream of the Thibodaux weir and decreases to 1.5 feet at Lockport.
- Seven bridges have been identified for replacement.

The positive attributes of this alternative include the following:

- Highest diversion capacity of all seven alternatives considered
- Construction of diversion structures outside of Donaldsonville (less construction impacts)
- UPRR Bridge not removed (cost savings, less construction impact on public)
- A medium level of water level rise relative to the seven remaining alternative considered

The shortcomings of this alternative include the following:

- High volume of dredging required (more expense and construction impacts)
- Multiple bridges require replacement/bracing

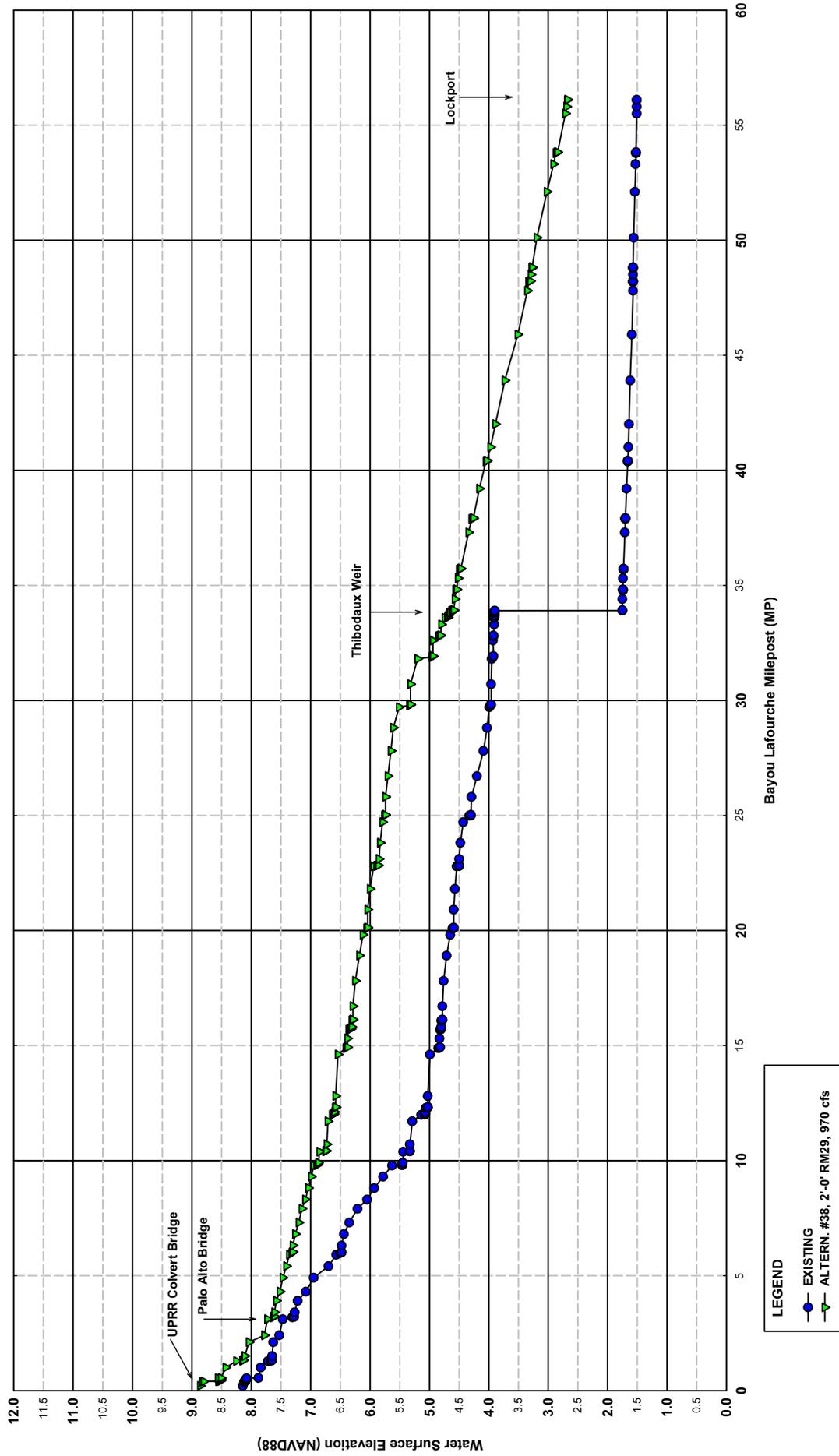
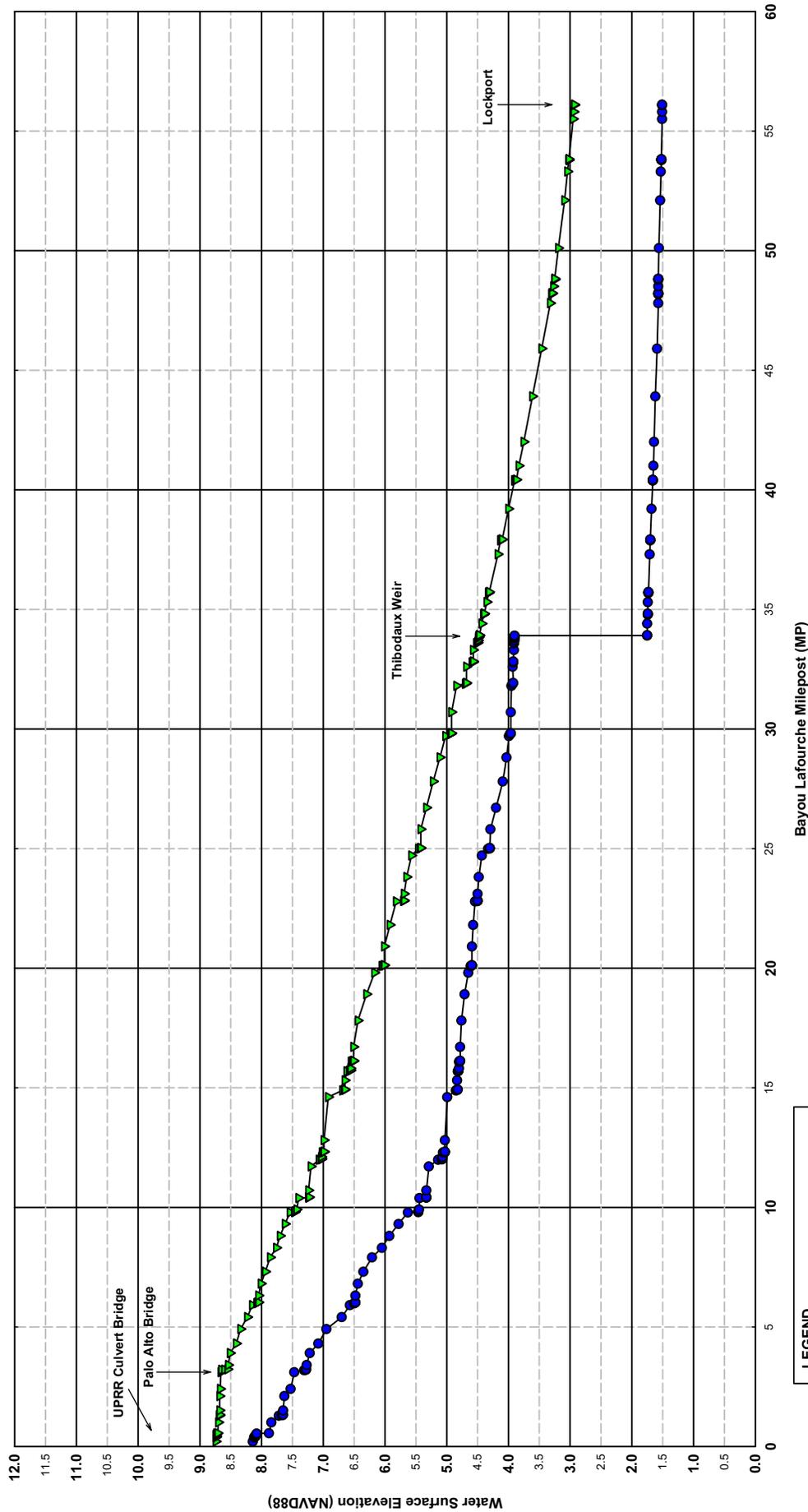


FIGURE 2-4
WATER SURFACE PROFILE -
ALTERNATIVE 38
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



LEGEND
 ● EXISTING
 ▲ ALTERN. #44, 2'-All' 1,400 cfs

FIGURE 2-5
WATER SURFACE PROFILE -
ALTERNATIVE 44
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

Figure 2-6 presents the water surface profile for alternative 47, compared with the existing water surface elevations, from Donaldsonville to Lockport.

2.1.7 Least Rise Alternative

The Least Rise alternative uses the Donaldsonville diversion site and alignment with the following project features:

- A new pump station at Donaldsonville with a capacity of approximately 1,000 cfs.
- 8 feet of dredging continuous from Donaldsonville to Lockport.
- Dredging quantity of approximately 8.6 mcy.
- Replace the UPRR Bridge.
- Water level control structures near the Palo Alto Bridge, in Napoleonville, and in Thibodaux (three structures total).
- Water levels would need to be increased to maintain at existing levels between Donaldsonville and the Thibodaux weir by using the control structures.
- Water level rise is approximately 1.5 feet just downstream of the Thibodaux weir and decreases to 1 foot at Lockport.
- Seven bridges have been identified for replacement.

The positive attributes of this alternative include the following:

- Least water surface rise relative to seven alternatives considered
- Maximum level of dredging allows for increased stormwater management flexibility

The shortcomings of this alternative include the following:

- Replacement of UPRR Bridge required (more expense and construction impacts)
- High volume of dredging required (more expense and construction impacts)
- Multiple bridges require replacement/bracing

Figure 2-7 presents the water surface profile for the Least Rise alternative, compared with the existing water surface elevations, from Donaldsonville to Lockport.

2.1.8 Grand Bayou Modifications

It was realized early in the hydrodynamic modeling process that much of the introduced flow from the diversion alternatives was being captured by the GIWW, providing substantial benefits to the Barataria Basin, but less so to the Terrebonne Basin. To capture more benefits for Terrebonne, so-called “outfall management” techniques were investigated to promote beneficial freshwater flow into areas of need. The proposed CWPPRA project, Grand Bayou Hydrologic Restoration (TE-10) had identified high-value marsh suffering from high salinities, and in need of additional freshwater input. The project team, therefore, investigated increasing the size and capacity of the connection between the GIWW and Grand Bayou with the intent of capturing some of the diversion water flowing east in the GIWW. In the hydrodynamic model, the northern end of Grand Bayou was widened to

350 feet, for approximately 1.1 miles. Model run simulations were added to test the value of this modified geometry for several of the diversion alternative scenarios. Details of this analysis can be found in Appendices F and N of this report.

Modifications to the Grand Bayou channel geometry resulted in additional benefits to this area. However, these modifications were not formally included as a specific component of the base diversion alternatives. Once the preferred alternative is selected, decisions on the addition of several potential outfall management scenarios can be finalized.

2.2 Detailed Description of Project Components and Issues

2.2.1 Diversion Facilities

2.2.1.1 Pump Station

General Pump Station Description. The general pump station configuration is depicted in Figure 2-8. The pump station would be a concrete structure with individual wet wells for each main pump as shown in Figures 2-9, 2-10, and 2-11. The number of pumps and pump wet wells would depend on the selected alternative. The pumps would be installed in individual wet wells as recommended by the Hydraulic Institute. Each pump would have its own discharge pipe routed from the pump station to the outlet structure at the head of the bayou or bypass channel.

The motors would be located on the main deck with the pump discharge piping below the main deck as shown in Figure 2-12. Access hatches in the main deck provide entrance to a mid-level deck for assembly/ disassembly of the pump discharge coupling at each pump.

The control building for the pump station is located on the main deck and houses the pump station control room, electrical room, office, rest room and equipment room. A bridge crane above the main deck is provided for maintenance of equipment. The main deck, motors, control building, electrical equipment, and discharge piping are located above the top of levee elevation to provide flood protection.

Auxiliary equipment for the pump station consists of the discharge piping fill pumps; the vacuum priming pumps; the sewage ejector pumps; and heating, ventilating, and air conditioning. A smaller utility bay for the discharge piping fill pumps is provided at one end of the pump station.

The electrical supply for the main pump motors would be 4,160 volt, three phase, 60 Hertz, and would be supplied by the local utility, Entergy Power Company. A typical schematic one-line diagram is depicted in Figure 2-13. A utility substation would be located on the land side of the levee to transform the power from the utility voltage down to the pump station supply of 4,160 volts. A 4,160- to 480-volt transformer for auxiliary equipment and other uses at the pump station would be located on the main deck.

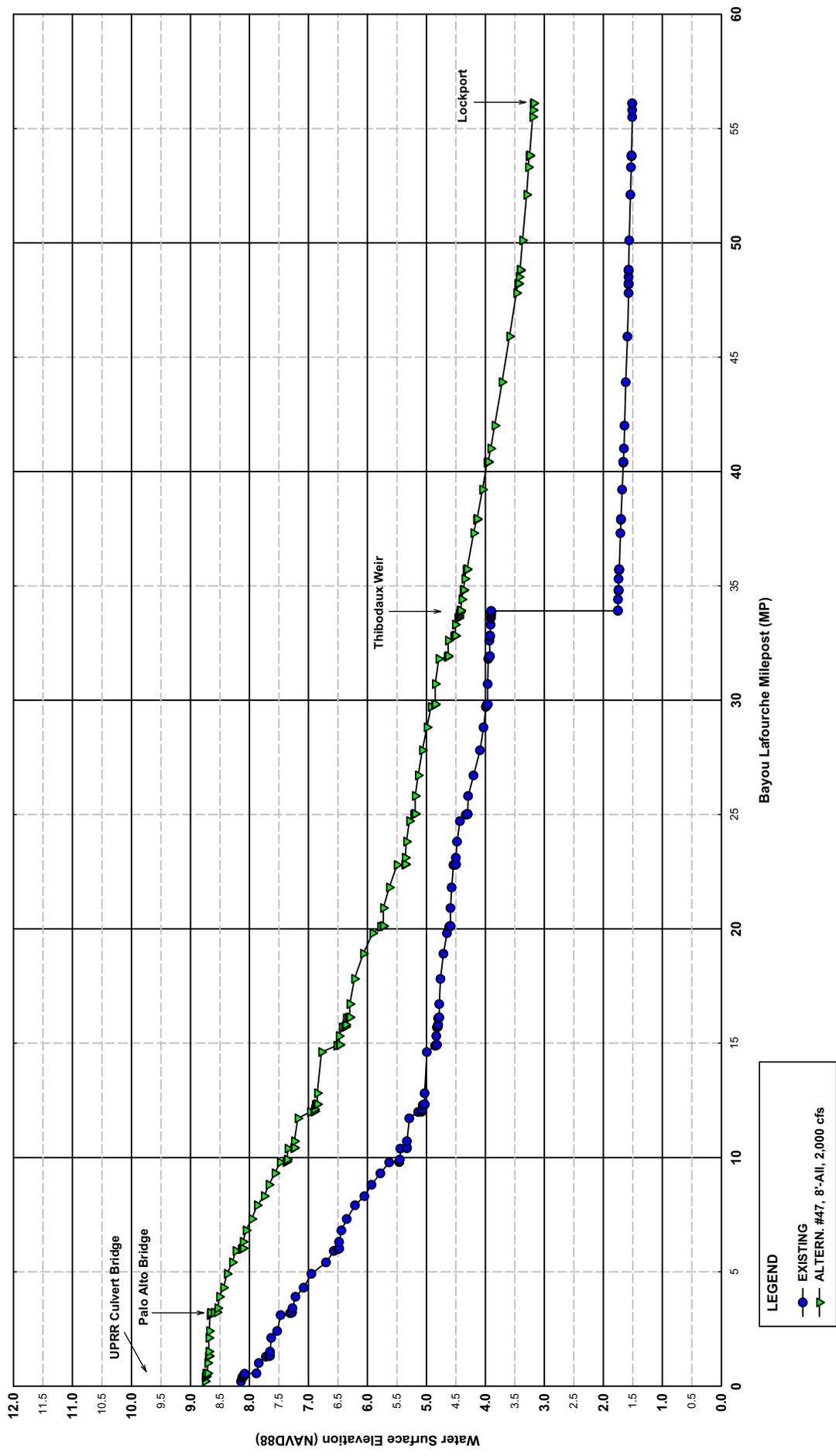
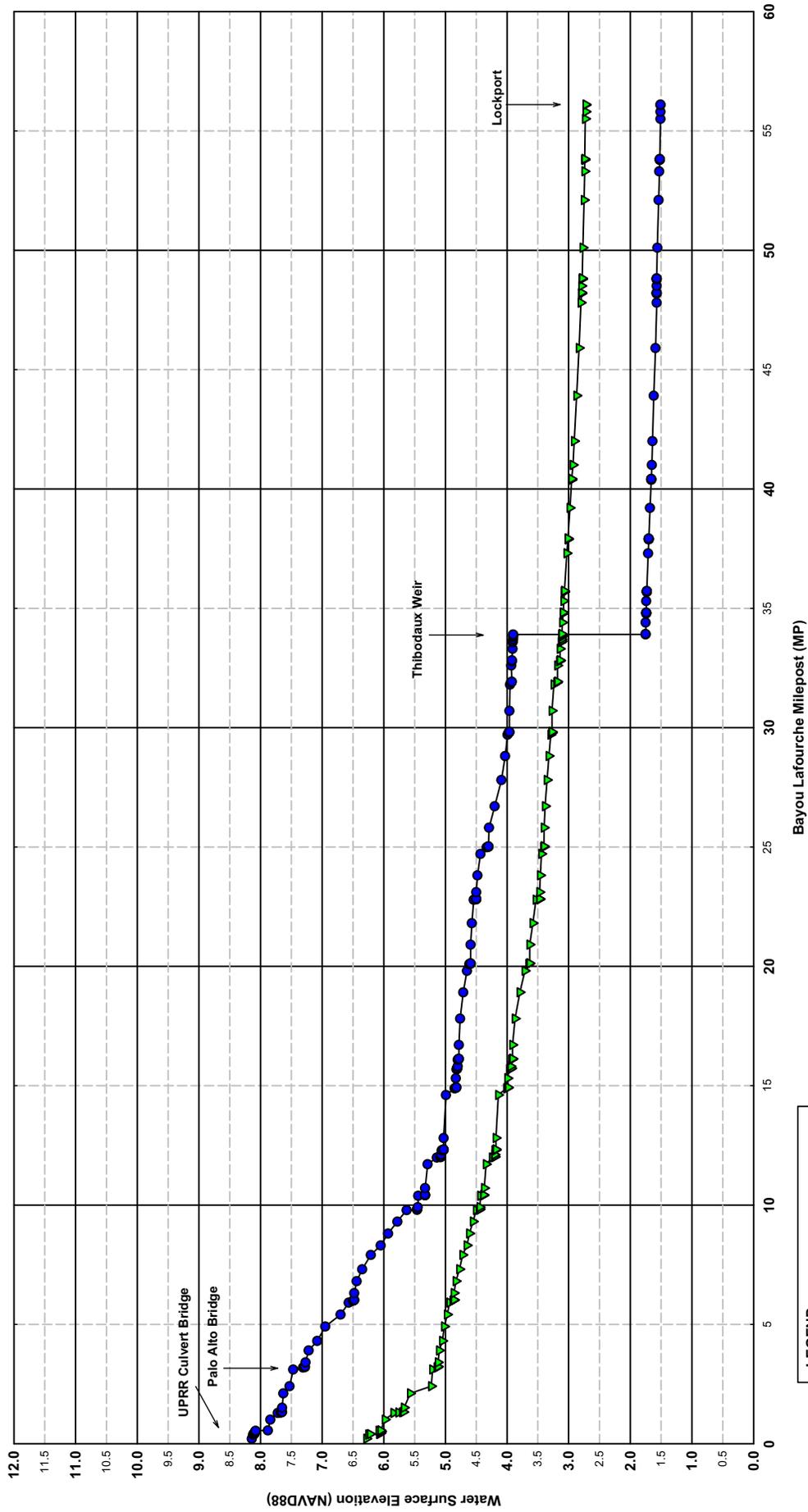


FIGURE 2-6
WATER SURFACE PROFILE -
ALTERNATIVE 47
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



LEGEND

- EXISTING
- ▲ LEAST RISE, 8'-All, 1,000 cfs

FIGURE 2-7
WATER SURFACE PROFILE -
LEAST RISE ALTERNATIVE
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

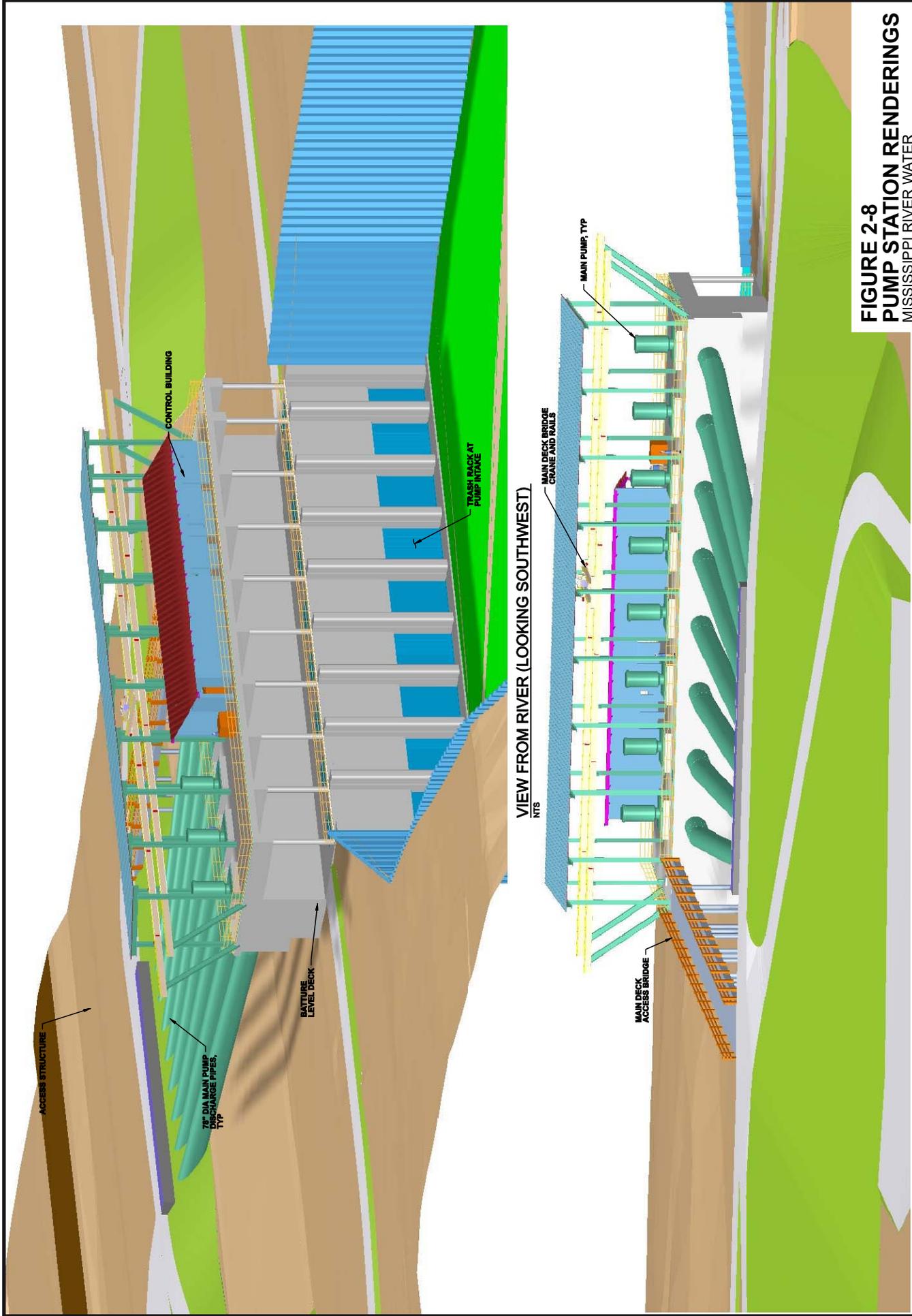
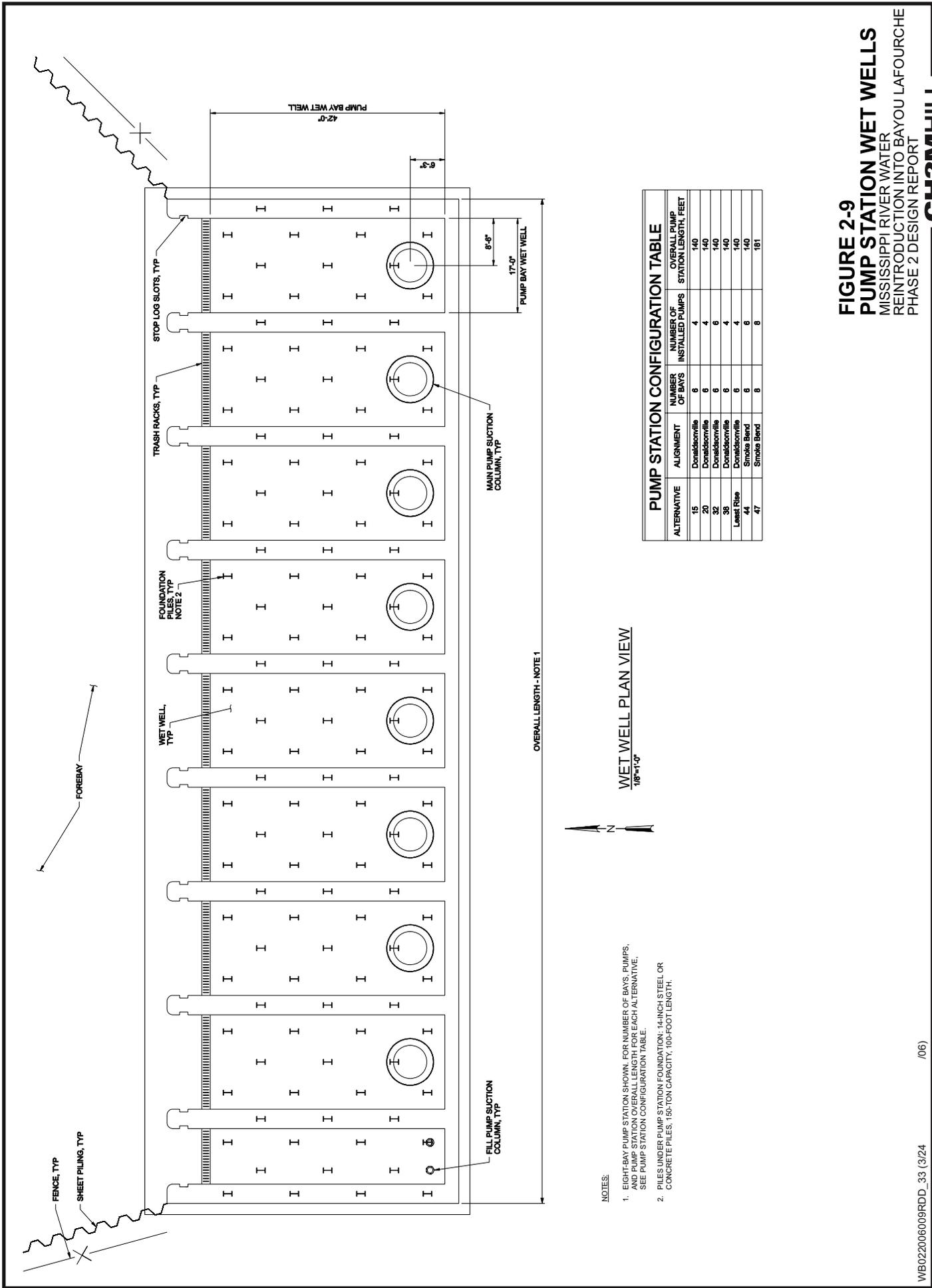


FIGURE 2-8
PUMP STATION RENDERINGS
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

VIEW FROM LEVEE (LOOKING NORTH)
 NTS

VIEW FROM RIVER (LOOKING SOUTHWEST)
 NTS



NOTES:

1. EIGHT-BAY PUMP STATION SHOWN. FOR NUMBER OF BAYS, PUMPS, AND PUMP STATION OVERALL LENGTH FOR EACH ALTERNATIVE, SEE PUMP STATION CONFIGURATION TABLE.
2. PILES UNDER PUMP STATION FOUNDATION: 14-INCH STEEL OR CONCRETE PILES; 150-TON CAPACITY; 100-FOOT LENGTH.

WET WELL PLAN VIEW
1/8"=1'-0"

PUMP STATION CONFIGURATION TABLE

ALTERNATIVE	ALIGNMENT	NUMBER OF BAYS	NUMBER OF INSTALLED PUMPS	OVERALL PUMP STATION LENGTH, FEET
15	Donaldsonville	6	4	140
20	Donaldsonville	6	4	140
32	Donaldsonville	6	6	140
38	Donaldsonville	6	4	140
Least Price	Donaldsonville	6	4	140
44	Smoke Bend	6	6	140
47	Smoke Bend	6	8	161

FIGURE 2-9
PUMP STATION WET WELLS
MISSISSIPPI RIVER WATER
REINTRODUCTION INTO BAYOU LAFOURCHE
PHASE 2 DESIGN REPORT
CH2MHILL

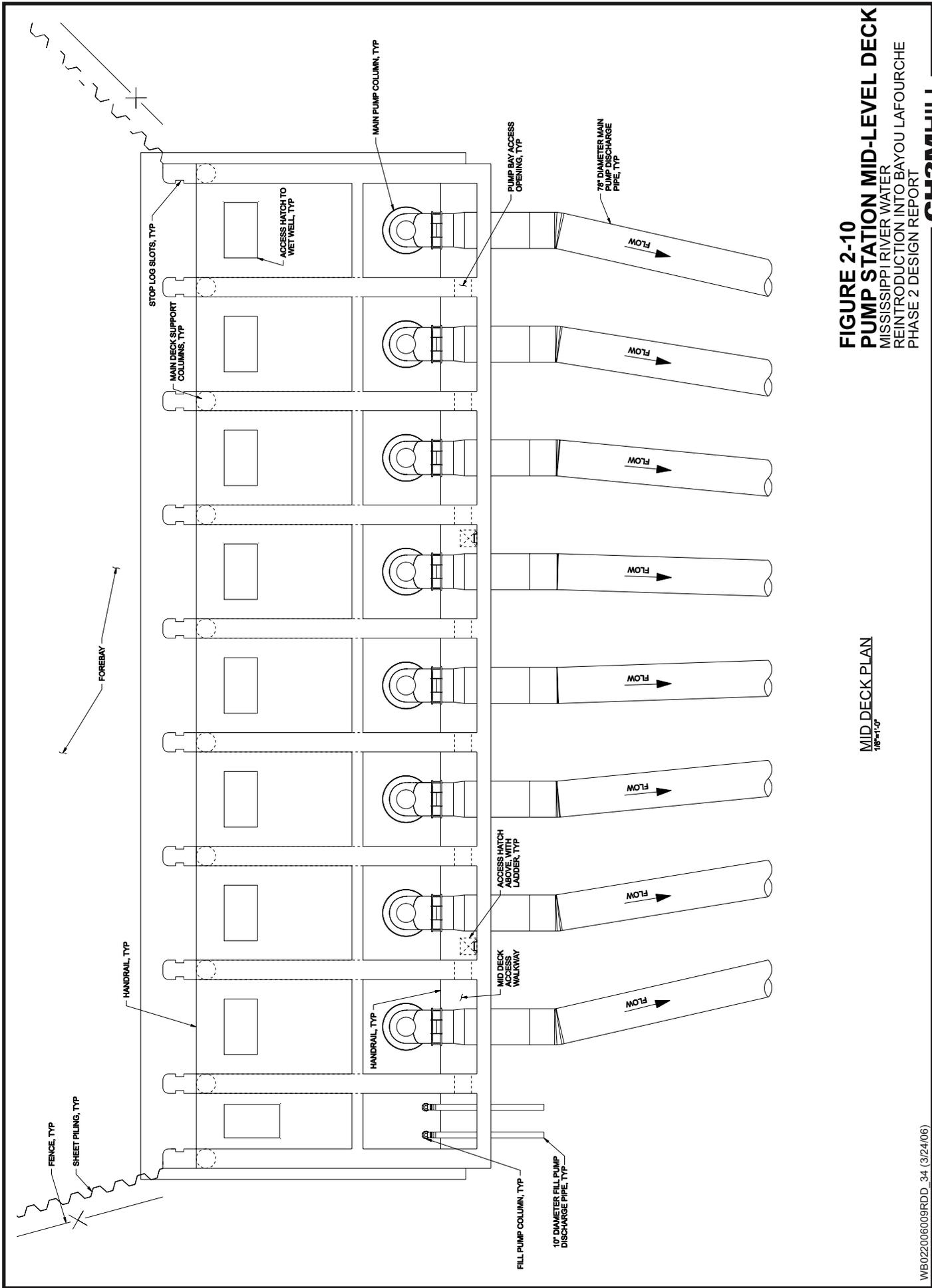
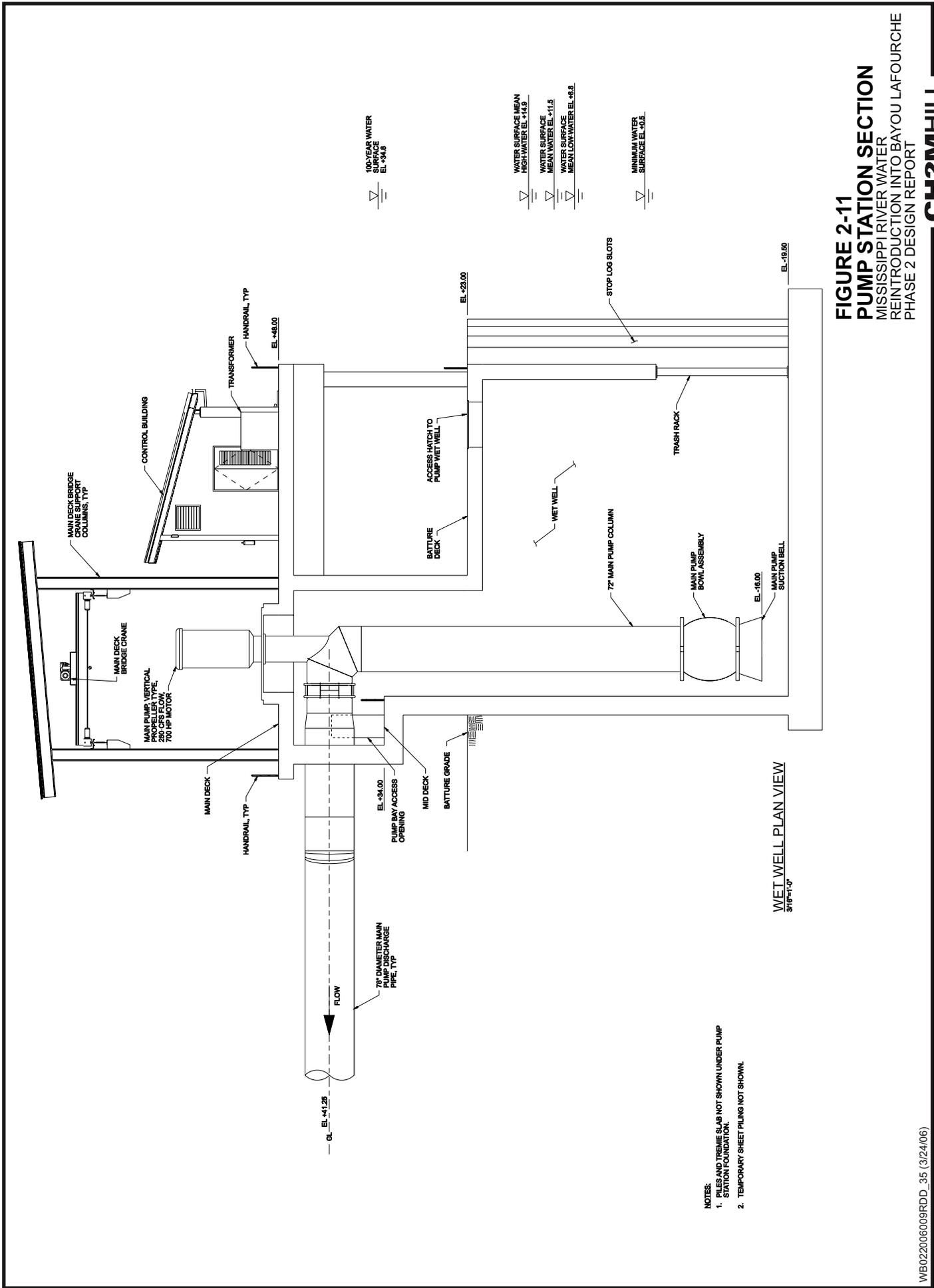


FIGURE 2-10
PUMP STATION MID-LEVEL DECK
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

MID DECK PLAN
 1/8"=1'-0"



100-YEAR WATER SURFACE ELEVATION EL. 44.0

WATER SURFACE MEAN HIGH WATER EL. 41.9
 WATER SURFACE MEAN WATER EL. 41.5
 WATER SURFACE MEAN LOW WATER EL. 38.8

MINIMUM WATER SURFACE EL. 30.0

- NOTES:
1. PILES AND TREMIE SLABS NOT SHOWN UNDER PUMP STATION FOUNDATION.
 2. TEMPORARY SHEET PILING NOT SHOWN.

WET WELL PLAN VIEW
 3/16/14

FIGURE 2-11
PUMP STATION SECTION
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

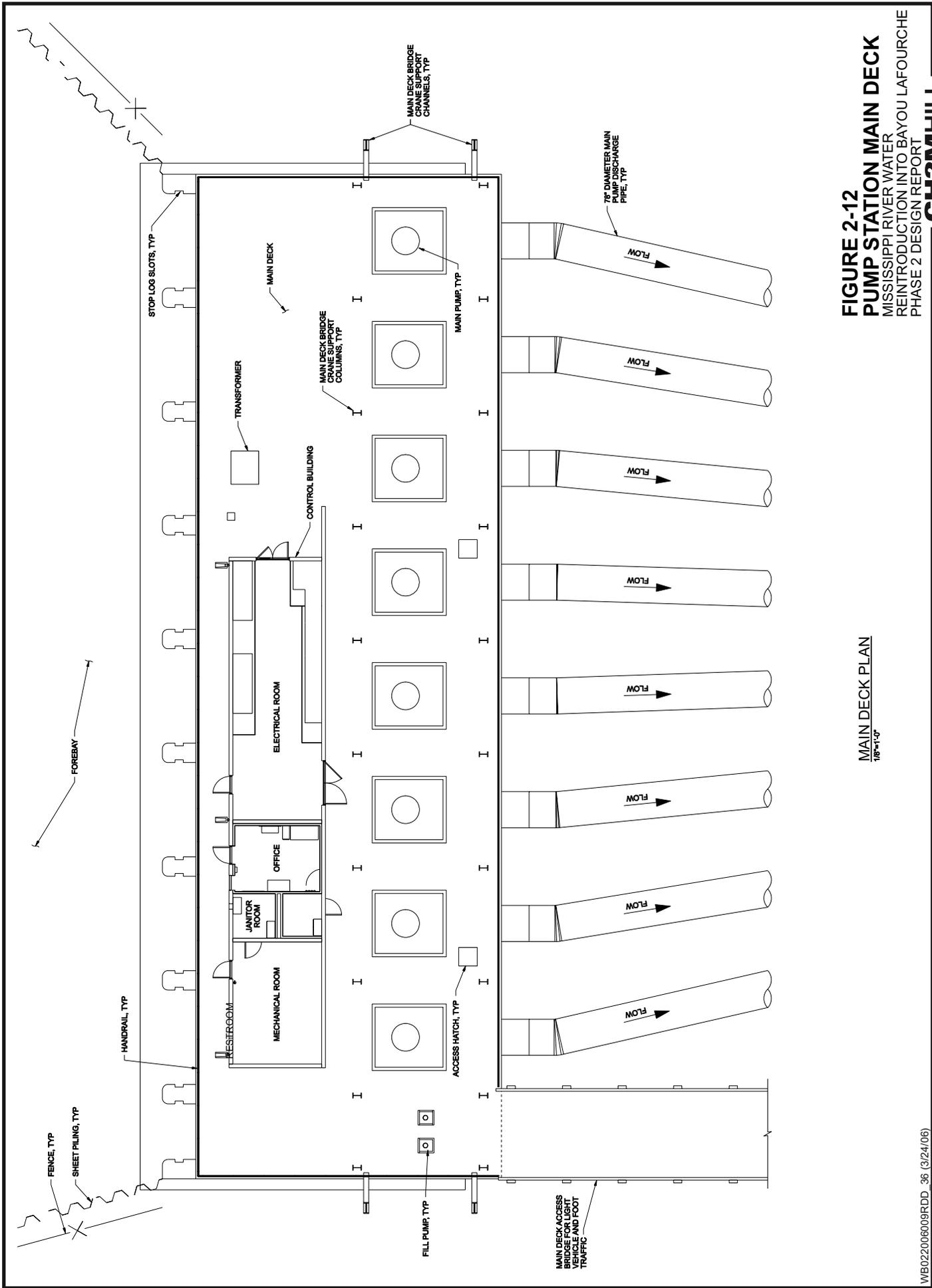


FIGURE 2-12
PUMP STATION MAIN DECK
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

MAIN DECK PLAN
 1/8"=1'-0"

ENTREGY POWER COMPANY, 4160V

NOTES:
 1. NUMBER OF INSTALLED PUMPS VARIES WITH EACH ALTERNATIVE.
 2000 CFS PUMP STATION WITH 8 PUMPS SHOWN.

DEVICES AND FUNCTIONS:
 50 INSTANTANEOUS OVERCURRENT RELAY
 51 GROUND FAULT RELAY
 52 AC CIRCUIT BREAKER
 86 LOCKOUT RELAY

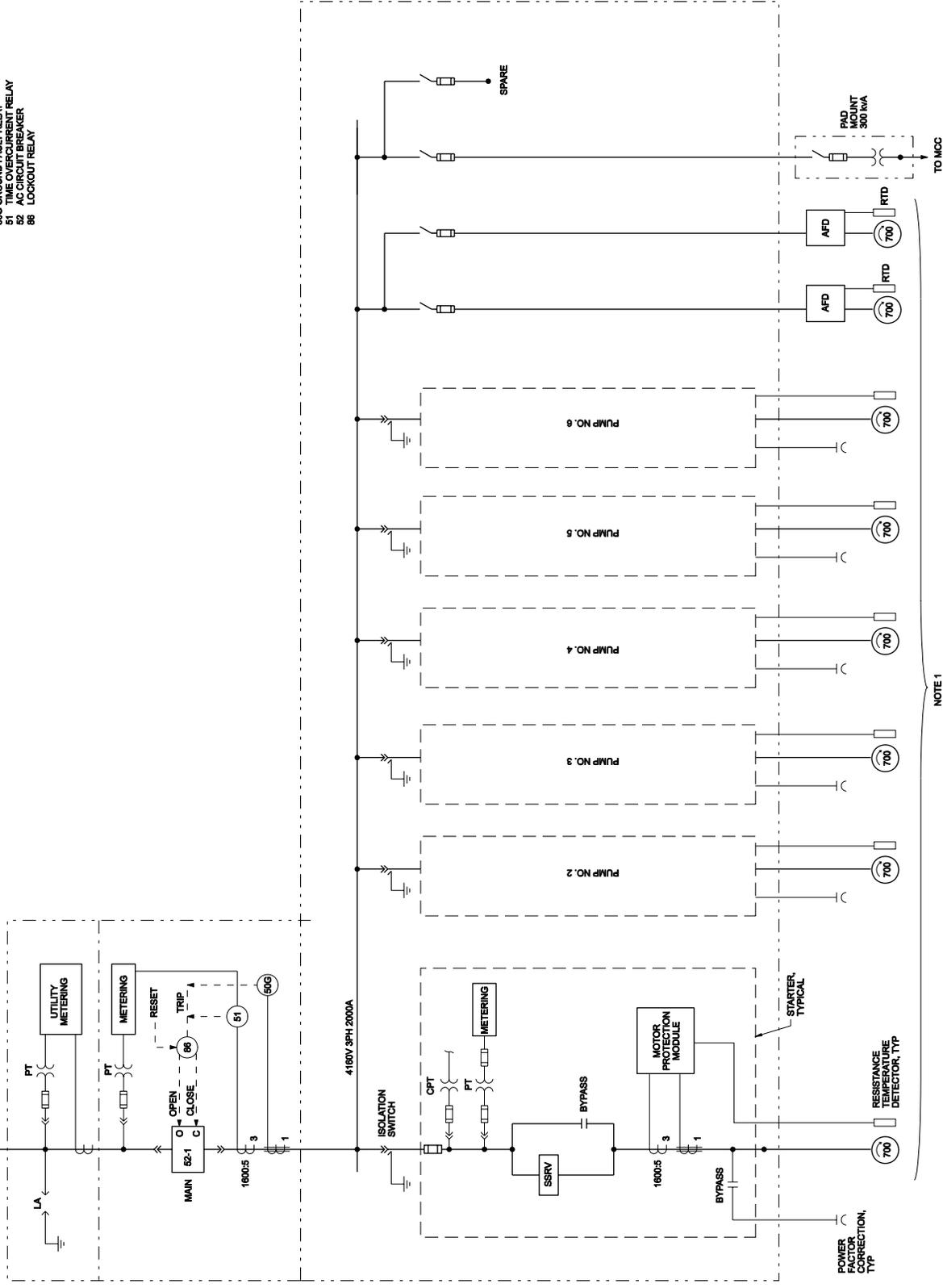


FIGURE 2-13
ELECTRICAL ONE-LINE DIAGRAM
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

Pump Station Capacity. The alternative diversion flows analyzed and the associated practical pump station capacities are shown in Table 2-2, for each of the seven alternatives. The flows represent a wide range of pump station capacities from 970 to 2,000 cfs. To simplify the analyses, two pump station structures and their related maximum capacities were selected for further analysis during the Phase 2 design.

TABLE 2-2
Pump Station Capacities for the Seven Alternatives Selected for Further Analysis in Phase 2

Alternative	Location	Alternative Diversion Flow Analyzed/Pump Station Capacity (cfs)	Number of Bays	Number of Installed Pumps
15	Donaldsonville	1,025/1,000	6	4
20	Donaldsonville	1,020/1,000	6	4
32	Donaldsonville	1,530/1,500	6	6
38	Donaldsonville	970/1,000	6	4
Least Rise	Donaldsonville	1,000/1,000	6	4
44	Smoke Bend	1,400/1,500	6	6
47	Smoke Bend	2,000/2,000	8	8

The two pump station capacities selected for the Phase 2 design are 1,500 cfs, consisting of six pump bays (250 cfs per bay); and 2,000 cfs, consisting of eight pump bays (250 cfs per bay). These capacities were selected to represent the maximum capacity required for each alternative. Should less capacity be achievable because of funding limitations, or other reasons, fewer pumps and/or bays could be installed to accommodate the desired flow and station capacity requirements.

The main elements of the new pump station configuration are listed below and are the basis for the construction costs. While these elements would be evaluated further as part of the final design, the following describes the current approach:

- River-side site on the batture between the river and the levee
- Over-levee discharge piping
- Vertical propeller pumps
- Two adjustable speed drives with the remainder of the pumps being constant speed drives

River-side Site. Siting the new pump station on the river side of the levee was selected to eliminate any levee penetrations required to bring the water into the pump station. A land-side location would require penetrations of the levee and for gravity flow of water and some type of valving to isolate flow into the pump station. The valving would require maintenance in the future and would increase risk for the project. A river-side location maintains the integrity of the existing levee and riverbank. Two sites, Donaldsonville and Smoke Bend, were considered as part of the seven alternatives for the Phase 2 design.

For the Donaldsonville alternatives, a site downstream of the existing pump station location is preferred because the batture is wider at this location, which maximizes forebay size and sedimentation removal capabilities. The downstream location also allows for the facility to

be located and piping to be routed parallel to the existing pump station and piping corridor to the bayou. Access to the new pump station is the same as for the existing pump station and use the existing levee access road.

For the Smoke Bend alternatives, the pump station is also sited on the river side of the levee and the piping would be routed to the outlet structure at the head of the new bypass channel. The pipe alignment requires the piping to be tunneled under Highway 1 and the railroad tracks that parallel the highway. Access to the new pump station at the Smoke Bend site is provided from a new access road off of Highway 1. The access road also connects to the batture access ramps.

Over-levee Discharge Piping. As the Mississippi River stages vary throughout the year, either over-levee or through-levee piping configurations would be part of pumping and siphon operations. There is an operating cost consideration between the two discharge pipe configurations. Because there are additional pipe losses for the longer over-levee piping, the additional annual power cost for one 250 cfs pump is estimated to be \$1,500, which is a 1.6 percent increase to the original \$95,000 estimate.

Because over-levee discharge pipe routing is technically feasible and only nominally increases operating cost, this alternative was selected for this project because it maintains the integrity of the levee. The levee would be raised where the pipes cross the levee to allow traffic to proceed along the top of the levee similar to the existing pump station at Donaldsonville.

Vertical Propeller (Axial Flow) Pumps. The pump size selected for the Phase 2 design is 250 cfs, which would result in six pumps for the Donaldsonville site to achieve the total capacity of 1,500 cfs and eight pumps for the Smoke Bend site to achieve the total capacity of 2,000 cfs. 250 cfs pumps are large enough to limit the required number of installed pumps to a reasonable number and yet not too large to limit the number of manufacturers. This size also provides reasonable ranges of flow to the bayou.

The pump size (250 cfs) dictates the use of vertical propeller (axial flow) pumps. Maximum size for the submersible pump type is approximately 140 to 180 cfs resulting in more pump bays and pumps installed to meet the pump station capacity requirements. The vertical propeller pump is well suited for the installation requirements and is available from several well known manufacturers.

Constant Speed and Adjustable Speed Drives. The main pumps would be both constant speed pumps and adjustable speed pumps. The adjustable speed pumps would vary the flow into the bayou in response to water surface conditions. Two pumps using adjustable speed drives would allow for a much wider range of flows to the bayou or bypass channel.

Normally, the pumps would be manually started and stopped whether in a manual or an automatic control mode. In manual mode, the operator would select the number and speed of the pumps they want to operate. In automatic mode, the operator would select a desired flow rate or discharge channel water surface and the pumps selected by the operator to run would adjust speed to meet the set condition. Whether in manual or automatic mode, instrumentation would provide information to the operator to confirm if the mix and speed of pumps is meeting the desired flow and/or discharge channel water surface. The number

and speed of pumps would vary seasonally due to many factors such as river water surface elevation, weather, the new check structures, and other downstream conditions.

2.2.1.2 Forebay Intake and Sedimentation Basins

The use of sedimentation basins has been an integral part of the design concepts for the enlargement of Bayou Lafourche since the beginning of the project. During the Phase 1 design, a sediment basin, where the velocity of the diversion flow would be low enough to settle out the sand particles, was planned at the upper end of the conveyance channel, just downstream of the UPRR Bridge.

For the Phase 2 design, the pump station and intake arrangement would include a forebay off of the Mississippi River through the batture as shown in Figures 2-8 and 2-14. The forebay would settle out the majority of the sediment instead of it settling in the channel sediment basins, thus allowing easier access for dredging and maintenance. The forebay can be dredged from a river barge, from excavation equipment located on the batture, or a combination of both. Vertical walls constructed with sheet piling were chosen for the Donaldsonville forebay because of the proximity to the existing pump station and its intake piping. The forebay would converge to approximately 160 feet at the pump station and diverge to approximately 400 feet at the normal water line. The Smoke Bend site would have a slightly larger forebay than the Donaldsonville site because of the greater diversion flow (2,000 cfs for Smoke Bend versus 1,500 cfs maximum for Donaldsonville). The vertical wall forebay arrangement is also shown for Smoke Bend to reduce the width while maintaining sufficient cross-sectional area for low velocities and settling. For either site, sloped forebay walls should be evaluated during the final design.

The basis of design for hydraulics in the forebay is to have the average velocity less than 0.2 foot per second. With this velocity, approximately 80 percent of the sands that are 0.1 millimeter (mm) or larger would settle out. Annual accumulation of sediment in the forebay is expected to be approximately 15 feet. Annual accumulation of sediment in the channel sedimentation basin is estimated to be approximately 3 feet.

Periodic monitoring of sediment depths throughout the forebay and channel sedimentation basin is recommended along with a maintenance dredging program. During flood years when the batture would be submerged, additional sedimentation in the forebay would likely occur. A log boom at the entrance may be considered during the final design phase of the project to prevent floating debris from entering and accumulating in the forebay.

2.2.1.3 Outlet Structure

The outlet structure is a concrete structure, which is located at the head of the bayou or bypass channel and would be rectangular in shape with walls on three sides to grade and a weir wall outlet on the water side of the structure. The structure width is dictated by the number of entering pipes and design flowrate exiting the structure. Figures 2-8, 2-14, and 2-15 provide different views of the outlet structure.

The pipe from the pump station enters through the back wall of the structure and ends at an elevation lower than the weir wall to maintain a submerged condition on the end of the pipe. The submerged outlet allows water to enter the pipe when the vacuum priming is

required during pump startup operations and allows the vacuum to develop maintaining a full pipe at the lower end of the pipe.

The water surface in the outlet structure would be 2 to 2.5 feet higher than the water surface elevations for the head of the bayou or bypass channel because of the loss over the weir. The loss can be minimized by increasing the weir length and by lowering the weir elevation. This exit loss would be more fully developed during the final design phase of the project to minimize the outlet structure water surface.

2.2.1.4 Existing Pump Station

The existing pump station is located at Donaldsonville and was constructed in the early 1950s. The existing pump station provides water from the Mississippi River into Bayou Lafourche and has a capacity of 300 to 400 cfs. The existing pump station consists of four constant speed motor driven vertical propeller pumps. Two of the pumps have an engine and right-angle gear drive, which allows pumped flow during power outages.

Rehabilitation and use of the existing pump station would be beneficial to the project for several reasons. The primary reason is that the existing pump station can provide emergency flow of water into the bayou during a power outage. Use of the existing pump station eliminates the need for an emergency generator to power one of the pumps on the new pump station. Another reason for using the existing pump station is that smaller increments of flow can be added to the larger increments from the new pump station providing a wider range of available flows into the bayou.

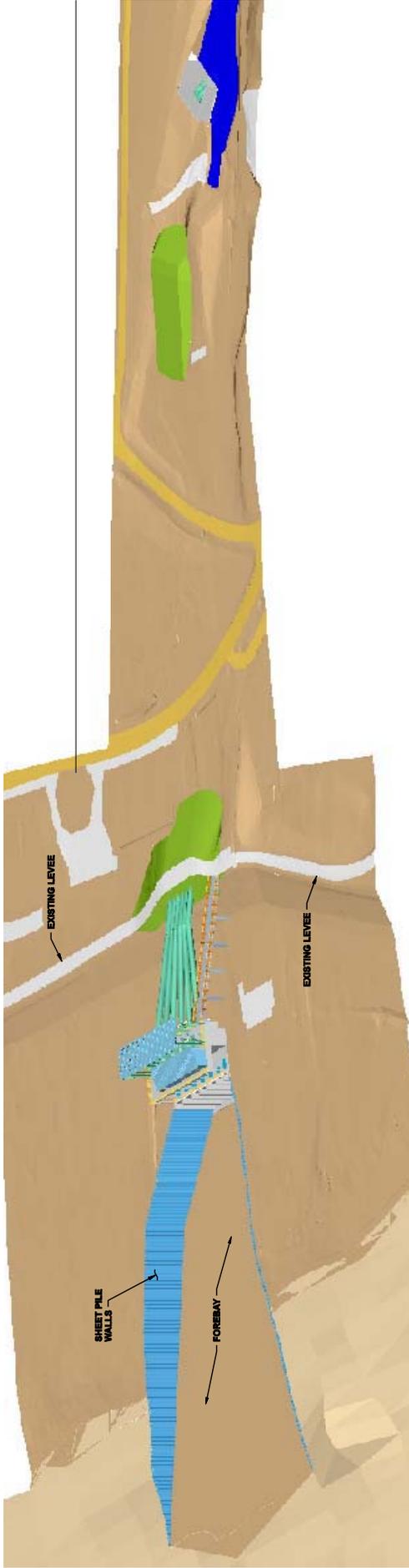
The existing pump station would maintain operations during construction of the new pump station so freshwater would be maintained to the bayou and to the relocated intake facilities.

2.2.2 Conveyance

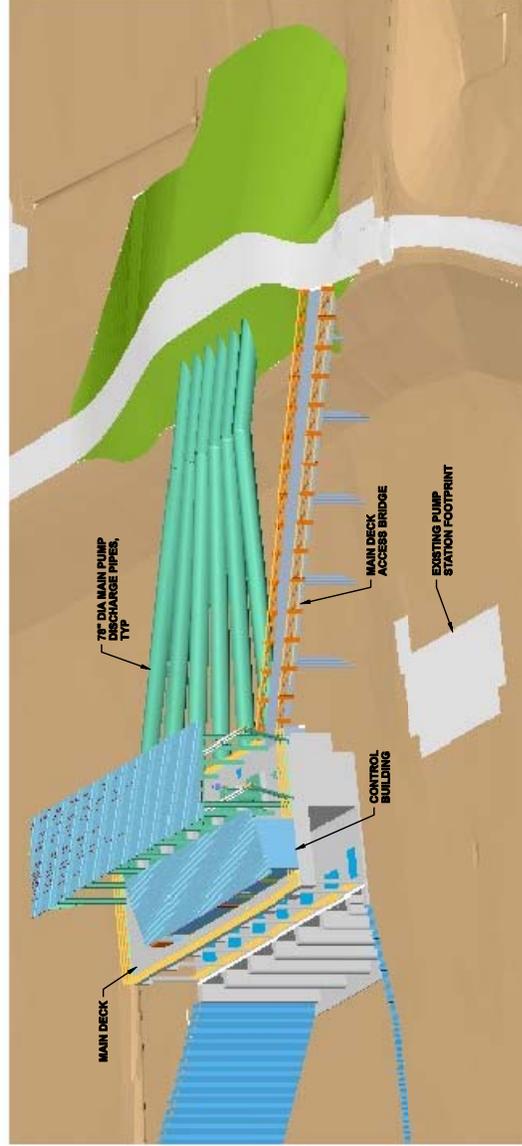
The conveyance capacity, channel size, dredging quantities, and alignment were common features in the design and evaluation of the seven remaining alternatives from Phase 1. The seven recommended alternatives from the Phase 1 Design Report included pump station and conveyance capacities from 1,000 to 2,000 cfs.

The selected alternative from the Phase 2 design would define the pump station size, width and depth of dredging, quantity of dredged material to manage, number of bridges requiring replacement, number of pipeline utility crossings needing replacement, and the location of the pump station.

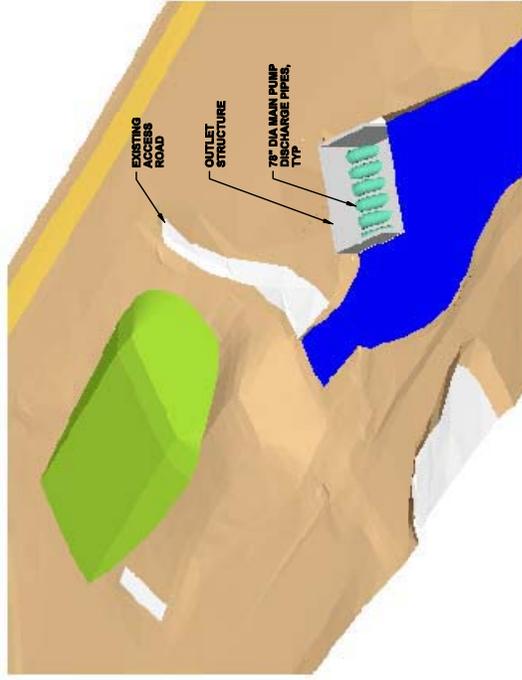
The location of the pump station determines the alignment of the first 3.5 miles of conveyance channel (to the Palo Alto Bridge) and would be located at either the Donaldsonville or Smoke Bend sites. Two locations for the pump station were evaluated in the Phase 1 Design Report to provide options for channel conveyance, capacity, and to manage impacts of water level increases through Donaldsonville.



CIVIL SITE OVERVIEW (LOOKING EAST)
NTS

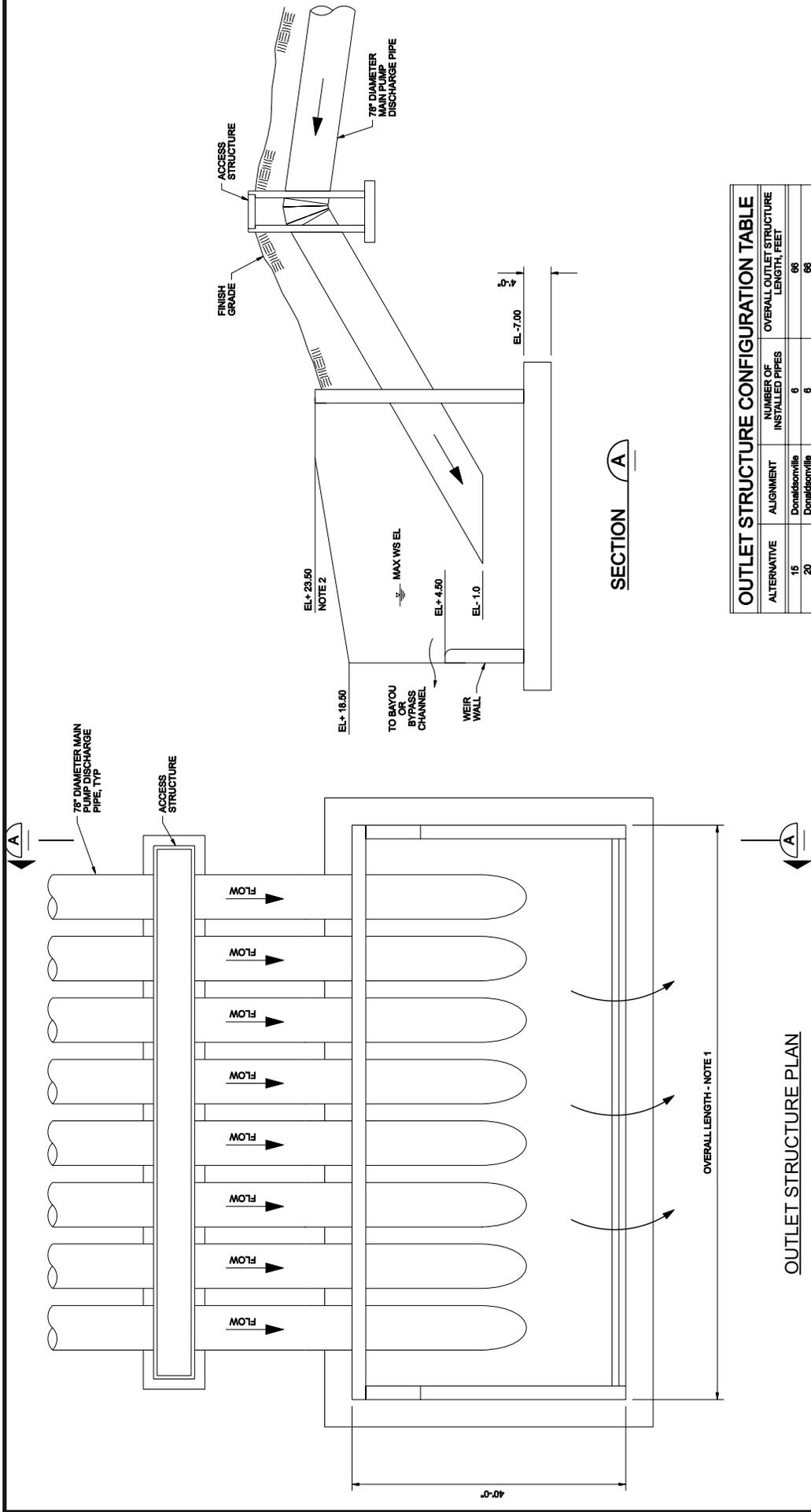


PUMP STATION SITE VIEW (LOOKING EAST)
NTS



OUTLET STRUCTURE SITE VIEW (LOOKING NORTHEAST)
NTS

FIGURE 2-14
PUMP STATION SITE RENDERINGS
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



OUTLET STRUCTURE CONFIGURATION TABLE

ALTERNATIVE	ALIGNMENT	NUMBER OF INSTALLED PIPES	OVERALL OUTLET STRUCTURE LENGTH, FEET
15	Donaldsonville	6	66
20	Donaldsonville	6	66
32	Donaldsonville	6	66
38	Donaldsonville	6	66
Least Rise	Donaldsonville	6	66
44	Smoke Bend	6	66
47	Smoke Bend	8	84

OUTLET STRUCTURE PLAN

- NOTES:**
- 8 PIPE OUTLET STRUCTURE SHOWN FOR NUMBER OF PIPES AND OUTLET STRUCTURE OVERALL LENGTH FOR EACH ALTERNATIVE. SEE OUTLET STRUCTURE CONFIGURATION TABLE.
 - TOP OF WALL ELEVATIONS MAY VARY WITH FINISH GRADE.

FIGURE 2-15
OUTLET STRUCTURE
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

2.2.2.1 Smoke Bend Bypass Channel

The Smoke Bend alternatives (44 and 47) use a bypass channel to convey the majority of the diversion flow around Donaldsonville. The channel design is trapezoidal with a bench for access and slope stability. Figure 2-16 shows the alignment of the bypass channel and location of confluence with Bayou Lafourche.

The existing pump station would be rehabilitated and continue to discharge about 100 cfs into the upper Bayou Lafourche while also providing redundancy for the new pump station. The discharge of 100 cfs through Donaldsonville would be used to maintain water quality and would increase the water level approximately 0.5 foot from existing.

The new pump station at Smoke Bend would convey the diversion flow to approximately where the Palo Alto Bridge crosses Bayou Lafourche. The plan view of the upper reach of the bypass channel and typical section are shown in Figure 2-17. Plans of the entire alignment of the bypass channel and associated details are shown in the Phase 2 Design Drawings (drawings 30-C-4 through 30-C-6). Approximately 800 feet of Bayou McCall would be realigned and cross-drainage structures would be provided for existing field drains. Bypass channel access roads are included along the bypass for maintenance and a bridge crossing replacement would be included for local traffic.

Highway 1 would have an under-crossing for the Smoke Bend bypass channel consisting of five 10-foot by 10-foot box culverts exiting into a channel transition. The confluence of the bypass channel with Bayou Lafourche is just upstream of the Palo Alto Bridge. The transition channel and banks of Bayou Lafourche would be protected with riprap.

The bypass will require a Highway 1 under-crossing and an outlet structure into Bayou Lafourche. These are shown in Figure 2-18 and also in the Phase 2 Design Drawings (drawings 30-C-7 through 30-C-9). The bypass channel would maintain a water level of about 8.7 feet with 1.5 to 2.0 feet of freeboard below the cross-drainage facilities.

Included in the bypass channel is a sedimentation basin (shown in plan view on Figure 2-17) that would be used to settle out most of the suspended sediment particles in the sand grain sizes. The sedimentation basin was sized for the minimum length required to settle out particles 0.1 mm and larger. Design drawings for the sedimentation basin are shown in Phase 2 Design Drawings (drawing 30-C-10).

Smoke Bend bypass channel size, dimensions of the cross drainage culverts, bridge crossing size, and sedimentation basin size and length vary with the alternative. The Highway 1 under-crossing has been designed with five box culverts for either alternative capacity.

2.2.2.2 Dredging and Dredged Material Reuse/Disposal

Approach. Dredging of Bayou Lafourche is a major component of all the remaining alternatives. The Dredged Material Management Options report, attached as Appendix I, identified options for managing dredged material that would be generated through implementation of one of the seven alternatives evaluated in this Phase 2 report. Approximately 3 to 8 mcy of dredged material will be generated depending on the final alternative selected as part of this Phase 2 evaluation process. To effectively evaluate the numerous potential options, the following approach was used:

1. Evaluation of regulatory permitting and consultation requirements. An understanding of regulatory requirements and restrictions on dredged material reuse and disposal are necessary to define and narrow the range of possible options.
2. Characterization of dredged material quantity and quality. The dredged material quantity was initially developed through the HEC-RAS modeling exercise, and is required to define appropriate dredging technologies, and define approximate costs. Dredge material quality will be essential in determining the range of ultimate disposal or reuse options. Initial evaluations of dredged material quality have not limited the management options; however additional assessment of the sediment will be required for final approval of all material management options.
3. Definition and characterization of dredged material management options. Based on information derived from the regulatory, quantity and quality evaluations, dredged material management options were defined. Consultation with dredging contractors was integral to this process.
4. Evaluation of defined dredged material management options. Evaluations included technical requirements, costs, and comparison of options. Defining future data requirements and uncertainties was undertaken to develop a plan for refining and selecting the specific dredge material management option during the final design phase.

The following sections briefly describe the findings, documented in further detail in Appendix I.

Regulatory Permitting and Consultation Requirements. Removal and disposal of dredged materials, regardless of disposal type or management option, requires specific permits and coordination at the federal, state, and local levels.

The Rivers and Harbors Act of 1899 required all work in navigable waters be permitted: including dredging, bank stabilization work; and bridge work. The National Environmental Policy Act (NEPA) of 1969 regulated actions such as dredging to assure balance between human activities and the environment. The Federal Water Pollution Control Act of 1972, also known as the Clean Water Act (CWA), further regulated in-water work to be protective of U.S. waters. The Endangered Species Act (ESA) of 1973 requires assurances that threatened and endangered species will not be harmed by the contemplated dredging activity. In addition, individual states have adopted removal/fill regulations either in their assumption of CWA or the Coastal Zone Management Act or related to their proprietary interest in submerged lands.

Removal and disposal of dredged materials, regardless of disposal type or management option, requires specific permits and coordination at the federal, state, and local levels.

Table 2-3 summarizes some of the key permitting and coordination requirements applicable to all project alternatives that include dredging.

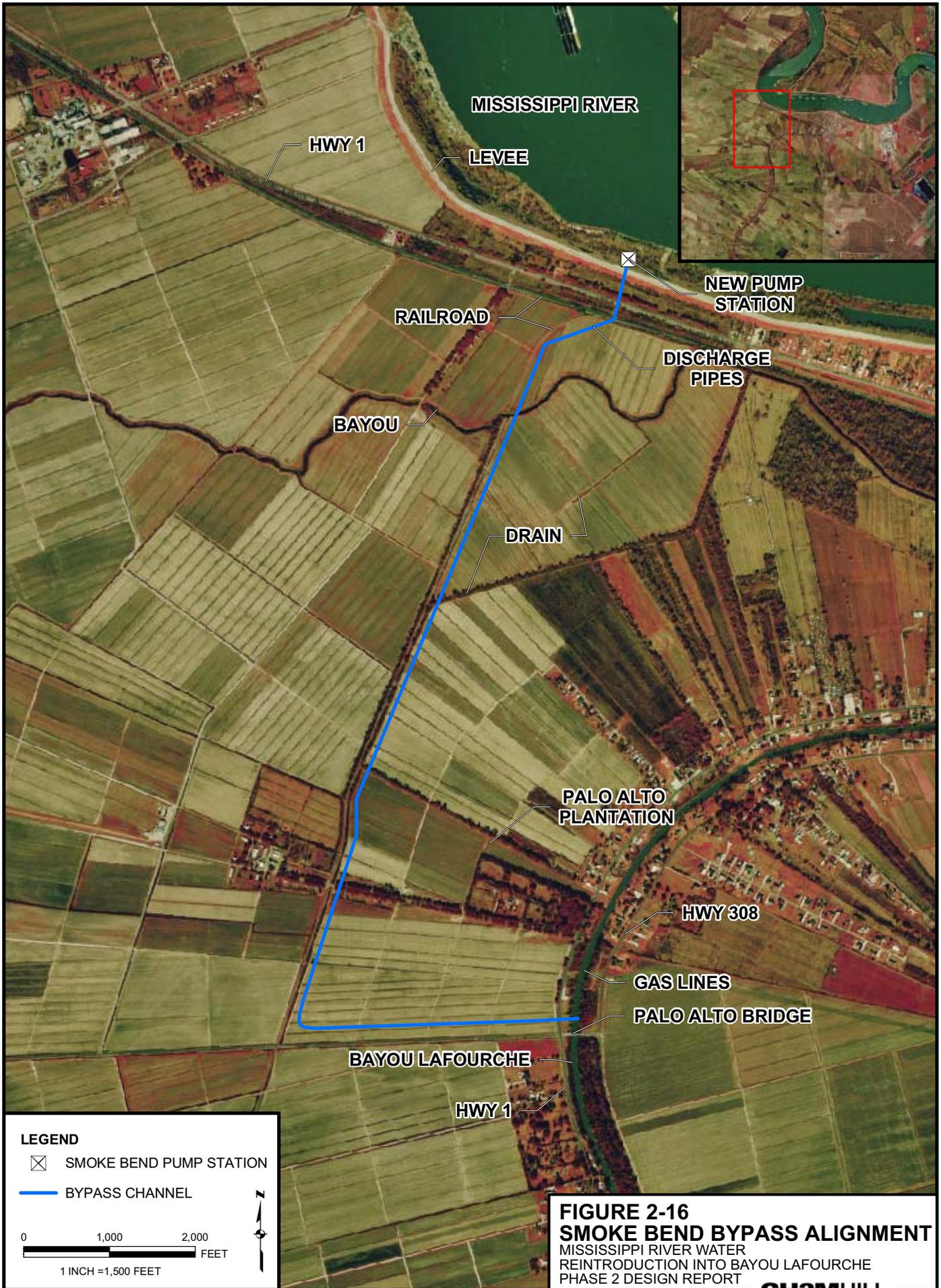
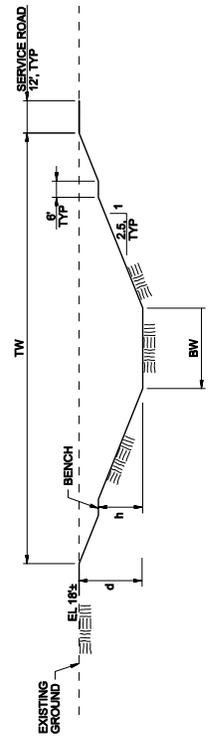
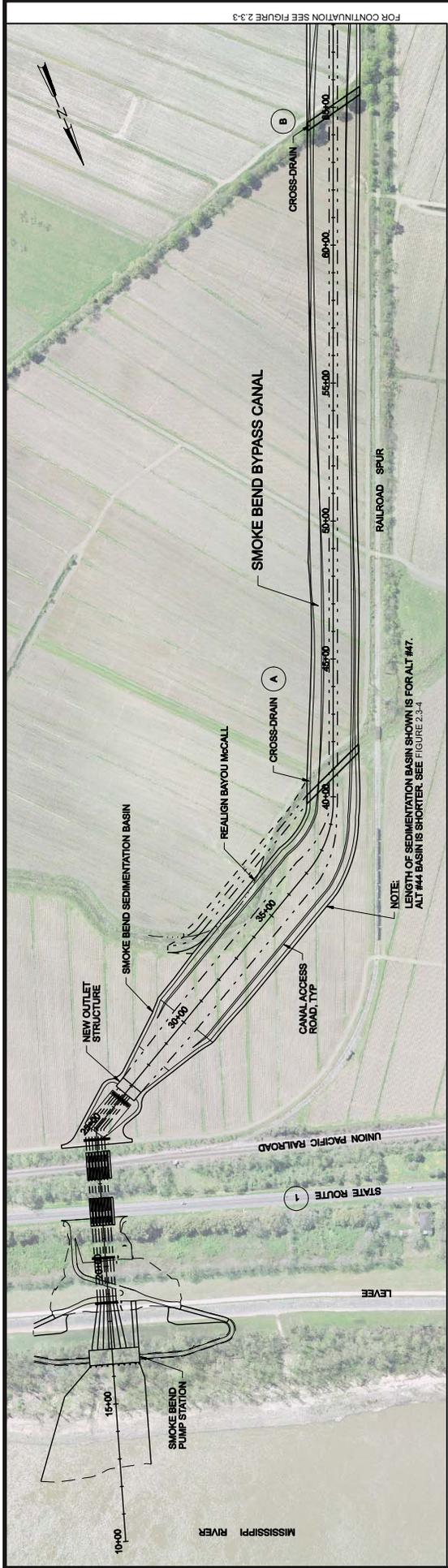


FIGURE 2-16
SMOKE BEND BYPASS ALIGNMENT
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

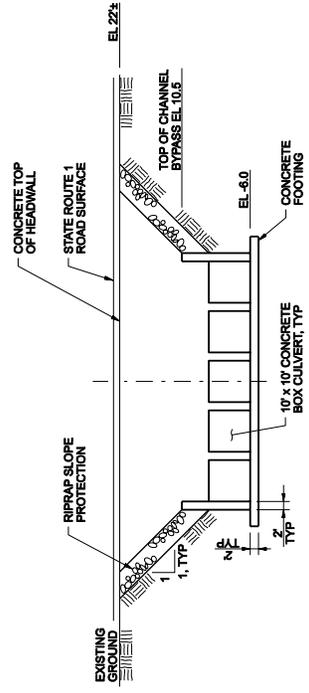
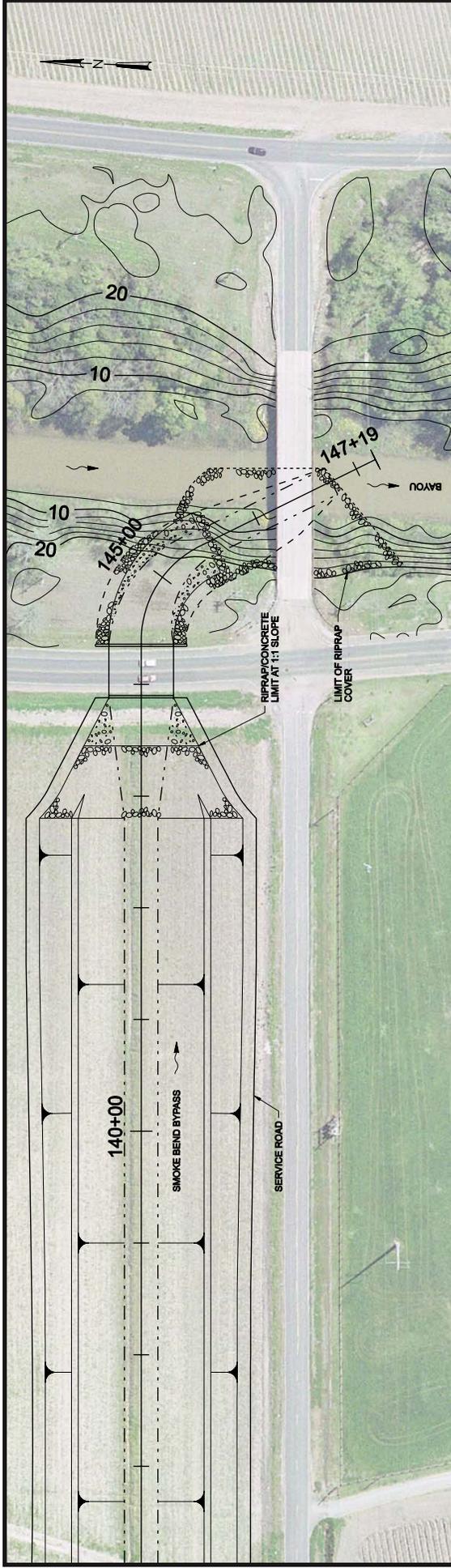


TYPICAL SECTION
NTS

TABLE 1

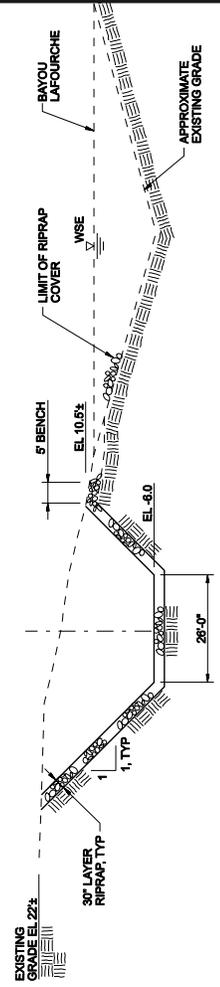
ALTERN	FLOW (CFS)	BW (FEET)	APPROX TW (FEET)	APPROX d (FEET)	h (FEET)	INVERT EL. @ OUT FALL
#44	1400	40	147.0	19.0	11.5	-1.0
#47	2000	30	150.0	24.0	18.5	-6.0

FIGURE 2-17
SMOKE BEND BYPASS CHANNEL
PARTIAL PLAN AND TYPICAL SECTION
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



HIGHWAY 1 CROSSING

BOX CULVERT, OUTLET SECTION
NTS



TYPICAL OUTLET CHANNEL SECTION
NTS

FIGURE 2-18
HIGHWAY 1 UNDER-CROSSING
AND BYPASS CHANNEL OUTLET
MISSISSIPPI RIVER WATER
REINTRODUCTION INTO BAYOU LAFOURCHE
PHASE 2 DESIGN REPORT

TABLE 2-3
Permitting and Consultation Requirements

Agency	Permit/Agency Coordination	Issues Addressed, General and Specific
Federal		
U.S. Army Corps of Engineers (USACE)	<p>Section 404 Permit for:</p> <ol style="list-style-type: none"> 1. Placement of dredged material into waters of the U.S., including open-water and wetland areas. <p>Section 10 Permit for:</p> <ol style="list-style-type: none"> 1. Work in Navigable Waterways, including dredging activities, 2. Installation of water intake pipes and related appurtenances in the Mississippi River. 3. Any structures located in the navigable waters of Bayou Lafourche (which are presently considered to be below the weir in Thibodaux). 	<p>Section 404 and 10 permits are considered together</p> <p>Compliance with the NEPA</p> <p>Sediment quality</p> <p>Disposal areas and methods</p> <p>Water Quality Certification by Louisiana Department of Environmental Quality (LDEQ)</p> <p>Public input</p> <p>Review by state and federal resource agencies</p>
U.S. Coast Guard	"Letters of No Objection" . Reviews and comments on issues related to USACE's Section 10 Permits.	Waterway safety
National Oceanic and Atmospheric Administration Fisheries	Review and Consultation. Routinely reviews and comments on separate or joint public notices filed by USACE, Coastal Management Division of the Louisiana Department of Natural Resources (LDNR-CMD), and LDEQ.	<p>Effects of dredging on wetlands</p> <p>Effects of dredging on water quality as related to fisheries</p> <p>Essential fish habitat consultation</p> <p>ESA consultation</p>
EPA	Review. Routinely reviews and comments on separate or joint public notices filed by USACE, LDNR-CMD, and LDEQ.	<p>Compliance with the NEPA</p> <p>Water quality and total maximum daily load issues</p> <p>Ecological risk</p> <p>Dredged material quality</p>
U.S. Fish and Wildlife Service (USFWS)	Review and Consultation. Routinely reviews and comments on separate or joint public notices filed by USACE, LDNR-CMD, and LDEQ.	<p>Effects of dredging on wetlands</p> <p>Effects of dredging on water quality as related to fisheries</p> <p>ESA consultation</p>
State of Louisiana		
Louisiana Agricultural Commodities Commission	Review. Approves of dredge material for agricultural use.	Physical and chemical acceptability of material for agricultural use
LDEQ	Water Quality Certification. Required pursuant to Section 401 of CWA as a prerequisite to issuance of a USACE Section 404 Permit.	<p>Compliance with state water quality standards</p> <p>Dewatering and discharge issues</p>
LDNR-CMD	Federal Consistency. A Federal Consistency Determination is required for a federally sponsored project that will directly and significantly impact coastal waters even though the project is located outside of Louisiana's Coastal Zone. Usual fee of \$300 is waived for CWPPRA projects.	<p>Sediment chemistry</p> <p>Disposal areas and methods</p> <p>Public, state, and federal input</p> <p>Land use, marsh, and wetland impacts</p> <p>Wetland creation, restoration, and enhancement</p>

TABLE 2-3
Permitting and Consultation Requirements

Agency	Permit/Agency Coordination	Issues Addressed, General and Specific
Louisiana Office of State Lands	Classes C and D Permits. Class C required for wharves and piers, if included as part of project. Class D required for control structures placed in Bayou Lafourche.	Structures in the bayou
Louisiana Dept. of Transportation and Development	Permit. Usually issues permits for projects that could affect state highways (for example, vehicular safety during construction), but does not issue permits in instances when a project is funded entirely or in part by state money.	Project effects on Louisiana Highway 1 and 308 (for example, effects on embankments or drainage crossings) Effects on integrity of bridges connecting Louisiana Highway 1 and Louisiana Highway 308
Louisiana Dept. of Wildlife and Fisheries	Review. Routinely reviews and comments on separate or joint public notices filed by USACE, LDNR-CMD, and LDEQ.	Effects of dredging on wetlands Effects of dredging on water quality as related to fisheries Threatened and endangered species (state)
Louisiana State Historic Preservation Officer	Review. Routinely reviews and comments on separate or joint public notices filed by USACE, LDNR-CMD, and LDEQ.	Effects on historically significant sunken vessels, if any Historical artifacts and archaeological resources Effects on historical structures at the diversion site and along the bayou, including aesthetics (for example, placement of dredged materials)
Louisiana Dept. of Health and Hospitals	Review. Routinely reviews and comments on separate or joint public notices filed by the USACE, LDNR-CMD, and LDEQ.	Effects on individual onsite wastewater systems (for example, effects on size of drain fields on batture lots)
Local		
BLFWD	Permit. Required from the District for any project that requires a Section 10 permit from USACE.	Water quantity and quality
Local governments	Comment letters. Local municipalities and parishes have no jurisdictional or regulatory oversight, but may issue letters of support or objection during the public comment period to USACE, LDNR-CMD, and LDEQ to influence permit decisions.	Effects on local flooding potential Effects of flow velocities and water levels as related to recreational safety Effects on residential and commercial structures, pipeline and utility crossings (submarine and aerial), and remedial actions needed, if any (for example, relocation) Effects on rail bridge at Lafourche Crossing Acceptability of dredged material for use as agricultural soil by local agronomists Impacts to local communities during implementation, traffic, and safety issues
Water intake facilities	Comment letters. No jurisdictional or regulatory oversight, but may issue letters of support or objection during the public comment period to USACE, LDNR-CMD, and LDEQ to influence permit decisions.	Dredging activities' effects on short-term water quality Dredging activities' effects on industrial intakes such as sugarcane mills

Pre-eminent in the decision process is a demonstration that the quality of sediments is environmentally acceptable. Dredged material quality is determined on the basis of physical, chemical, and biological properties of dredged material.

More details on the federal and state regulatory permitting and consultation requirements can be found in Appendix I.

Dredged Material Quantity and Quality. Dredged material quantity was determined based on hydraulic modeling and is further described in the Phase 1 design report. Dredged material quantities were calculated using the HEC-RAS model discussed in Section 3.1 of the Phase 1 Design Report. The model divided the bayou channel into four reaches, each of which was assumed to have a consistent bottom slope but varying channel geometry that was determined using surveyed cross sections. The dredging templates were then applied to the modeled channel for each of the dredging scenarios. The dredging templates lowered the invert of the channel by either 2 or 8 feet, depending on the dredging scenario, while applying side slopes of 2.5 feet horizontal to 1 foot vertical (2.5H:1V).

Three dredging scenarios were used to develop dredged material management options: low, medium, and high volume of dredged material quantity. The low volume of dredged material is based on a 2-foot dredge, cut from RM 0 to RM 29, which is estimated at 2.85 mcy. The medium volume of dredged material quantity is based on an 8-foot dredge cut from RM 0 to RM 3.4 and a 2-foot cut from RM 3.4 to RM 56.3, which is estimated at 4.93 mcy. The high volume of dredged material quantity is based on an 8-foot dredge cut from RM 0 to RM 56.3, which is estimated at 8.62 mcy. These quantities do not correspond exactly to the quantities for each of the seven alternatives presented at the end of the Phase 1 Design Report. However, the high and low quantities do correspond to the maximum and minimum extremes, respectively, and the medium volume is representative of some of the mid-range dredging alternatives.

Each of the low, medium, and high quantities were then determined for 28 sections of the bayou, based on the dredge cuts described previously. The 28 sections, or reaches, are consistent with the 1997 *Bayou Lafourche Freshwater Diversion Preliminary Dredging Plan* (Preliminary Dredging Plan) (CEEC, 1997). The reaches were generally delineated between two consecutive bridges. The reaches are also shown graphically on the sheet index map of the Phase 2 Design Drawings (Appendix P). Dredge volumes were calculated for each reach (see Table I-2, Appendix I) of the bayou.

Quality of the existing dredged sediments was evaluated using information in the *Bayou Lafourche Sediment Study* (EPA Sediment Study) (EPA, 2004) as well as soil samples collected for physical analysis by Eustis Engineering Company, Inc., in 2005. In general, the material characterization based on available data, did not indicate any significant contamination problems. Based on evaluation of existing data, dredged material management options have not been limited due to quality; however, additional assessment of the sediment will be required for final approval of all material management options. Analytical results are further described in Appendix I. Specific conclusions of the existing sediment characterization include the following:

- There are sufficient data to request approval for in-water placement of dredged material into the Mississippi River from the upper 3 miles of the bayou

- Further effluent quality testing and analysis will be required prior to requesting regulatory approval for reuse of dredged material as agricultural topsoil or construction fill from the upper 3 miles of the bayou
- There is sufficient data to request approval for reuse of dredged material as agricultural topsoil or construction fill from RM 16 through RM 56
- A limited desktop assessment will be required for reuse of dredged material as agricultural topsoil or construction fill from RM 3 through RM 16 of the bayou
- Further biological effects testing and analysis on freshwater and estuarine organisms will be required prior to requesting regulatory approval for marsh creation

Development of Options. Sediment must be removed to increase the flow through Bayou Lafourche. The alternatives require different removal volumes. Sediment removal would increase the cross-sectional area of the channel, which increases flow capacity. The lowest dredged sediment removal volume (alternatives 15 and 38) require removal of approximately 2.9 mcy, while the highest dredged sediment volumes (alternatives 47 and Least Rise) require removal of more than 8 mcy.

Dredging options include mechanical, hydraulic, or a combination of both. Initial conveyance of the material dredged from the bayou would be by pipeline. Truck conveyance of material initially removed from the bayou, either by hydraulic or mechanical means would not likely be cost effective. Hydraulic dredging would be performed from a barge, transporting the slurry for further processing by pipeline conveyance. Pipeline conveyance may require the use of additional booster pump(s), depending on the distance to the initial/final placement location. Discharged return water would be required to meet applicable water quality standards. Debris is expected to be encountered during dredging activities. The amount and type of debris is not yet well defined and would vary throughout the length of the bayou. Without debris, it is likely that the preferred dredging method would be hydraulic dredging and conveyance. With a limited amount of debris that is identifiable in type and location, mechanical removal of debris prior to hydraulic dredging would likely be preferred. With high volumes of debris, sediment would likely be removed using a mechanical dredge and screened. The sediment that passes through the screen (approximately 2-inch to 6-inch slots) would be hydraulically conveyed to the designated dredged material placement location. Material that is caught by the screen would be separated for proper management. Debris would likely be placed on a barge and then offloaded for transportation to either a recycling facility or landfill. Organic debris, such as tree limbs or root wads may be placed on bankside, if regulatory and/or property owner approval is obtained, or chipped and removed by truck.

Assumptions were made regarding the amount of debris to be encountered. It is assumed that 5 percent of the dredging volume would require management as debris: 2.5 percent of this debris could be recycled; and 2.5 percent would require landfill disposal. Debris and limited volumes of contaminated sediment are assumed to require truck transport to a recycling or disposal facility. The cost of managing debris or contaminated sediment is much higher than management of clean dredged material. Material management costs will escalate if debris or contaminated sediment increases beyond the assumed 5 percent. To verify this assumption, additional evaluation of debris volume will be required.

Initial descriptions of the dredged material management options were provided in the *Phase 1 Design Report for the Mississippi River Water Reintroduction into Bayou Lafourche Project* (Phase 1 Design Report) (CH2M HILL, 2005). Four viable dredged material management options were identified and evaluated (Appendix I). The four viable options were separated into two categories: upland placement and in-water placement.

Management options for upland placement include the following:

- Beneficial reuse as agricultural soil
- Beneficial reuse as construction fill for levee, residential, or industrial use

Management options for in-water placement include the following:

- Open-water placement in the Mississippi River
- Beneficial reuse for marsh reclamation or marsh creation

The evaluation of the dredged material management options require knowledge of the quantity of the material, quality of the material, regulatory permitting requirements, benefits to the environment, and comparative construction costs. A description of the evaluation criteria is included in the Dredged Material Management Options technical memorandum (Appendix I).

With necessary approvals, sediment that is dredged and placed upland for dewatering can be beneficially used as agricultural soil or construction fill, including levee construction or maintenance. Upland containment areas require design for proper sizing to allow sufficient dredged slurry retention time. Settlement of the solids occurs within the containment areas, with the effluent decanted back to receiving waters. The effluent must be treated, if necessary, to meet state regulatory requirements for the particular receiving water. Water management within the containment areas is another component of the dredging operation. The effluent water is decanted over a weir and conveyed through a pipeline or drainage ditch into the receiving water. The receiving waters could be the bayou or the marsh and open-water areas beyond the sugar cane fields. The effluent must meet state regulatory requirements for the particular receiving water. In upland containment areas, the excess water would also be allowed to infiltrate into the soil. With large containment areas and thin-lift placement, water that infiltrates into the soil may exceed the water that passes over the weir. However, a weir system and return-water conveyance system is expected to be required in the upland containment areas.

Using the *Confined Disposal of Dredged Material* manual (USACE, 1987) and the assumptions listed in the Appendix I, approximately 30 acres are sufficient for approximately 50,000 cubic yards (cy). The containment areas were, therefore, sized based on 30 acres for each 50,000 cy of dredged material. If dredged material is placed at depths greater than 2 feet, containment areas would be smaller. Dredged material beneficially used for construction fill would likely be placed in lifts greater than 2 feet and would require less area for containment. Appendix I, Attachment 1 contains maps of upland containment areas positioned to visualize approximate areas needed for dewatering of dredged material placed in an upland environment. The containment areas were sized based on the highest estimate of dredge material quantity (8.2 mcy), which required significantly more acreage for the containment areas than the lower estimates (2.9 mcy). These locations were identified simply by identification of open-land areas (sugar cane fields) in these figures and property

ownership issues were not considered at this phase. The containment areas were positioned based on a 50-foot buffer from homes, buildings, or trees, and, when possible, within a 1-mile pumping distance from the bayou. Access for construction and pipeline placement will be dependent on the specific locations of the containment areas, and available ROW. Figure 2-19 is an example sheet from Appendix I that illustrate the approximate size of the upland containment areas for the high volume estimate of dredged material for portions of two dredging reaches; Reach 24 and Reach 25.

Open in-water placement into the Mississippi River would consist of placing dredged material into the flow lane of the Mississippi River. Marsh creation is the other in-water material management option and will consist of placing sediment dredged from Bayou Lafourche into an in-water containment area.

Depending on the size of the containment area, the amount of dredged material placed, water quality limits (such as turbidity), and regulatory approval, it may be beneficial to allow the dredged material to naturally settle and not design full enclosure. If the dredged material would be allowed for beneficial use in land reclamation, it might be possible to use natural containment areas without construction of dikes. Sediment would be controlled within the containment area and allowed to naturally settle for maximum beneficial use.

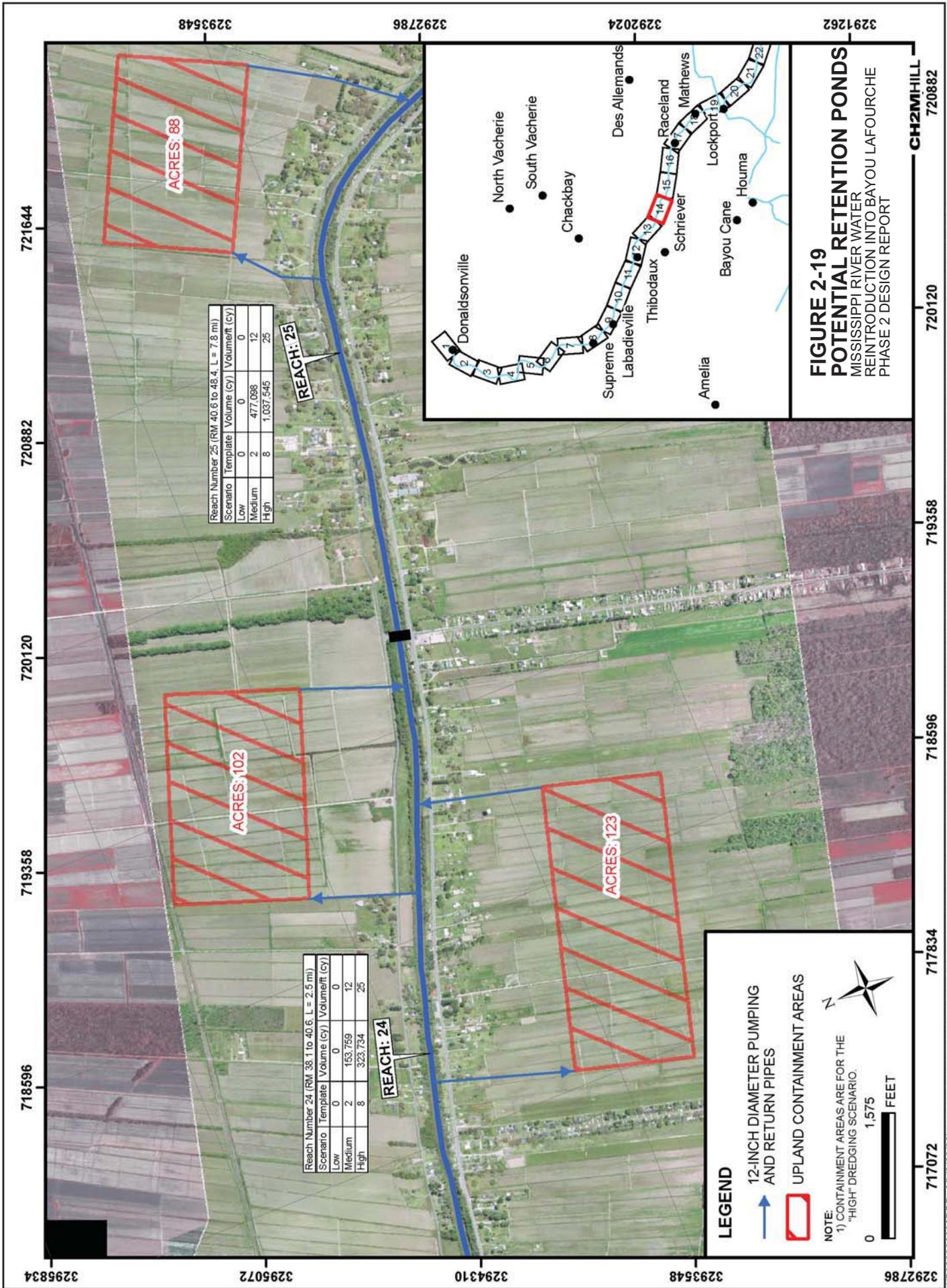
Appendix I, Attachment 2 contains areas that have been identified as potential sites to accept dredged material for wetland creation. This initial evaluation was conducted using available SPOT/Landsat images. Currently, the acreage is known but the available depth, and therefore, the volume is not. Additional investigation is required to determine the available volume. The depth of the potential wetland areas could be determined using sonar or an alternative technology. However, based on acreage and initial estimates, there is sufficient volume available to place a significant percentage of the dredged material. Figure 2-20 is an example sheet from Appendix I that illustrates approximately 500 acres within 5 miles of the bayou for potential placement of dredged material into low land areas for marsh creation.

Based on equal weighting of the evaluation criteria (material acceptability, constructability, and environmental benefits) and existing sediment characterization information, placement into the Mississippi River and reuse of dredged material as agricultural topsoil, construction fill, or marsh creation are viable options for select reaches of the bayou. These dredged material management options are potentially acceptable for all reaches of the bayou, with additional information. Additional information includes landowner acceptability, debris volumes, sediment characterization, and regulatory approvals. In addition, socio-economic and regulatory criteria will likely influence the final acceptability of the various dredged material management options for each reach.

2.2.2.3 Bridge Evaluation

Background and Analysis Procedure. There are 28 bridges in the dredging area of Bayou Lafourche. The bridge support systems are as follows:

- 9 by timber piles
- 11 by reinforced concrete piles
- 7 by reinforced concrete piers supported by piles
- 1 by sheetpile retaining walls



Reach Number 25 (RM 40.6 to 48.4, L = 7.8 mi)

Scenario	Template	Volume (cy)	Volume (cy)	Volume (cy)
Low	0	0	477,098	12
Medium	2	8	1,037,545	25
High	8	8	1,037,545	25

Reach Number 24 (RM 38.1 to 40.6, L = 2.5 mi)

Scenario	Template	Volume (cy)	Volume (cy)	Volume (cy)
Low	0	0	153,759	12
Medium	2	8	323,734	25
High	8	8	323,734	25

LEGEND

- 12-INCH DIAMETER PUMPING AND RETURN PIPES (blue arrow)
- UPLAND CONTAINMENT AREAS (red outline)

NOTE:
1) CONTAINMENT AREAS ARE FOR THE "HIGH" DREDGING SCENARIO.

0 1,575 FEET

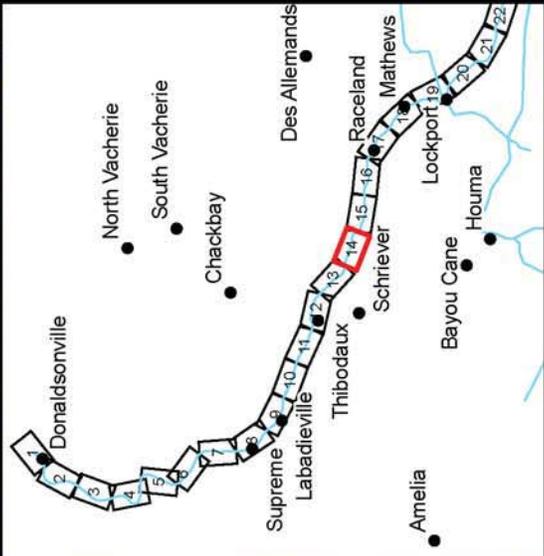


FIGURE 2-19
POTENTIAL RETENTION PONDS
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

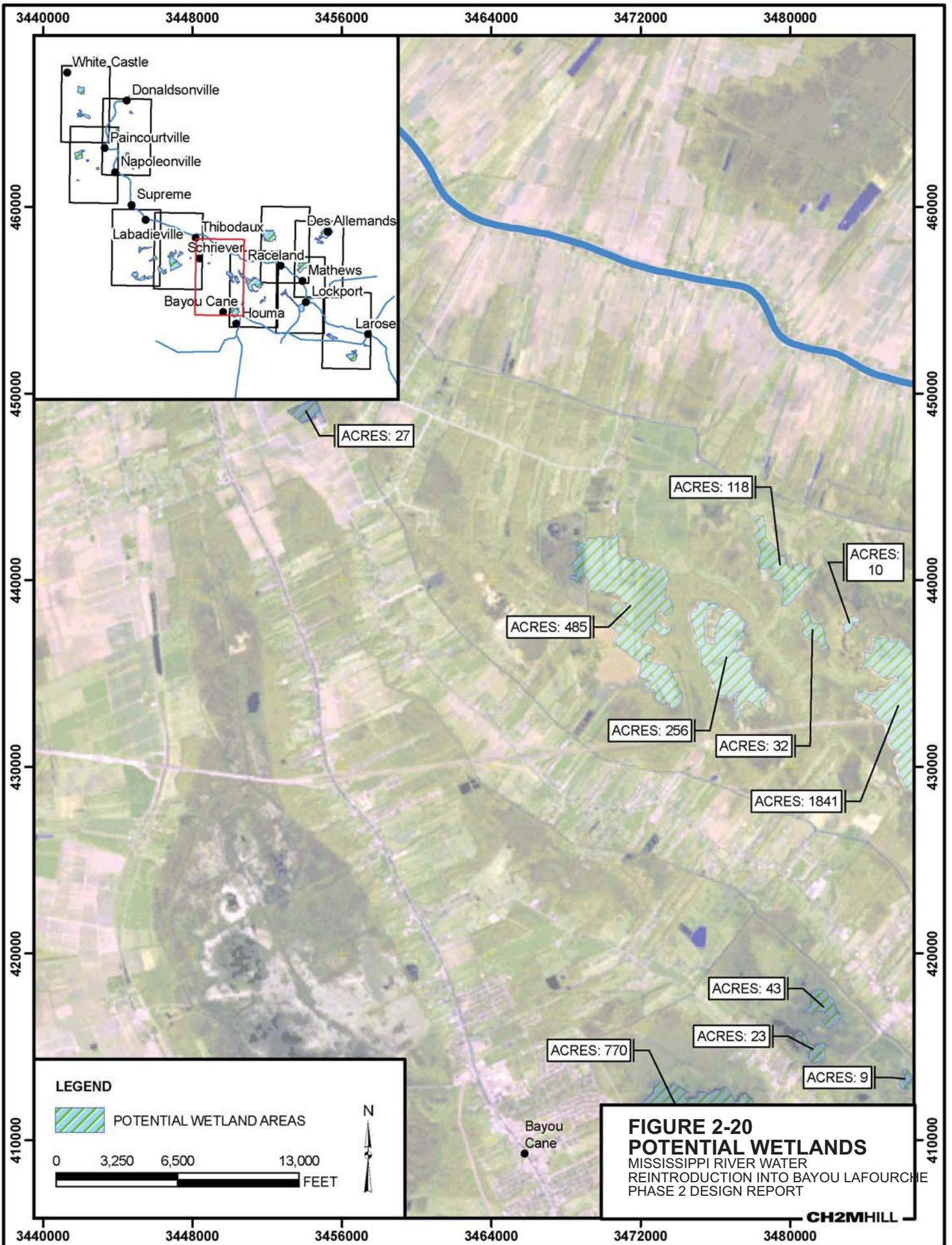


FIGURE 2-20
POTENTIAL WETLANDS
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

A technical memorandum explaining the bridge evaluation is included in Appendix B. The following describes the process used and the results. The Louisiana Department of Transportation and Development (LDOTD) indicated to CH2M HILL that the stability analysis should determine which bridges would have less than a 60 percent pile penetration after dredging and hydraulic scour. LDOTD also suggested that a structural stability analysis for the foundations of two representative bridges having less than 60 percent pile penetration should be completed.

LDOTD recommended that the Highway LA402 bridge (founded on timber pile bents) and Highway LA648 bridge (founded on reinforced concrete pile bents) would be good candidates for a structural stability analysis where additional loss of earthen support due to dredging and scour may cause potential foundation stability problems.

The analysis approach focused on a review of all bridges where dredging would occur to determine if the project would result in less than 60 percent pile penetration for the 8-foot dredge. If there is less than 60 percent pile penetration, additional analysis would be needed to determine if a structural stability problem had been created by dredging.

Both dredging depth (2 feet or 8 feet) and scour depth (based on scour calculations using the proposed flow rates) were used to determine the exposure of the bridge piles and the resulting percent pile penetration. Using bridges with less than the 60 percent penetration guideline, a structural stability analysis was completed on two representative bridges. Structure LA402 is a timber pile supported bridge and structure LA648 is a reinforced concrete pile supported bridge. Results from the structural stability analysis were used to make recommendations for other bridges with similar supporting piles and less than 60 percent pile penetration.

The bridge stability analysis was a three-step process based on the following:

- Pile Penetration Assessment
- Detailed Structural Stability Analysis (i.e., pile buckling analysis)
- Pile Capacity of the Supporting Sub-grade Soils

Conclusions of Analysis. For concrete pile bridges, some piles were exposed more than the 60 percent pile penetration criterion, but the structural analysis of LA 648 revealed that this would not be problematic for buckling. For the remaining concrete pile bridges, it was assumed there would not be a problem with buckling for those bridges with more than 60 percent pile exposure.

The pile buckling capacity of the existing timber pile bridges was evaluated and it was found that the bridges supported by timber pile bents are most susceptible to instability arising from dredging and scour. However, with a relatively simple retrofit strategy, the vertical load carrying capacity of the existing timber piles can be increased to carry the current load demands after dredging and scour. Figure 2-21 presents the bracing strategy plan for retrofit of timber piles.

For 2 feet of dredge depth and up to 2 feet of scour, the pile load capacity provided by the remaining soil does not significantly decrease. None of the bridges analyzed would therefore have to be modified based on soil capacity. Three bridges will require pile bracing

as noted above. Several of the timber pile supported bridges are 30 to 55 years old and within the next 10 to 20 years will reach their normal service life.

For the 8 feet of dredge depth and up to 2 feet of future scour, there is a significant decrease in the load carrying capacity of the piles from the existing condition. Six of the eleven bridges analyzed for pile soil capacity would likely require some type of significant retrofit or may need to be replaced. These bridges were constructed before 1970. As an alternative, the bridges could have load restrictions placed on them given that the dredging has reduced their capacity. In addition to the replacement bridges, four remaining timber pile bridges would need bracing.

Recommendations. Table 2-4 lists bridges between Donaldsonville and Lockport along with bracing and replacement recommendations for each of the Phase 2 alternatives. The following summary of recommendations is provided to aid in the design and to estimate construction costs.

For the 2-foot dredging alternatives, additional study to verify assumptions is recommended. The following procedure would be used:

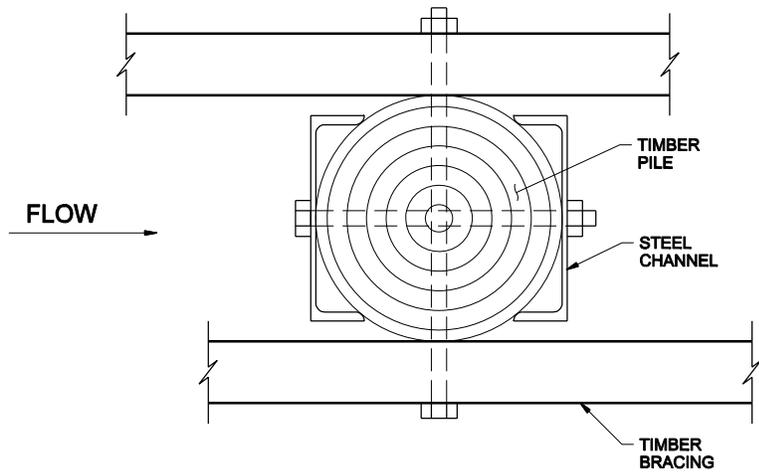
1. Prior to proceeding with the development of final design details, the existing timber pile size, supporting and bracing member size and condition should be verified in the field.
2. Each bridge cross section should be field surveyed for the specific dredging template to be constructed.
3. Each bridge should have structural and geotechnical analyses performed including determination of material properties of the timber piles.
4. Each bridge location should have one boring drilled in the bayou to estimate new soil strength properties near the bridge.

For the 8-foot dredging alternatives, additional study for verification of replacement and bracing assumptions is recommended. The following procedure would be used:

1. Complete structural and geotechnical evaluations should be performed on each bridge.
2. Before proceeding with the development of final design details, the existing timber pile size, supporting and bracing member size, and condition should be verified in the field.
3. Additional borings should be drilled at each bridge from within the bayou.
4. Each bridge cross section should be field surveyed for the specific dredging template to be constructed.

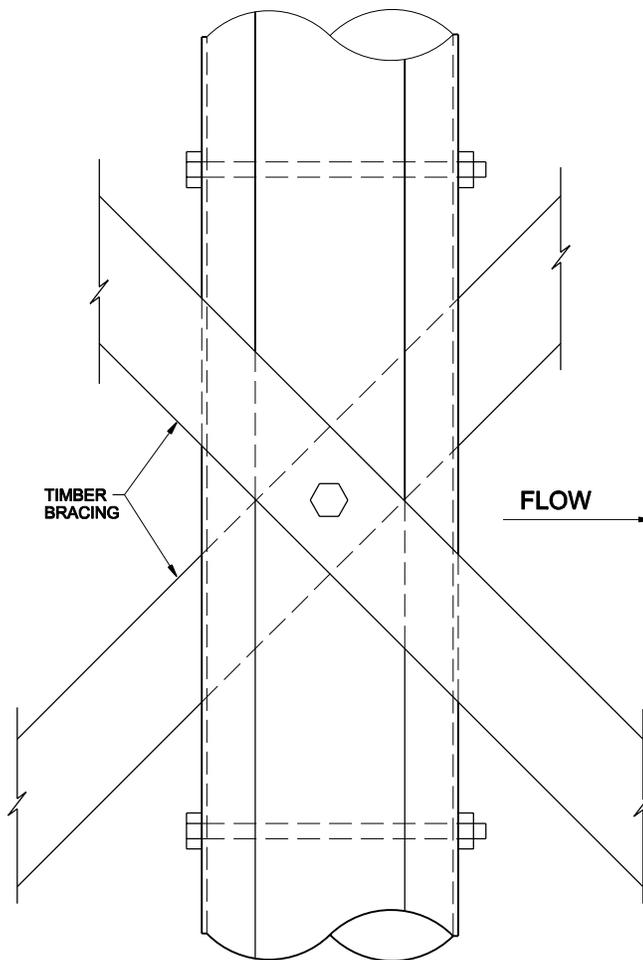
2.2.2.4 Union Pacific Railroad Bridge Replacement

The existing railroad crossing at Donaldsonville has an earthfill foundation with three culverts near its base. There are two 8.33-foot-diameter steel pipes and one 5-foot by 6-foot concrete box culvert. Currently a significant head build up on the upstream side forces water through the conduits. A majority of the seven remaining alternatives, include replacement of this bridge with an open supported bridge structure, to alleviate the existing hydraulic constriction. The UPRR Bridge in Donaldsonville is the most costly bridge replacement on the project. Discussions with UPRR about the replacement have been very



PLAN

NTS



ELEVATION

NTS

FIGURE 2-21
TIMBER PILE RETROFIT STRATEGY
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

TABLE 24

Bridge Replacement Recommendations

Original Spreadsheet provided by LDOT with additions/modifications (see Legend below)										Bridge Data by CH2M HILL					Replacement Recommendations for Phase 1 Alternatives ^a				
River Mile	Bridge Name	Par	Route	Struc. Number	Map 113 Code	Information Available	Date Constructed	Bridge Length (ft)	Bridge Width (ft)	Bridge Deck Area (ft ²)	Alt. #15, BL (2'-0"RM29) ^b	Alt. #20, BL (2'-0"RM29) ^b	Alt. #32, BL (8'-2"RM29) ^b	Alt. #38, BL (2'-0"RM29) ^b	Alt. #44, SB (8'-All) ^b	Alt. #47, SB (8'-All) ^b	Alt. #48, SB (8'-All) ^b		
1	BL0096	Mechand Bridge	3	9260100007	U	Initial Scour Assessment	1989	120	60	7,200	V	V	S	V	-	-	-		
2	BL0125	Cy-Hans Bridge	3	600302	U	Initial Scour Assessment	No Data	No Data	No Data	No Data	V	V	S	V	-	-	-		
3	BL0324	Hwy 943 Bridge	3	61033003200001	8	Initial Scour Assessment	1981	220	33	7,500	V	V	S	V	-	-	-		
4	BL0622	Hwy 998 Bridge	4	61048043600021	8	Initial Scour Assessment	1971	191	32	6,100	S,B	S,B	S,B	S,B	S,B	S,B	S,B		
5	BL0100	Hwy 70 Bridge	4	61042232000041	8	Initial Scour Assessment	No Data	242	80	19,400	V	V	S,R	V	S,R	S,R	S,R		
6	BL0106	Hwy 403 Bridge	4	61048041009651	8	Initial Scour Assessment	1971	191	32	6,100	S,B	S,B	S,B	S,B	S,B	S,B	S,B		
7	BL0122	Hwy 70 Spur Bridge	4	61048044001521	8	Initial Scour Assessment	1969	242	47	11,400	V	V	S	V	-	-	-		
8	BL0225	Phillipsville Bridge	4	910141	8	Initial Scour Assessment	1983	171	27	4,600	V	V	S	V	-	-	-		
9	BL0151	Hwy 402 Bridge	4	6104804102481	8	Initial Scour Assessment	1975	210	32	6,000	S,B	S,B	S,B	S,B	S,B	S,B	S,B		
10	BL0151	Hwy 402 Bridge	4	6104804102481	8	Initial Scour Assessment	1975	210	32	6,000	S,B	S,B	S,B	S,B	S,B	S,B	S,B		
11	BL0151	Hwy 1008 Bridge, Franklin Ave.	4	61048041102481	8	Phase 1 - Hydraulic Data Table													
12	BL0151	Hwy 1010 St. Thomas Bridge	4	61048041102481	8	Phase 1 - Hydraulic Data Table													
13	BL0250	Hwy 1011 Supreme Sugar Bridge	4	61048041200041	8	Initial Scour Assessment	1947	235	29	6,500	V	V	S,R	V	S,R	S,R	S,R		
14	BL0350	Hwy 1287 Labadieville Bridge	4	61048043500011	8	Initial Scour Assessment	1952	216	24	5,200	V	V	S	V	S	S	S		
15	BL0350	St. John's Bridge	4	294993952819325	8	Initial Scour Assessment	1950	263	34	8,900	V	V	S,R	V	S,R	S,R	S,R		
16	BL0350	LA 3165 Bridge	29	02298292500001	8	Initial Scour Assessment	2004	160	31	5,600	-	-	-	-	-	-	-		
17	BL0350	Tiger Dr. Bridge	29	02298292500001	8	Initial Scour Assessment	1985	160	49	8,600	-	-	-	-	-	-	-		
18	BL0350	Jackson Bridge	29	02298292500001	8	Initial Scour Assessment	No Data	No Data	No Data	No Data	-	-	-	-	-	-	-		
19	BL0450	Thibodaux Weir	29	294783904912168	8	Initial Scour Assessment	No Data	190	48	9,100	-	-	-	-	-	-	-		
20	BL0450	Canal Bridge, State Route 20	29	02298292500001	8	Initial Scour Assessment	1966	220	27	5,900	-	-	-	-	-	-	-		
21	BL0450	Peledrian Bridge	29	02298292500001	8	Initial Scour Assessment	No Data	No Data	No Data	No Data	-	-	-	-	-	-	-		
22	BL0450	Audubon Bridge	29	294783904912168	8	Initial Scour Assessment	1985	228	30	6,800	-	-	-	-	-	-	-		
23	BL0450	Percy Brown Bridge	29	294783904912168	8	Initial Scour Assessment	1987	200	35	7,000	-	-	-	-	-	-	-		
24	BL0450	St. Charles Bridge	29	02298292500001	8	Initial Scour Assessment	No Data	No Data	No Data	No Data	-	-	-	-	-	-	-		
25	BL0450	Receand 1 Bridge	29	294383935411650	U	Initial Scour Assessment	1992	167	63	7,500	-	-	-	-	-	-	-		
26	BL0450	Receand 2 Bridge	29	022980650700011	U	Initial Scour Assessment	1986	196	30	5,800	-	-	-	-	-	-	-		
27	BL0450	Hwy 90 Overpass	29	022980650700011	U	Initial Scour Assessment	No Data	241	34	8,200	-	-	-	-	-	-	-		
28	BL0450	Bayou Crossing Bridge	29	02298292500001	8	Initial Scour Assessment	1973	500	103	51,500	-	-	-	-	-	-	-		
29	BL0450	Lockport Bridge	29	02298292500001	8	Initial Scour Assessment	1941	203	24	4,900	-	-	-	-	-	-	-		
30	BL0625	Valentine Bridge	29	02298291440791	U	Initial Scour Assessment	1999	243	88	21,400	-	-	-	-	-	-	-		
31	BL0625	Valentine Bridge	29	6104232300851	8	Initial Scour Assessment	1939	253	27	6,800	-	-	-	-	-	-	-		
32	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	No Data	No Data	No Data	-	-	-	-	-	-	-		
33	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1986	196	30	5,800	-	-	-	-	-	-	-		
34	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	241	34	8,200	-	-	-	-	-	-	-		
35	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1973	500	103	51,500	-	-	-	-	-	-	-		
36	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1941	203	24	4,900	-	-	-	-	-	-	-		
37	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1999	243	88	21,400	-	-	-	-	-	-	-		
38	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1939	253	27	6,800	-	-	-	-	-	-	-		
39	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	No Data	No Data	No Data	-	-	-	-	-	-	-		
40	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1986	196	30	5,800	-	-	-	-	-	-	-		
41	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	241	34	8,200	-	-	-	-	-	-	-		
42	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1973	500	103	51,500	-	-	-	-	-	-	-		
43	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1941	203	24	4,900	-	-	-	-	-	-	-		
44	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1999	243	88	21,400	-	-	-	-	-	-	-		
45	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1939	253	27	6,800	-	-	-	-	-	-	-		
46	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	No Data	No Data	No Data	-	-	-	-	-	-	-		
47	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1986	196	30	5,800	-	-	-	-	-	-	-		
48	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	241	34	8,200	-	-	-	-	-	-	-		
49	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1973	500	103	51,500	-	-	-	-	-	-	-		
50	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1941	203	24	4,900	-	-	-	-	-	-	-		
51	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1999	243	88	21,400	-	-	-	-	-	-	-		
52	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1939	253	27	6,800	-	-	-	-	-	-	-		
53	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	No Data	No Data	No Data	-	-	-	-	-	-	-		
54	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1986	196	30	5,800	-	-	-	-	-	-	-		
55	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	241	34	8,200	-	-	-	-	-	-	-		
56	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1973	500	103	51,500	-	-	-	-	-	-	-		
57	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1941	203	24	4,900	-	-	-	-	-	-	-		
58	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1999	243	88	21,400	-	-	-	-	-	-	-		
59	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1939	253	27	6,800	-	-	-	-	-	-	-		
60	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	No Data	No Data	No Data	-	-	-	-	-	-	-		
61	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1986	196	30	5,800	-	-	-	-	-	-	-		
62	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	241	34	8,200	-	-	-	-	-	-	-		
63	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1973	500	103	51,500	-	-	-	-	-	-	-		
64	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1941	203	24	4,900	-	-	-	-	-	-	-		
65	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1999	243	88	21,400	-	-	-	-	-	-	-		
66	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1939	253	27	6,800	-	-	-	-	-	-	-		
67	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	No Data	No Data	No Data	-	-	-	-	-	-	-		
68	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1986	196	30	5,800	-	-	-	-	-	-	-		
69	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	241	34	8,200	-	-	-	-	-	-	-		
70	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1973	500	103	51,500	-	-	-	-	-	-	-		
71	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1941	203	24	4,900	-	-	-	-	-	-	-		
72	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1999	243	88	21,400	-	-	-	-	-	-	-		
73	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1939	253	27	6,800	-	-	-	-	-	-	-		
74	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	No Data	No Data	No Data	No Data	-	-	-	-	-	-	-		
75	BL0625	Valentine Bridge	29	022980649000001	8	Initial Scour Assessment	1986	196	30</										

limited however, the best indication is that UPRR would support construction of shoo fly tracks, including a new trestle bridge. The existing embankment would then be demolished and the new shoofly trestle would become the permanent alignment. A plan view of the proposed bridge replacement alignment is presented in Appendix P, Drawing 10-C-80.

2.2.2.5 Utility Protection and Relocation

The investigation of utilities began with a list of pipeline crossings provided in the EPA summary report (1998 Summary Report). The list was later supplemented from survey data of oil and gas pipeline crossings in Louisiana (Oil Spill Research and Development Program, Louisiana Oil Spill Coordinator's Office, Baton Rouge, Louisiana Geological Survey, 2002).

Using the combination of the two lists, field surveys were completed as part of the project by T. Baker-Smith, Inc., in 2004 to locate as many utilities as possible. The field surveys also found additional utilities that were not part of either list.

The EPA, Louisiana Oil Spill Coordinator's Office, and field survey data for utility crossings were combined to provide a total of 107 known utility crossings under Bayou Lafourche. The utility crossings varied in size, pipeline material type, pressure, and transported fluids (gas or liquid). The list consists of many different utility types. Some of the most common pipeline crossings were:

- Gas (ranging in diameter from 1 inch to 36 inches)
- Oil (ranging in diameter from 6 inch to 36 inches)
- Natural gas (ranging in diameter from 4 inch to 30 inches)
- Water (ranging in diameter from 4 inch to 16 inches)
- Crude oil (ranging in diameter from 8 inch to 36 inches)

Based upon the specific alternatives dredging template, many utilities would require replacement. A minimum of 3 feet of cover was used as a criterion for replacement and utilities with unknown depths (not located by surveyors) were assumed to be replaced.

For each of the seven alternatives remaining with associated dredging templates, the following number of utilities would require replacement:

- Alternatives 15 and 38, 2-foot and 0-foot @ RM 29: 40
- Alternatives 20 and 44, 2-foot ALL: 72
- Alternative 32, 8-foot and 2-foot @ RM 29: 89
- Alternative 47 and Least Rise, 8-foot ALL: 99

Through discussions with utility companies and industrial process engineers in the oil and gas industry, it was concluded that horizontal directional drilling (HDD) is typically the replacement method of choice.

Based on general design guidelines for HDD, replacement lengths were determined for each utility crossing. A common depth of 15 feet below the dredged invert (used for both the 2- and 8-foot template) was used for design. Replacement length depended heavily on pipeline diameter because of the entrance and exit angles necessary to achieve the replacement depth without exceeding specific pipe material (typically steel) bending criteria. The replacement lengths (from entry point to exit point) ranged from 250 to 1,100 feet. For those utilities of unknown pipe diameter an estimated length of 600 feet was

used with a diameter that appeared common to the type of utility (e.g., water, wastewater, oil, natural gas). Figure 2-22 shows a typical plan and section view for utility relocation using horizontal direction drilling methods. Table 2-5 below presents a list of utility crossings, location, ownership, and replacement by alternative.

It has not yet been determined specifically how much of the pipeline relocation costs would be borne by the project. In some cases, the burden of a relocation may clearly fall on the owner because of permit conditions. In other cases, the cost of relocation may be voluntarily borne by the owner. For the purposes of this Phase 2 Design Report, it was assumed that 100 percent of the relocation costs are included within the project budget.

2.2.2.6 Bank Stabilization

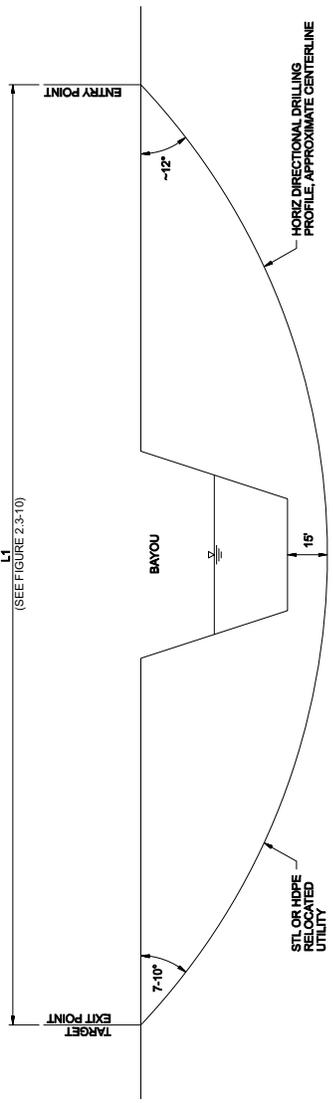
Background. Bayou Lafourche is a natural channel that conveys water from the Mississippi River. The water enters the bayou through the Donaldsonville pump station via gravity, pumping and some groundwater discharge. Since the channel was isolated around 1900 by the river levee, flows have been controlled and the channel alignment has not changed. This has led to human development and modification such as grading, residential and commercial buildings, boat access ramps, boat docks, bridges, and cultivation. Currently the slopes outside the water channel are generally heavily vegetated. Where residential structures are located at the top of the slope, lawns and managed vegetation is generally present. It is apparent that many of these slopes have been graded to create a gentle slope down to a short retaining structure at the water edge. Flat areas at the top of the slope have been widened by filling toward the channel.

Bank Geometry. Based on many soundings of the channel, the depth of the bayou ranges from as little as 3 to 4 feet near Donaldsonville to about 5 to 6 feet in the Thibodaux area. Deeper areas may exist near Lockport for boat navigation, but limited bathometric information was available. Slopes near the shoreline in the upper reaches are very flat due to deposition of sediment. Their height ranges from 14 feet near Donaldsonville to 12 feet in Thibodaux to 8 feet at Lockport.

Natural slopes above the water surface in heavily vegetated near-natural areas are 1.1H:3.1V but are near vertical in some areas where grading has occurred. It is very difficult to estimate the original natural slopes as vegetation grows very rapidly and, with grading the exposed soil is rapidly covered with vegetation. Many structures are constructed on split level foundations with wood or concrete wall supporting the ground floor.

For the alternatives under consideration to increase flows down the bayou, the following may occur: water surface raised, channel dredged 2 feet in some areas, channel dredged 8 feet in some areas, or a combination of all of these. In addition, scour up to 2 feet is anticipated for some alternatives. This earthwork would change the geometry of the channel below the water line. It may also affect the stability of the slopes above the water line.

Soil Conditions. Twenty borings were drilled to sample soils along the bayou. Typically, a boring was drilled on the land and one in the channel. With approximately 50 miles of channel from Donaldsonville to Lockport, the average boring spacing was 5 miles. Bridge subsurface information was also reviewed but due to the age of the records the information is somewhat spotty.



TYPICAL DIRECTIONAL DRILLING SECTION
NTS

FIGURE 2-22
UTILITY RELOCATION
HORIZONTAL DIRECTIONAL DRILL
MISSISSIPPI RIVER WATER
REINTRODUCTION INTO BAYOU LAFOURCHE
PHASE 2 DESIGN REPORT

- NOTES:**
1. REPLACE EXST UTILITY PIPELINE WITH EQUAL DIAMETER PIPING.
 2. REPLACE EXST PIPELINES WITH MATERIAL OF OWNERS REQUEST.

TABLE 2-5
Bayou Lafourche Utilities Relocation Data

Station	Pipe Material and Diameter	Pipeline Owner	Required Replacement (by Dredging Alternative)				HDD Lengths (DWG 10-c-77) Based on N8' Dredge ^a	
			2-0 (RM 29) (Alt. 15 & 38)	2-ALL (Alt. 20 & 44)	8-2 (RM 29) (Alt. 32)	8-All (Alt. LR & 47)	Lf (ft)	L2 (ft)
55+27	12" Potable Water PVC	Peoples Water Service of Donaldsonville	X	X	X	X	630	640
177+10	6" Gas HVL	Bridgeline	X	X	X	X	440	450
177+45	6" Natural Gas	Texaco	X	X	X	X	440	450
177+65	24" Natural Gas	Texaco	X	X	X	X	900	910
177+95	8" Crude Oil, Steel	Ashland Chemical Company	X	X	X	X	520	530
178+40	6" Potable Water, PVC	Peoples Water Service of Donaldsonville	X	X	X	X	440	450
179+30	Ethane	Williams Energy ^b			X	X	600	600
184+97	6" Ethane, Steel	Union Texas Petrochemicals Corp.	X	X	X	X	440	450
185+10	6" Crude Oil, Steel	Union Texas Petrochemicals Corp.	X	X	X	X	440	450
186+00	6" Gas, Steel	City of Donaldsonville	X	X	X	X	440	450
212+28	12" Natural Gas	Texaco	X	X	X	X	630	640
212+50	16" Natural Gas	Texaco	X	X	X	X	730	740
233+57	6" Promix, Enterprise	Acadian Gas, LLC	X	X	X	X	440	450
233+69	8" Promix, Enterprise	Acadian Gas, LLC	X	X	X	X	520	530
233+80	12" Gas, Steel	Bridgeline	X	X	X	X	630	640
234+00	20" Gas, Steel	Bridgeline	X	X	X	X	820	840
234+15	20" Gas, Steel	Acadian Gas, LLC	X	X	X	X	820	840
251+95	6" Water, Cast Iron	Assumption Parish Water Dist No. 1	X	X	X	X	440	450
252+00	24" Gas, Steel	LA Intrastate Gas			X	X	900	910
256+50	2" Gas, Steel	Trans LA Gas Comp.	X	X	X	X	250	265
314+86	8" Water, PE	Assumption Parish Water Dist No. 1	X	X	X	X	520	530
335+66	8" Water, PE	Assumption Parish Water Dist No. 1	X	X	X	X	520	530
335+70	2" Gas, Steel	Trans LA Gas Comp.	X	X	X	X	250	265
371+82	36" Crude Oil	Shell Pipeline Company, L.P.			X	X	1,100	1,130
371+92	36" Oil, Coated Steel	Shell Pipeline Company, L.P.			X	X	1,100	1,130
372+08	16" Crude Oil (Imported)	Exxon Mobil Pipeline	X	X	X	X	730	740
372+22	16" Crude Oil (Domestic)	Exxon Mobil Pipeline	X	X	X	X	730	740
372+37	20" Gas, Steel	Acadian Gas, LLC	X	X	X	X	820	840
411+14	8" Water, Cast Iron	Assumption Parish Water Dist No. 1	X	X	X	X	520	530
435+57	36" Gas, Steel	Duke Energy ^b					--	--

TABLE 2-5
Bayou Lafourche Utilities Relocation Data

Station	Pipe Material and Diameter	Pipeline Owner	Required Replacement (by Dredging Alternative)				HDD Lengths (DWG 10-c-77) Based on N8' Dredge ^a		
			2-0 (Alt. 15 & 38)	2-ALL (Alt. 20 & 44)	8-2 (Alt. 32)	8-ALL (Alt. LR & 47)	Lf (ft)	Lf (ft)	L2 (ft)
455+00	36" Gas, Steel	LA Intrastate Gas	X	X	X	X	1,100	1,130	
456+50	20" Gas, Steel	Acadian Gas, LLC	X	X	X	X	820	840	
456+75	8" Liquid Anhydrous Ammonia	Kaneb Pipe Line Operating, LP.	X	X	X	X	520	530	
481+94	12" Promix, Enterprise	Bell Rose Pipeline NGL (Acadian)	X	X	X	X	630	640	
500+05	2" Gas, Steel	Trans LA Gas Comp.	X	X	X	X	250	265	
536+12	8" Water, PE	Assumption Parish Water Dist No. 1	X	X	X	X	520	530	
573+68	8" Water, Cast Iron	Assumption Parish Water Dist No. 1	X	X	X	X	520	530	
667+54	2" Gas, Steel	Trans LA Gas Comp.	X	X	X	X	250	265	
776+64	8" ETH; Steel	UCAR Pipeline Inc	X	X	X	X	520	530	
776+64	8" LPG, Steel	UCAR Pipeline Inc	X	X	X	X	520	530	
776+72	8" ETH; Steel	UCAR Pipeline Inc	X	X	X	X	520	530	
776+72	8" LPG, Steel	UCAR Pipeline Inc	X	X	X	X	520	530	
803+07	1" Gas	E. Sundbery	X	X	X	X	250	260	
822+45	12" Brine, Steel	Paul Bradley Energy	X	X	X	X	630	640	
822+62	2" Gas, Steel	Trans LA Gas Comp.	X	X	X	X	250	265	
846+40	2" Gas, Steel	Acadian Gas, LLC	X	X	X	X	250	265	
864+65	5" Cable, Steel Armor Cable	Bell South	X	X	X	X	400	410	
875+30	8" Water, Cast Iron	Assumption Parish Water Dist No. 1	X	X	X	X	520	530	
956+55	2" Gas, Steel	Trans LA Gas Comp.	X	X	X	X	250	265	
1081+40	8" Water, Cast Iron	Assumption Parish Water Dist No. 1	X	X	X	X	520	530	
1138+90	1" Gas, Steel	Trans LA Gas Comp.	X	X	X	X	250	260	
1254+75	4" Gas, Steel	Acadian Gas, LLC	X	X	X	X	360	370	
1338+26	2" Cables, Steel Armor	Bell South	X	X	X	X	250	265	
1338+26	2" Cables, Steel Armor	Bell South	X	X	X	X	250	265	
1339+70	6" Water, Cast Iron	Assumption Parish Water Dist No. 1	X	X	X	X	440	450	
1421+60	6" Water, Cast Iron	Assumption Parish Water Dist No. 1	X	X	X	X	440	450	
1479+70	4" Water, Steel	North Lafourche Water District No. 1	X	X	X	X	360	370	
1481+60	20" Crude Oil, Conc. Coated	Shell Pipeline Company, LP. ^c					--	--	
1483+65	14" Brine	Texas Brine Company, LLC			X	X	680	690	
1528+05	8" Water, Steel	North Lafourche Water District No. 1 ^c					--	--	
1574+90	2" Gas, Steel	Trans LA Gas Comp.	X	X	X	X	250	265	

TABLE 2-5
Bayou Lafourche Utilities Relocation Data

Station	Pipe Material and Diameter	Pipeline Owner	Required Replacement (by Dredging Alternative)				HDD Lengths (DWG 10-c-77) Based on N8' Dredge ^a					
			2-0 (RM 29) (Alt. 15 & 38)	2-ALL (Alt. 20 & 44)	8-2 (RM 29) (Alt. 32)	8-All (Alt. LR & 47)	Lf (ft)	Lf (ft)	L2 (ft)			
1578+75	4" Gas, Steel	Energy Mana. Corp.										
1603+00	4" Water, Steel	North Lafourche Water District No. 1	X	X	X	X	X	360	370			
1625+10	4" Gas, Steel	Acadian Gas, LLC ^c										
1641+10	8" Gas, Steel	Acadian Gas, LLC	X		X			520	530			
1660+00	10", Gas	Texas Gas Transmission, LLC						580	590			
1717+65	30" Gas, Conc. Coated Steel Pipe	Williams Energy						1,000	1,010			
1718+05	30" Gas, Conc. Coated Steel Pipe	Williams Energy ^c										
1718+50	24" Gas, Conc. Coated Steel Pipe	Williams Energy										
1726+00	8" Water, Steel	North Lafourche Water District No. 1	X		X			900	910			
1742+70	6" Water, Steel	North Lafourche Water District No. 1	X		X			520	530			
1753+20	16" Water, Ductile Iron	City of Thibodaux	X		X			440	450			
1772+00	Sewer Force Main	City of Thibodaux ^b						730	740			
1776+85	6" Water	City of Thibodaux ^c						600	600			
1777+60	6" Gas, PE	City of Thibodaux										
1777+80	6" Water, Cast Iron	City of Thibodaux	X		X			440	450			
1792+40	3" Gas, CI	City of Thibodaux	X		X			440	450			
1792+50	6" Water, CI	City of Thibodaux	X		X			310	350			
1803+85	8" Water, Steel	City of Thibodaux						440	450			
1803+85	12" Water, Ductile Iron	City of Thibodaux						520	530			
1807+65	4" Gas, Steel	City of Thibodaux	X		X			630	640			
1837+60	16" Water, Ductile Iron	City of Thibodaux ^c						360	370			
1876+65	12" Water, Steel	North Lafourche Water District No. 1										
1899+60	8" Gas, Conc.	Williams Energy						630	640			
1930+20	10" Water, Steel	North Lafourche Water District No. 1						520	530			
2019+90	Gas	South Coast Gas ^b						580	590			
2037+75	20" Gas, Steel	Bridgeline	X		X			600	600			
2038+00	Water	North Lafourche Water District No. 1 ^b						820	840			
2054+15	18" Crude Oil	Shell Pipeline Company, L.P.	X		X			600	600			
210+85	Gas	South Coast Gas ^b	X		X			780	790			
2182+75	Water	Lafourche Parish Water District ^b	X		X			600	600			

TABLE 2-5
Bayou Lafourche Utilities Relocation Data

Station	Pipe Material and Diameter	Pipeline Owner	Required Replacement (by Dredging Alternative)			HDD Lengths (DWG 10-c-77) Based on N8' Dredge ^a			
			2-0 (RM 29) (Alt. 15 & 38)	2-ALL (Alt. 20 & 44)	8-2 (RM 29) (Alt. 32)	8-All (Alt. LR & 47)	Lf (ft)	L2 (ft)	
2390+85	Water	Lafourche Parish Water District ^b		X	X	X	X	600	600
2485+20	4" Natural Gas	Eagle Natural Gas Co.		X	X	X	X	360	370
2611+90	Water	Lafourche Parish Water District ^b		X	X	X	X	600	600
2631+35	8" Crude Oil	Central Crude		X	X	X	X	520	530
2637+85	12" Natural Gas	Koch Pipeline Co.		X	X	X	X	630	640
2637+85	16" Natural Gas	Koch Pipeline Co.		X	X	X	X	730	740
2637+85	30" Natural Gas	Koch pipeline Co.		X	X	X	X	1,000	1,010
2639+00	Gas	Gulf South Pipeline ^b		X	X	X	X	600	600
2660+35	Gas	Columbia Gulf Transmission ^b		X	X	X	X	600	600
2746+50	Electric	--		X	X	X	X	600	600
2798+75	Gas	South Coast Gas ^b		X	X	X	X	600	600
2878+35	Cable	--		X	X	X	X	600	600
2880+40	Gas	South Coast Gas ^b		X	X	X	X	600	600
2903+50	Water	Lafourche Parish Water District ^b		X	X	X	X	600	600
2960+75	Water	Lafourche Parish Water District ^b		X	X	X	X	600	600
2973+85	Cable	South Central Bell ^b		X	X	X	X	600	600
Total			40	72	89	99			

^aHDD lengths are based on pipe diameter.

^bLengths with unknown diameter were set at a standard of L1 - 600', L2 = 600'.

^cNo replacement work required.

Soils encountered in most borings were silty clay to clayey silt with fine sand lenses. Over 98 percent of the samples logged were low to high plasticity clay. In boring 2005-12 located on the left side of the bayou 1 mile upstream of the Palo Alto Bridge in Donaldsonville, a 25-foot-thick layer of silty sand was found. In several other borings a 5-foot-thick sand layer was encountered near a depth of 30 feet.

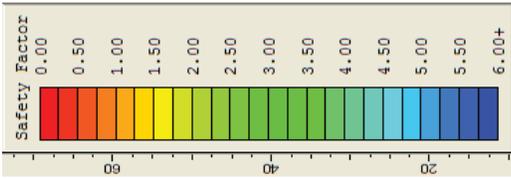
Grain size analyses including hydrometer tests were run on samples from within the bayou at a depth of 2 feet below the channel bottom. All samples from the channel were classified as silt or silty clay except Boring 2005-21 (just below Donaldsonville Railroad Bridge), which had silty sand.

Based on the borings, the soils along the bayou are nearly all cohesive materials. Shear strength testing done at each boring had a wide range of values. The softest materials were in the upper 3 to 5 feet of the bottom of the bayou. Generally, the materials from Donaldsonville to Thibodaux are stronger than the materials in or downstream of Thibodaux. There is thick vegetation on the banks of the bayou and no slope failures were visible from the water during a reconnaissance in 2005. There has been no significant damage to the bayou shoreline due to the effects of recent hurricanes Katrina and Rita.

Stability Analysis. A bank stability analysis was made to evaluate the potential stability impacts to slopes that are not retained by retaining walls or other existing man-made structures. The potential changes to the water surface and dredging of the channel would cause changes to the appearance and stability of the slopes. To evaluate these changes a stability analysis was made on five cross sections spaced along the bayou from Donaldsonville to Lockport. The program Slide was used with the soil strength parameters from the borings. Runs were made for 2 and 8 feet of dredging with 2 feet of scour added. A rapid drawdown analysis was done for 2 feet of drawdown to simulate fluctuations in the water surface during rainfall periods or pump station flow fluctuations. The dredging template of an under water slope of 2.5H:1V was used.

A typical cross section (Station 1735+10) of the right bank looking downstream with 2 feet of dredging is shown on Figure 2-23. The stability analysis utilizes soil strength input for the various layers of materials. These strength parameters were derived from the nearby soil borings. The stability program searches approximately 5,000 different circles to locate the one with the lowest factor of safety. A factor less than 1.0 indicates that the slope may fail. To account for variations, a target factor of safety of 1.5 is recommended for static conditions with no drawdown. With a calculated factor of safety of 1.07 for the cross section shown, bulkheading could be required. More borings are needed in this area to refine the limits of the soft clay layer. It may be limited to just one property but could also be indicative of a longer reach. For the Phase 2 analysis, it was assumed that the soft soil extended for some distance upstream and downstream of Station 1735+10.

The stability results with 2 feet of dredging and a bulkhead added are shown on Figure 2-24. The bulkhead serves to add shear strength to the slope and retain materials above the water that may move downslope. With a factor of safety of 1.47 the slope is deemed acceptable. Similar analyses were made for 2 feet of dredging with 2 feet of drawdown. The same type of analysis was performed for the other 4 cross sections using 8 feet of dredging. All stability results are summarized on Table 2-6 for the five cross sections.



Material Properties	
Material: Material 1	Unit Weight: 115 lb/ft ³
	Cohesion Type: Constant
	Cohesion: 200 psf
Material: Material 2	Unit Weight: 118 lb/ft ³
	Cohesion Type: Constant
	Cohesion: 300 psf
Material: Material 3	Unit Weight: 120 lb/ft ³
	Cohesion Type: Constant
	Cohesion: 500 psf
Material: Material 4	Unit Weight: 104 lb/ft ³
	Cohesion Type: Constant
	Cohesion: 35 psf
Material: Material 5	Unit Weight: 118 lb/ft ³
	Cohesion Type: Constant
	Cohesion: 600 psf

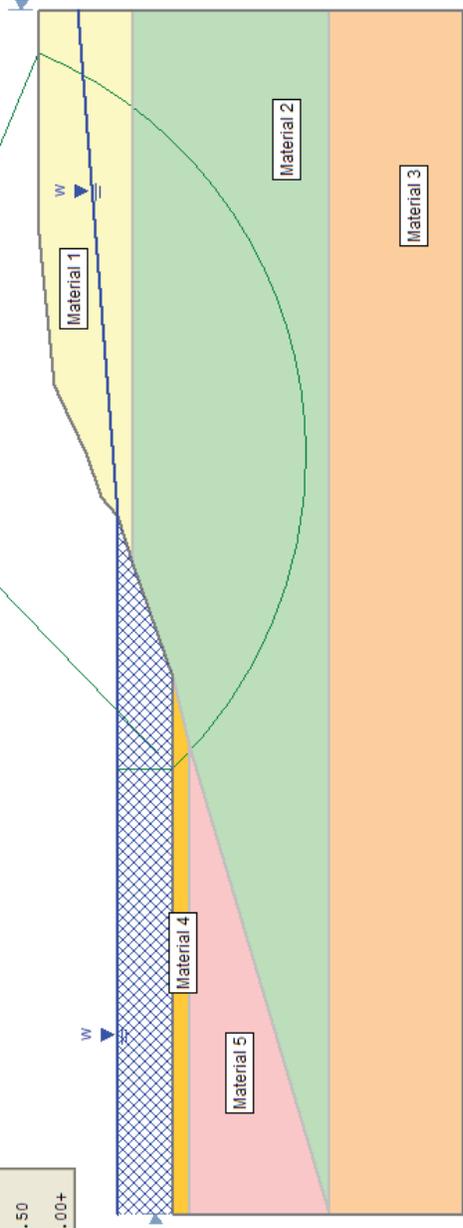
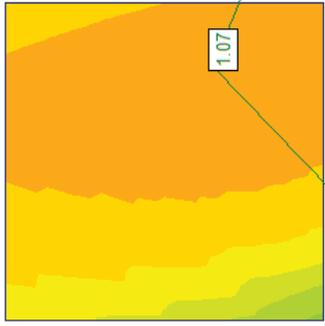
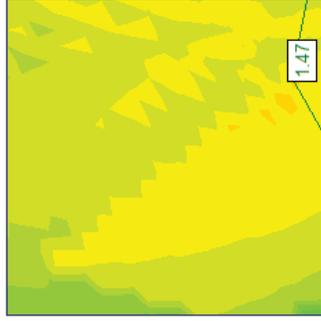
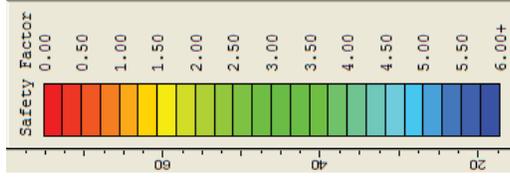


FIGURE 2-23
BANK STABILITY ANALYSIS
TYPICAL CROSS SECTION
2-FOOT DREDGE NO BULKHEAD
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



Material Properties	
Material: Material 1	Unit Weight: 115 lb/ft ³
	Cohesion Type: Constant
	Cohesion: 200 psf
Material: Material 2	Unit Weight: 118 lb/ft ³
	Cohesion Type: Constant
	Cohesion: 300 psf
Material: Material 3	Unit Weight: 120 lb/ft ³
	Cohesion Type: Constant
	Cohesion: 500 psf
Material: Material 4	Unit Weight: 104 lb/ft ³
	Cohesion Type: Constant
	Cohesion: 35 psf
Material: Material 5	Unit Weight: 118 lb/ft ³
	Cohesion Type: Constant
	Cohesion: 600 psf

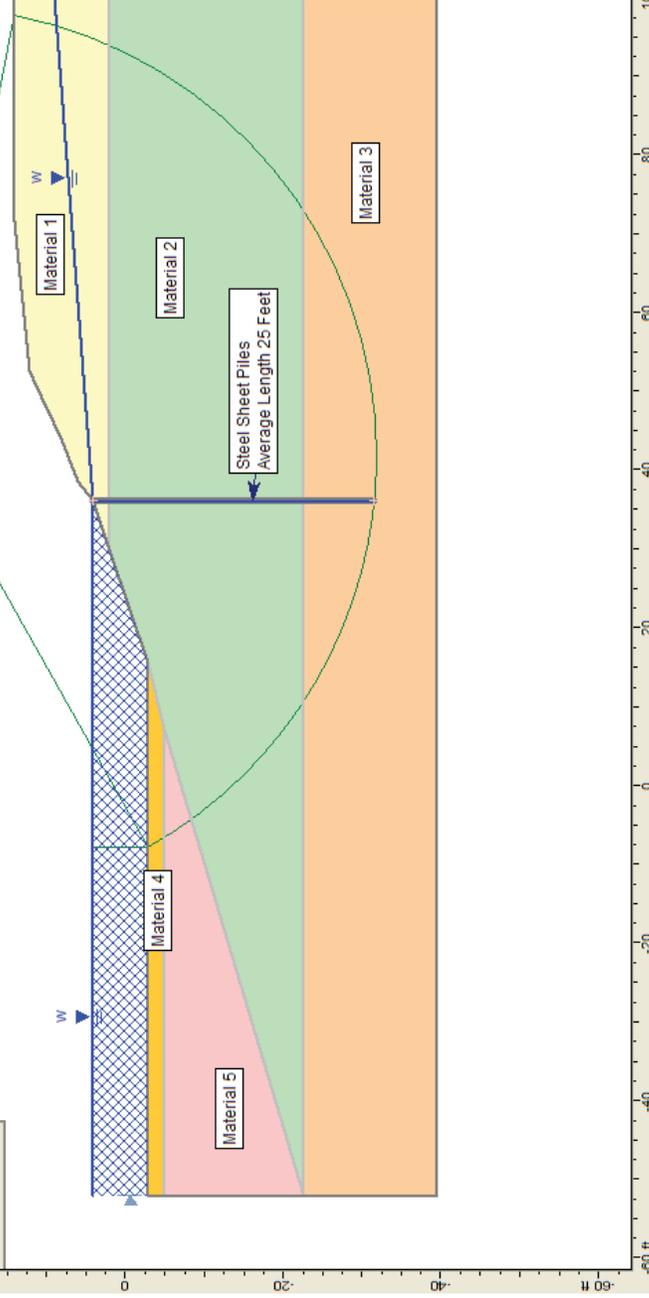


FIGURE 2-24
BANK STABILITY ANALYSIS
TYPICAL CROSS SECTION
2-FOOT DREDGE PLUS BULKHEAD
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

TABLE 2-6
Bulkhead Stability Results

Station	Borings Used (2005)	Slope Height Above Water (feet)	Slope Inclination (degrees)	Slope Inclination (H:V)	Soil Cohesion (psf)		Computed Factor of Safety				Bulkhead Required		
					Shallow	Deep	Existing Geometry	Existing w/2-ft Drawdown	2-ft Dredge w/2-ft Drawdown	8-ft Dredge w/2-ft Drawdown			
258+00	11,21	10	60	0.6:1	450	700	1.97	1.88	1.94	1.87	1.94	1.91	N
714+60	13,23	12	49	0.86:1	700	500	1.75	1.66	1.71	1.62	1.59	1.52	N
907+20	14,24	12	50	0.84:1	450	750	1.81	1.68	1.74	1.64	1.62	1.54	N
1735+10	17,27	10	43	1.07:1	200	300	1.11	1.04	1.07	1.02	0.95	0.91	Y
2741+50	20,31	6	74	0.3:1	300	475	2.31	2.14	2.28	2.09	1.84	1.72	N

Notes:

H:V = horizontal:vertical

psf = pounds per square foot

The following three proposed locations along the bayou were selected for control structures:

- Palo Alto Bridge
- Napoleonville
- Thibodaux

The three control structures would significantly increase the operational flexibility and capability to maintain water levels at different flows in the bayou.

The inflatable control structure was selected based on the ability to quickly and easily change position. Two inflatable dam/weir manufacturers were investigated, Bridgestone and Obermeyer Hydro, Inc., Bridgestone manufactures an inflatable dam that is a rubber bladder that spans the width of a channel (or bay). Obermeyer's inflatable weir is made up of several smaller bladders (sometimes two stacked on top of one another) overlaid by a steel plate.

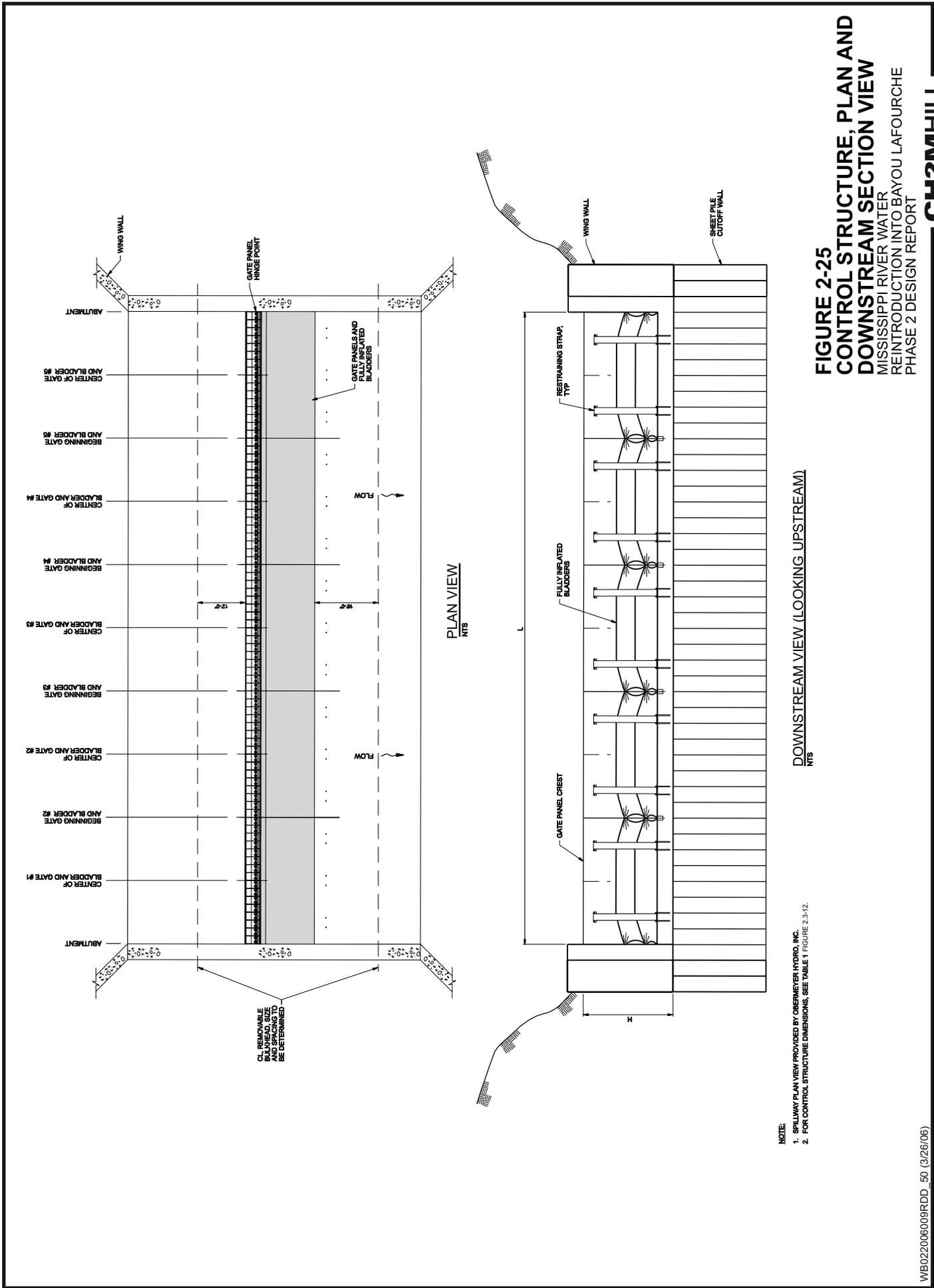
CH2M HILL employees met with representatives from both Bridgestone and Obermeyer to understand more about the capabilities and benefits of each design for the applications in Bayou Lafourche. After discussing the two products in detail, the attributes of the Obermeyer inflatable weir appeared to be more suitable for the project and were also more economical. The Bridgestone rubber dam has complications with accurate water level control and deflation in the presence of tail water; both being necessities for this application. Obermeyer overcomes these difficulties by laying a steel plate over the inflated bladders, creating a sharp crest for accurate water level control and extra weight for fast and efficient deflation.

In the three locations along the bayou, control structure heights range from 10 to 18.5 feet and lengths from 135 to 160 feet. Height and length requirements are based on the location and alternative's design flow. The Obermeyer inflatable control structures plan and section, along with a table of facility dimensions by location are shown in Figures 2-25 and 2-26 (also in Appendix P, Phase 2 Design Drawings).

2.2.3 Operations and Control

The operations and control components of the new diversion and conveyance facilities include the pump station and discharge structure, three control structures, sedimentation basin, and the bayou between Donaldsonville and Lockport. The operation of the pump station would be integrated with the three control structures for toxic spill containment and drainage management during storm/flood conditions. Management of sediment deposition in the pump station forebay and in the sedimentation basin would be through annual monitoring and periodic dredging.

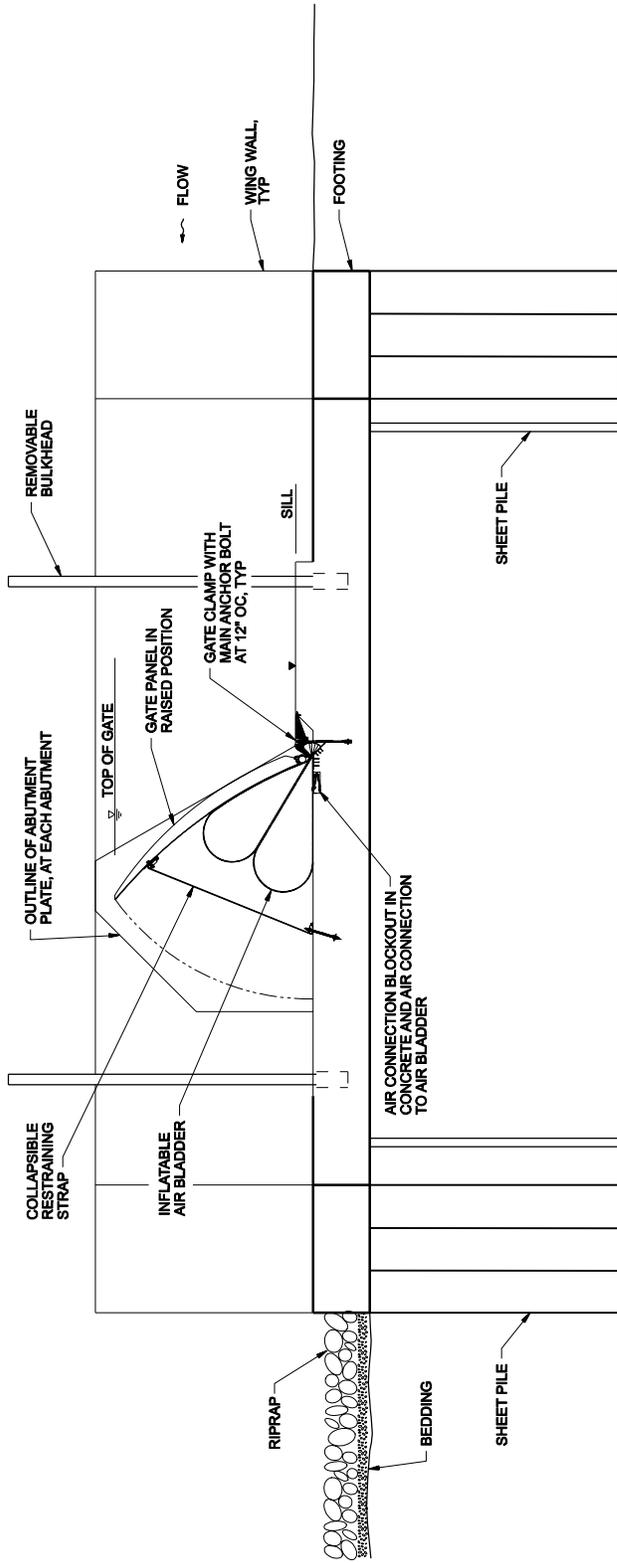
Continuous monitoring and communication of water levels in the bayou, particularly during flood conditions, and raising or lowering of the control structures for toxic spill management would be through a Supervisory Control and Data Acquisition (SCADA) system.



NOTE:
 1. SPILLWAY PLAN VIEW PROVIDED BY OBERMEYER HYDRO, INC.
 2. FOR CONTROL STRUCTURE DIMENSIONS, SEE TABLE 1, FIGURE 2.3-12.

DOWNSTREAM VIEW (LOOKING UPSTREAM)
 NTS

FIGURE 2-25
 CONTROL STRUCTURE, PLAN AND
 DOWNSTREAM SECTION VIEW
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



NOTE:

1. SPILLWAY SECTION PROVIDED BY OBERMEYER HYDRO, INC.

CROSS SECTION VIEW
NTS

TABLE 1
SPILLWAY GATE SIZE (FEET)

ALTERNATIVE	PALO ALTO LOCATION		MAPOLEONVILLE LOCATION		THIBODAUX LOCATION	
	HEIGHT, H	LENGTH, L	HEIGHT, H	LENGTH, L	HEIGHT, H	LENGTH, L
15	12	150	12.5	160	11	160
20	10	140	11.5	140	12	160
32	16.5	135	17.5	135	12.5	160
38	10.5	140	10.5	140	11	160
LEAST RISE	14	135	15	140	17	135
44	11	150	13	145	13	160
47	17	135	18	140	18.5	135

FIGURE 2-26
CONTROL STRUCTURE
CROSS SECTION VIEW
MISSISSIPPI RIVER WATER
REINTRODUCTION INTO BAYOU LAFOURCHE
PHASE 2 DESIGN REPORT

2.2.3.1 Normal, Flood Conditions, and Contaminant Spill Operations

The operation of the conveyance facilities would have three basic modes of management:

- Normal
- Toxic spills
- Flood or storm conditions

During normal operations the pump station would divert Mississippi River water into Bayou Lafourche at design capacity for the alternative selected for final design. The control structures would not be in use and design water levels would be maintained throughout the bayou.

For toxic spill conditions, the coordination of the pump station with the control structures would be managed to isolate and contain the contaminated water within pools between the control structures. Figure 2-27 shows a generalized schematic of monitoring sites, sampling parameters, and control structure locations for detection, analysis, and containment of toxic spills. Depending on where the spill occurs (Mississippi River or within the bayou), the pump station diversion would be reduced or stopped and the control structure downstream of the spill would be operated to contain the contaminated water for clean up. Limited flows can be conveyed past the control structures to maintain water levels for intake facilities, if necessary, or municipal water systems can withdraw from storage sources in their system.

In flood operations, the pump station may reduce the diversion flow rate to allow drawdown of the system's water level and provide additional storage, depending on the strength of the storm. The control structures can be used to maintain water levels as needed or limit conveyance of diversion flows from upstream reaches while downstream reaches are draining. The sequence and timing of pump station diversion and control structure operation, severity of the storm, and location of heavy runoff would be important operational constraints for the development of the control system during final design.

The water diverted from the Mississippi River contains suspended sediment that would settle in the pump station forebay and in the sedimentation basins. The monitoring of sediment depth and periodic dredging would be part of the annual maintenance program to maintain conveyance capacity.

The Operations Strategy and Maintenance Plan technical memorandum, Appendix K, discusses the basic operational conditions and development of management strategies. Additional studies and investigation of travel time in the bayou for operation of the pump station and control structures (toxic spill containment and flood conditions) would be completed during final design.

2.2.3.2 Supervisory Control and Data Acquisition

The SCADA would provide for monitoring and control of the diversion facilities at the Mississippi River and the check structures along Bayou Lafourche from a single location. The SCADA system would facilitate communication of information between remote sites and the BLFWD's main office via radio telemetry. A diagram of the proposed SCADA system is presented in Figure 2-28.

The diversion facility would have a combination of constant speed pumps and adjustable speed pumps, which would allow for varying the flow into the bayou during pumping

operations. During siphon operation, a valve on each pipeline can be throttled to control the flow rate through each pipeline. It is anticipated that individual pumps and siphons would be monitored and controlled at the diversion facility by a local operator. Individual pump status, pump/siphon flow, total station flow, levels in the forebay and outlet structure, and the status of ancillary equipment would be communicated to the BLFWD's office via the SCADA system. Other pertinent individual pump and station data would also be available via the SCADA system as determined during final design.

The check structures would not normally be monitored by a local operator. Upstream and downstream water surfaces and check structure position information would be gathered at each control structure site at a local control panel and then transmitted to the BLFWD's main office. Because the check structures do not typically have an operator onsite, remote control of these facilities may be required; control options for the check structures would be evaluated and determined during final design.

2.3 Estimates of Cost

The Phase 2 cost estimate is described in this section. The costs presented do not include engineering, legal, administrative, or ROW costs. Costs are presented in 2006 dollars, and are not inflated to the midpoint of construction because the construction schedule is not known at this time.

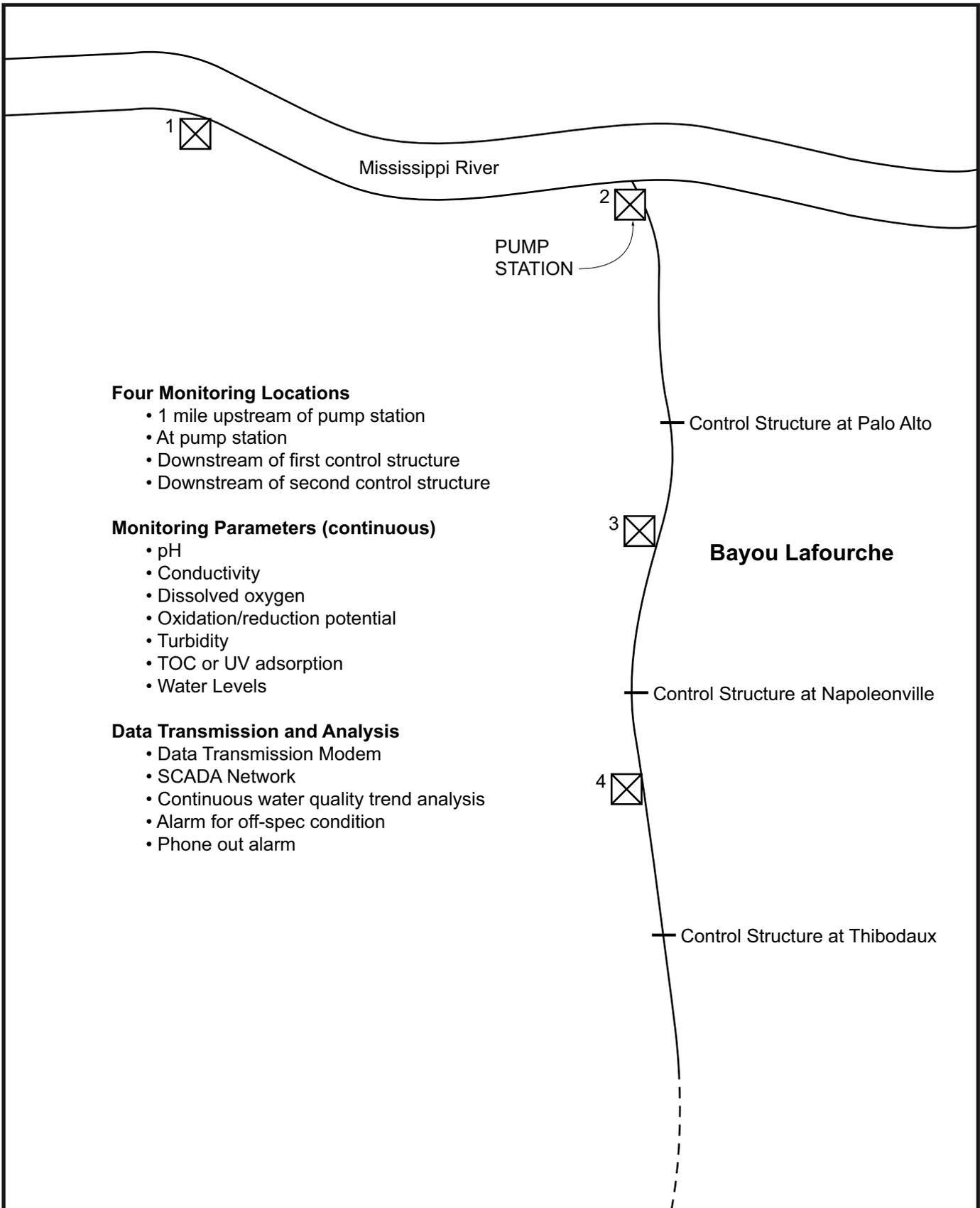
Appendix L includes the Cost Estimate technical memorandum, which includes details on the basis of the estimate and estimated construction cost for each alternative.

2.3.1 Basis of Estimate

The estimate was prepared in accordance with the guidelines of the Association for the Advancement of Cost Engineering International, and can be defined as a Class 3 level estimate. According to the definitions of Association for the Advancement of Cost Engineering International, the "Class 3 Estimate" is defined as follows:

The estimate is generally prepared to form the basis for the project authorization, and or funding. Typically engineering is from 10 to 40 percent complete, and would comprise process flow diagrams, preliminary piping runs for major processes, facility layout drawings and essentially complete process and facility equipment lists. This estimate becomes the project control or project budget estimate until more detailed estimates are completed. Examples of methods used would be a high degree of detailed unit cost and quantity takeoffs for major processes. Factoring and or scale-up factors can be used for less significant or support areas of the project. This type of estimate requires a great deal of time to prepare, where actual equipment and processes have been designed. The typical expected accuracy ranges for this class estimate are -10 to -20 percent on the low side and +10 to +30 percent on the high side.

The cost estimates shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project and resulting feasibility would depend on actual labor and material



Four Monitoring Locations

- 1 mile upstream of pump station
- At pump station
- Downstream of first control structure
- Downstream of second control structure

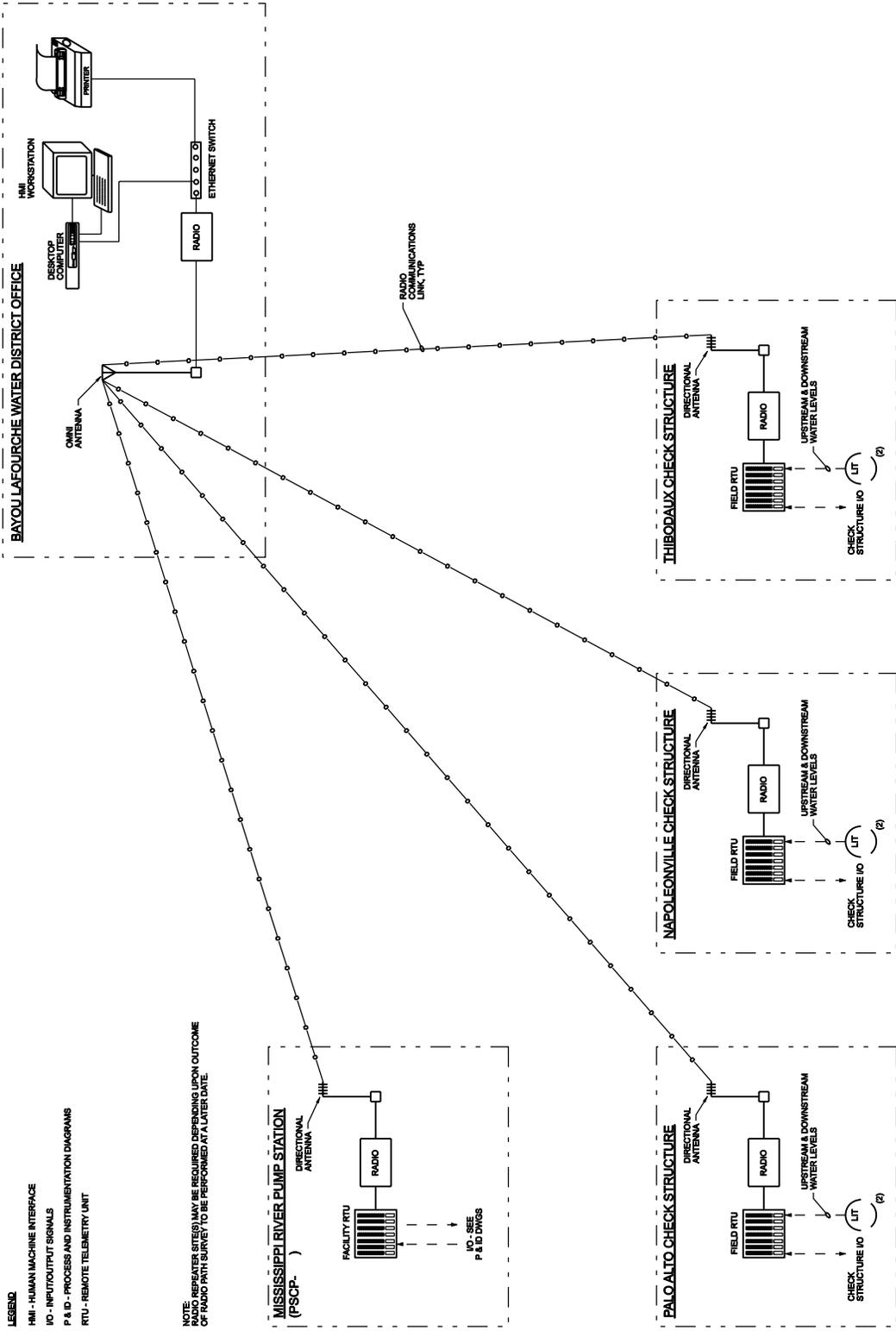
Monitoring Parameters (continuous)

- pH
- Conductivity
- Dissolved oxygen
- Oxidation/reduction potential
- Turbidity
- TOC or UV adsorption
- Water Levels

Data Transmission and Analysis

- Data Transmission Modem
- SCADA Network
- Continuous water quality trend analysis
- Alarm for off-spec condition
- Phone out alarm

FIGURE 2-27
EARLY WARNING FLOOD AND
WATER QUALITY MONITORING SYSTEM
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



LEGEND
 HMI - HUMAN MACHINE INTERFACE
 IO - INPUT/OUTPUT SIGNALS
 P & ID - PROCESS AND INSTRUMENTATION DIAGRAMS
 RTU - REMOTE TELEMETRY UNIT

NOTE:
 RADIO REPEATER SITES MAY BE REQUIRED DEPENDING UPON OUTCOME OF RADIO PATH SURVEY TO BE PERFORMED AT A LATER DATE.

SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM
 NTS

FIGURE 2-28
SCADA SYSTEM
 MISSISSIPPI RIVER WATER
 REINTEGRATION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the estimate presented here. Because of these factors, project feasibility, benefit/cost ratios; risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

2.3.2 Detailed Cost Estimates

Construction costs were separated into the following elements:

- Pump station (Donaldsonville or Smoke Bend locations)
- Dredging (not including excavation costs of the Smoke Bend bypass channel)
- Smoke Bend bypass channel
- Control structures (at Donaldsonville, Napoleonville, and Thibodaux)
- Bridge replacements and modifications
- Utility relocations
- Bulkheads

Additional costs to the project are included for:

- Allowances and contingencies
- Structure impacts (including land inundation)

Table 2-7 shows the cost estimates for each of the components described above for each alternative.

Figure 2-29 shows a summary graphic of how the overall and project component costs compare for each alternative. Alternative 15 is the least costly, with a total estimated cost of \$170 million. The Least Rise alternative is the most expensive with a total estimated cost of \$379 million. Dredging is the greatest cost component, followed by the pump station, control structures, and utilities.

Figure 2-30 shows the cost effectiveness of each alternative in terms of the flow produced. Alternative 15 is the most cost effective at \$166,000 per cfs, closely followed by alternatives 38, 44, and 47, which range from \$179,000 to \$189,000 per cfs.

At the 1,000 cfs flow range, alternative 15 is the most cost effective. At 1,500 cfs, alternative 44 is the most cost effective. Although alternative 47 is a 2,000 cfs option, it is very close in cost effectiveness to alternative 44. This illustrates that the Smoke Bend alternatives are a cost-effective solution at the 1,500 and 2,000 cfs flows.

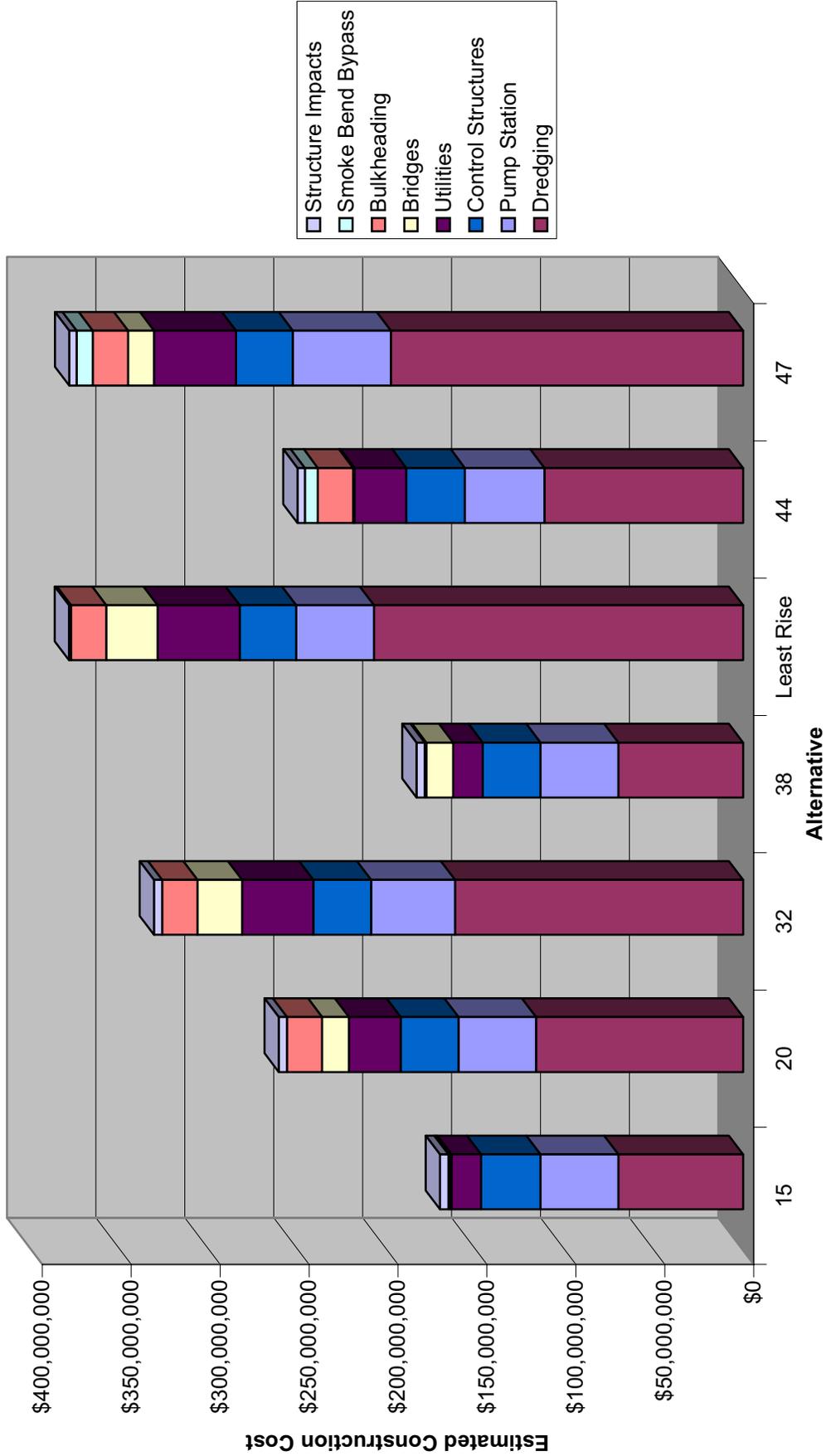


FIGURE 2-29
BAYOU LAFOURCHE COST COMPONENTS
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

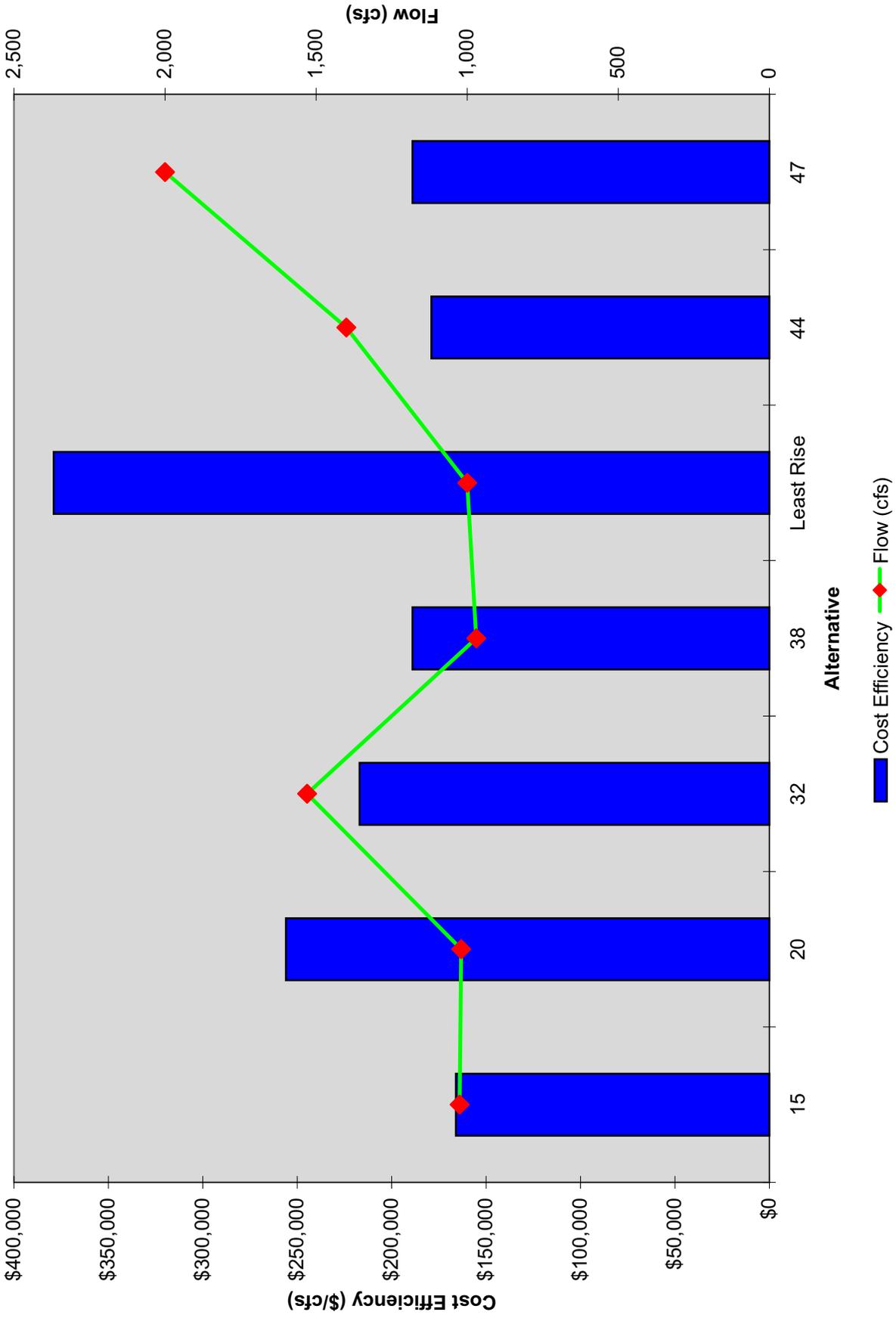


FIGURE 2-30
COST EFFICIENCY
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

Modeling of Alternatives and Benefits Assessment

3.1 Phase 2 Model – Application and Results

3.1.1 Introduction

The goal of the Phase 2 modeling effort was to provide a description of flow and salinity transport through the Barataria and Terrebonne basins for the purposes of defining wetland benefits associated with various project alternatives. The level of detail included in the present RMA-2 model provides a more accurate representation of the physical system and the driving forces controlling flow through the Barataria and Terrebonne basins as compared to the modeling effort conducted in the original study that determined potential wetlands benefits associated with the Bayou Lafourche Diversion project (EPA, 1998).

3.1.2 Model Description

The modeling effort was conducted with the USACE TABS-MD system, which contains the RMA-2 and RMA-11 models. The Surface Water Modeling System was used to assist in the development of the model grid. Dr. Ian King, one of the original authors of the RMA-2 model, worked with the project team to add capabilities specific to this application.

The RMA-2 hydrodynamic model was applied to determine the ambient circulation patterns and channel flows in the project area and to quantify changes in these flows associated with various project alternatives. RMA-2 is a two-dimensional model that solves the vertically averaged equations of mass and momentum conservation at nodal points in a user defined, irregular network or grid. The Phase 2 model grid, presented in Figure 3-1, is comprised of over 90,000 nodal points, 34,000 triangular and quadrilateral elements, and covers more than 2,500 square miles of wetland and open water. The model solves for velocity and surface water elevation at each nodal point.

Results from this two-dimensional, vertically integrated model were used in the RMA-11 transport model to predict salinity concentrations throughout the model grid for both existing conditions and future conditions for the project alternatives.

The Barataria Basin portion of the model grid was provided to FTN Associates for use in this project. The Barataria Basin model was developed for use in the Myrtle Grove Siphon Project by the New Orleans District of the Army Corps of Engineers. The Terrebonne Basin portion of the model grid was developed by FTN Associates for this project. Georeferenced digital orthophoto quarter quads were used to delineate the model boundaries in Terrebonne Basin and to lay out the one-dimensional channels.

3.1.3 Model Inputs

The hydrodynamic and salinity transport models require a number of inputs, including topographic information and data quantifying the physical forces controlling the system, such as winds, tides, and inflows. Other parameters, such as friction coefficients, eddy viscosities, and dispersion coefficients, are required to characterize such processes as energy loss, momentum transfer, and mixing.

Bathymetric data for the Terrebonne Basin is limited, and subsidence decreases the usefulness of historic bathymetric surveys, such as those conducted by the National Oceanic and Atmospheric Administration and compiled in the Coastal Relief Model. For the purposes of this investigation, wetland areas in the Terrebonne Basin were set at a constant elevation. Marsh areas surrounded by one-dimensional channels were assigned a bottom elevation of -1 foot North American Vertical Datum 1988, while those connected to open-water areas in southern Terrebonne Basin were assigned a depth of -5 feet North American Vertical Datum 1988.

The hydrodynamic model uses time-series representations of flow and water surface elevation at the model boundaries to force the movement of water through the model grid. Measured tidal data at Grand Isle, Port Fourchon, and Isles Dernieres were used in the model to represent water level fluctuations at the ocean boundary. Flows into the head of Bayou Lafourche were taken from measurements at Thibodaux. Water surface elevations measured near Houma were applied at the western boundary of the model on the GIWW to account for water flowing into Terrebonne Basin from the Atchafalaya River. Winds were not addressed in this modeling effort.

Initial values for friction coefficients, eddy viscosities, and dispersion parameters were initially set by FTN Associates using engineering judgment and subsequently refined during the calibration process were appropriate.

3.1.4 Model Testing and Sensitivity

A series of tests and sensitivity analyses were conducted during the modeling effort to ensure proper model setup and gain insight into the system. Tests were conducted to investigate a new type of element used to model the interaction of the one-dimensional channel elements and the two-dimensional marsh areas. Sensitivity tests were conducted on boundary water levels, bathymetric specification of the Terrebonne marsh areas, model time steps, and friction factors. Additional tests were required to address deficiencies in the water surface elevation data at several gages.

3.1.5 Model Mesh Modification

The following refinements to the two-dimensional mesh used in the Phase 1 analysis were implemented during the Phase 2 study:

- The Barataria Basin was added back into the model grid. Recall that for the wet-season calibration runs conducted in Phase 1, the flow in the GIWW was from west to east over 90 percent of the time. This, coupled with model run time issues, led to the removal of the Barataria portion of the grid during the Phase 1 analysis.

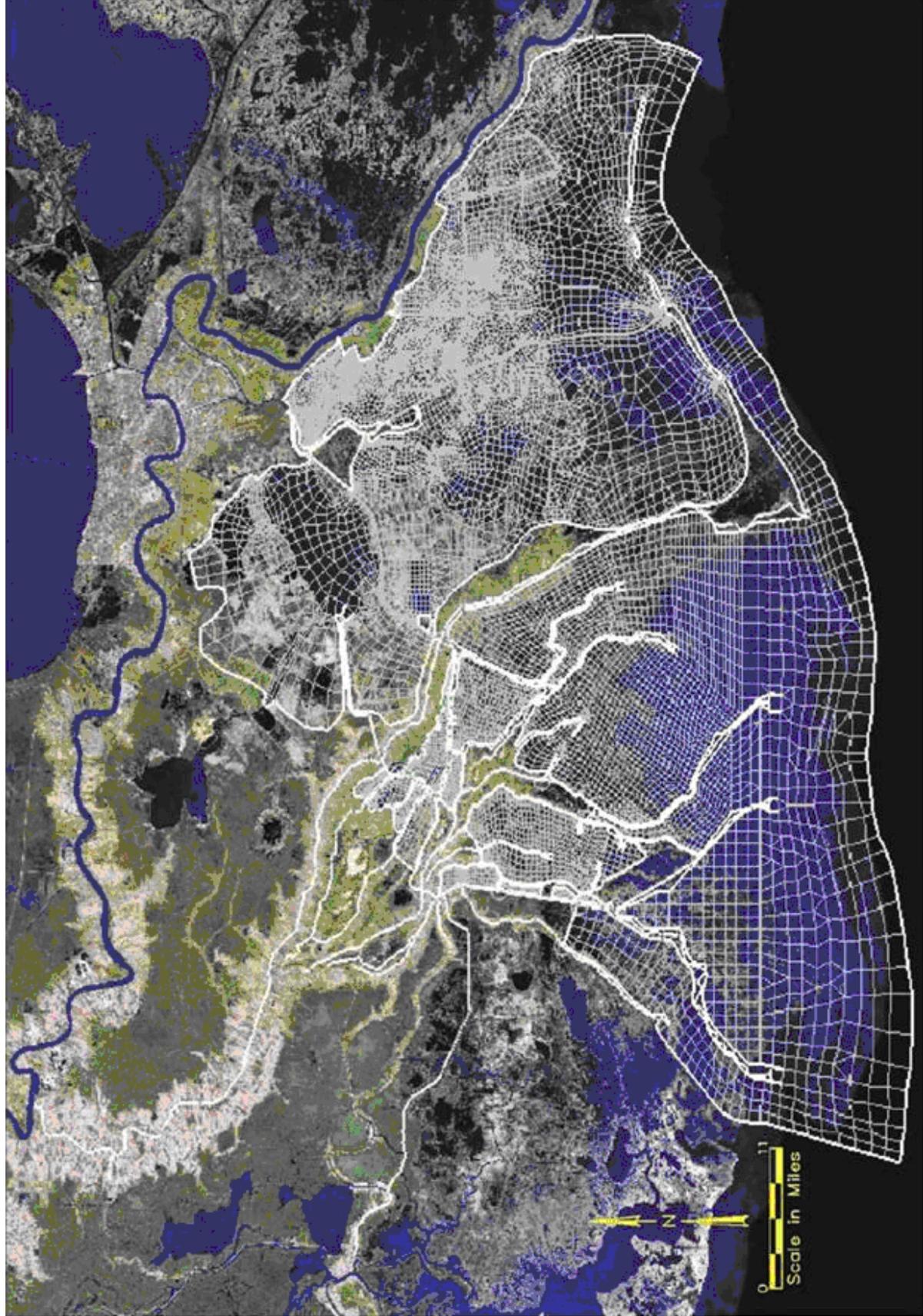


FIGURE 3-1
FINAL PHASE 2 MODEL GRID
MISSISSIPPI RIVER WATER
REINTRODUCTION INTO BAYOU LAFOURCHE
PHASE 2 DESIGN REPORT

- Additional survey data were obtained to assist in describing the banks of the GIWW east of the Bayou Lafourche Ridge.
- A rough representation of the barrier islands in the Terrebonne Basin was implemented with the use of the National Geophysical Data Center's Coastal Relief Model.
- The representation of the southern portion of Grand Bayou was improved to provide interaction between the one-dimensional bayou and the marsh areas to the south and east.

3.1.6 Model Calibration and Verification

The model was calibrated with a 2-month dataset representative of wet-season conditions (May and June 2004), meaning that flows in the GIWW from the Atchafalaya River were larger than average. The calibration effort involved matching model predictions to field measurements of stage, velocity, and salinity at a series of locations throughout the system. Figure 3-2 shows the locations of the data collection points.

Model verification was performed with a 2-month dataset representative of dry-period conditions (October and November 2004). Model predictions were compared against field measurements for the same set of gage locations utilized in the calibration effort. Several gages used during the calibration effort were removed from service between the period used for calibration and that used for model verification. Two gages in the middle of Barataria Basin, BA-06 and BA-07, (20 and 21 in Figure 3-2) were not available for model verification. These two gages were particularly useful in the salinity calibration because they provide a midpoint along the salinity gradient in Barataria Basin.

The majority of the field data collection sites were located in channels as opposed to marsh areas. Thus, although the model may adequately reproduce measured flows in one-dimensional channels, the flow exchange between channels and marsh areas has not been calibrated. Specifically, flow exchanges into the majority of the isolated marshes represented by two-dimensional areas in the model grid are currently controlled by the specification of bank elevations. The best available data were used to specify the elevation of these banks; future refinement of the model could improve representation of the exchange with marsh areas, such as those adjacent to Bayou L'Eau Bleu.

3.1.7 Model Application

Initial Phase 1 model simulations were conducted to determine the distribution of both a 1,000 and 2,000 cfs diversion into Bayou Lafourche during wet-season flows on the Atchafalaya River. These two simulations were conducted before final calibration and verification of the model was conducted. Results indicate that 79 percent of the 1,000 cfs diversion and 83 percent of the 2,000 cfs diversion flows into Barataria Basin via the GIWW. These simulations were conducted without the Barataria portion of the model grid. An additional run was conducted to gage the sensitivity of the model to the hydraulic gradient in the GIWW; an increase in the water surface elevation at Larose of 0.25 foot was enough to completely shift the average flow in the GIWW towards the west.

In Phase 2, the Barataria portion was added back into the model grid and both wet- and dry-season simulations (calibration and verification, respectively) were conducted modeling

existing conditions. Dry-season results indicate a different flow split than those determined in Phase 1.

Finally, a series of simulations was conducted to ascertain the flow distribution of various freshwater diversions and to gage the sensitivity of the model to changes in geometry and existing freshwater diversions such as Davis Pond and Myrtle Grove. A total of 15 separate project alternatives were modeled in Phase 2. A complete tabulation of the input variables used in the model simulations is shown below in Table 3-1. The 15 simulations included the following:

- Five different diversion scenarios and dredging templates
- Two simulations with variations in Bayou Terrebonne/Company Canal geometry and diversion flows
- Six simulations with variations in Grand Bayou geometry, season, and diversion flows
- Two simulations to determine sensitivity of model results to existing freshwater inflows (Davis Pond, Myrtle Grove)

Results of the alternatives analysis show a range in flow distributions for the full range in diversion flows investigated for the project. Table 3-2 presents a summary of the distribution of the increased diversion into Bayou Lafourche for 13 dry period runs. Flows exiting the central Terrebonne Basin through each of five paths (HNC, GIWW West of HNC, GIWW East to Barataria Basin, Bayou Terrebonne South, and Grand Bayou South) are presented on a percentage basis. The flows entering the Barataria Basin range from 1 to 33 percent of the diversion inflow. As the diversion flow increases, more flow travels to the west in the GIWW, as the increased stages associated with the increased discharge limit the ability of the Atchafalaya River to push water through the GIWW into the Terrebonne Basin. The increase in flow down the HNC into Terrebonne Bay ranges from 12 to 18 percent of the diversion flow. Modifications to Company Canal made to increase flows in Bayou Terrebonne (runs 13 and 14) were only able to capture a maximum of 9 percent of the increased diversion. The geometry changes made in Grand Bayou were much more efficient at redirecting flows; enlarging Grand Bayou captures between 13 and 22 percent of the increased diversion, depending on the magnitude of the diversion.

Table 3-3 presents a more detailed look at the diversions into Barataria Basin. The average flows (calculated over the two month duration of the simulation) are presented for both the diversion and the flow into Barataria Basin via the GIWW. Flows are also presented on a percentage basis for verification with Table 3-2.

Figure 3-3 presents a schematic of the flow distribution through Bayou Lafourche, Company Canal, and the GIWW for runs 5 (Baseline), 10 (2,000 cfs diversion), 12 (Grand Bayou geometry modifications), and 14 (Bayou Terrebonne geometry modifications). Arrows in the figure indicate the direction of positive flow.

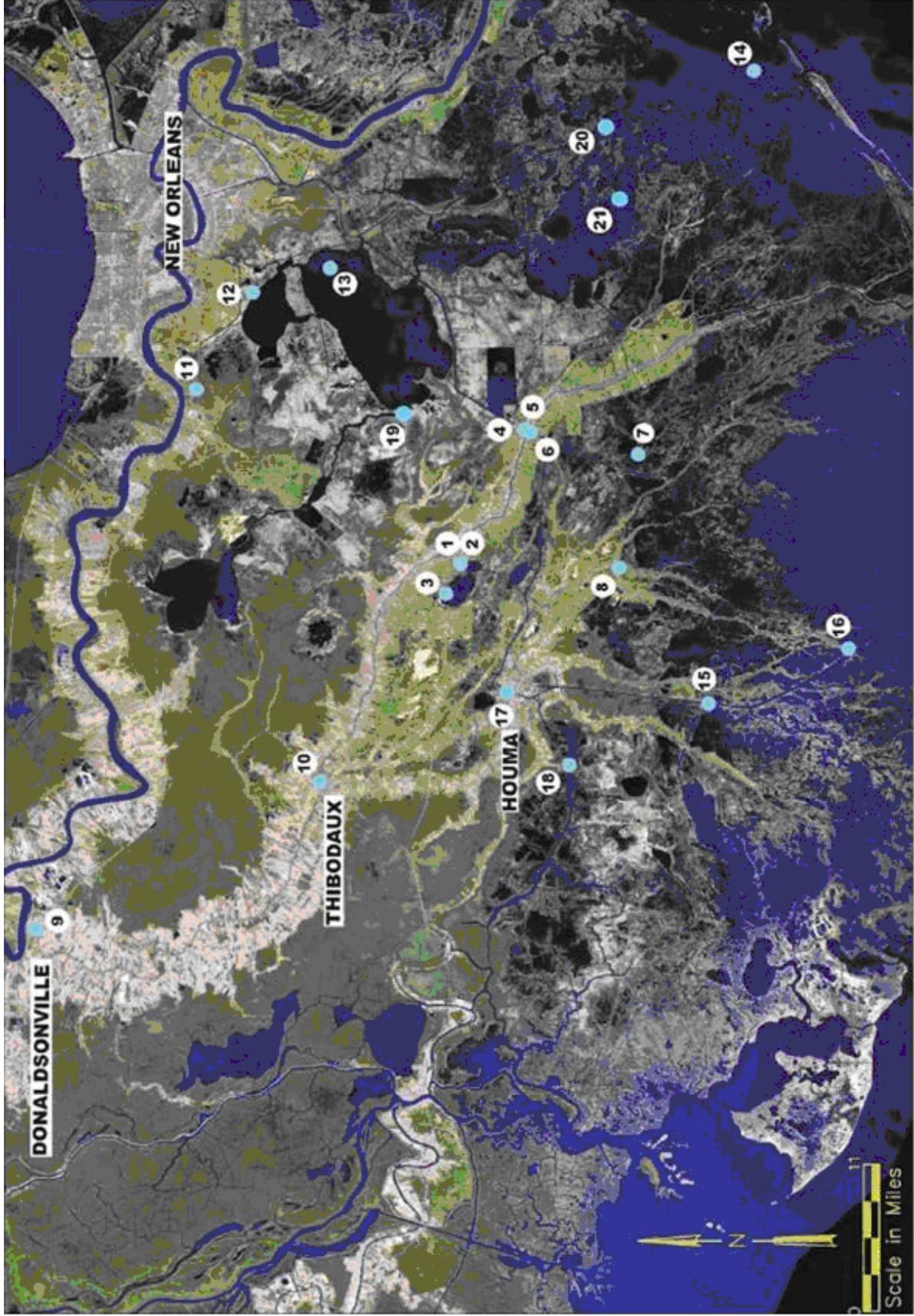


FIGURE 3-2
LOCATION OF DATA COLLECTION STATIONS
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT
CH2MHILL

TABLE 3-1
Dredging and Operational Scenarios Modeled

Description/Type	Run Number	Simulation Period	Diversion Flow (cfs)	Dredging	Lower Bayou L'Eau Bleu Geometry	Lower Company Canal Geometry	Davis Pond Flow (cfs)	Naomi Siphon Flow (cfs)	Myrtle Grove Siphon Flow (cfs)
Calibration of Phase 2 Grid	4	May – June 2004	Existing Flow	None	Existing	Existing	Existing	Existing	Existing
Verification of Phase 2 Grid	5	October – November 2004	Existing Flow	None	Existing	Existing	Existing	Existing	Existing
Bayou Lafourche Dredge Alternative 1	6	October – November 2004	1,530	8-ft average, RM 0-29 2-ft average, RM 29-56	Existing	Existing	1,000	1,000	1,000
Bayou Lafourche Dredge Alternative 2	7	October – November 2004	970	2-ft average, RM 0-29	Existing	Existing	1,000	1,000	1,000
Bayou Lafourche Dredge Alternative 3	8	October – November 2004	1,400	2-ft average, RM 0-56	Existing	Existing	1,000	1,000	1,000
Bayou Lafourche Dredge Alternative 4	9	October – November 2004	1,020	2-ft average, RM 0-56	Existing	Existing	1,000	1,000	1,000
Bayou Lafourche Dredge Alternative 5	10	October – November 2004	2,000	8-ft average, RM 0-56	Existing	Existing	1,000	1,000	1,000
Increase Flow to Grand Bayou	11	October – November 2004	1,020	2-ft average, RM 0-56	Widened	Existing	1,000	1,000	1,000
Increase Flow to Grand Bayou	12	October – November 2004	2,000	8-ft average, RM 0-56	Widened	Existing	1,000	1,000	1,000
Increase Flow to Lower Bayou Terrebonne	13	October – November 2004	1,020	2-ft average, RM 0-56	Existing	Widened	1,000	1,000	1,000
Increase Flow to Lower Bayou Terrebonne	14	October – November 2004	2,000	8-ft average, RM 0-56	Existing	Widened	1,000	1,000	1,000
Davis Pond Influence	15	October – November 2004	1,020	2-ft average, RM 0-56	Existing	Existing	Variable	1,000	1,000
Myrtle Grove Influence	16	October – November 2004	1,020	2-ft average, RM 0-56	Existing	Existing	1,000	1,000	Variable
Increase Flow to Grand Bayou	17	October – November 2004	970	2-ft average, RM 0-29	Widened	Existing	1,000	1,000	1,000
Increase Flow to Grand Bayou	18	October – November 2004	1,400	2-ft average, RM 0-56	Widened	Existing	1,000	1,000	1,000
Increase Flow to Grand Bayou	17b	May – June 2004	970	2-ft average, RM 0-29	Widened	Existing	1,000	1,000	1,000
Increase Flow to Grand Bayou	18b	May – June 2004	1,400	2-ft average, RM 0-56	Widened	Existing	1,000	1,000	1,000

TABLE 3-2

Analysis of Distribution of Diversion Flows: Percent of Diversion Flows out of Central Terrebonne Basin

Simulation Number and Diversion Flow	Bayou Lafourche South of GIWW (%)	GIWW into Barataria Basin (%)	GIWW West of HNC (%)	HNC South of GIWW (%)	Grand Bayou South of GIWW (%)	Bayou Terrebonne South of St. Louis Canal (%)
Run 6, Alternative 32; Q = 1,530 cfs	9	30	37	14	4	5
Run 7, Alternative 38; Q = 970 cfs	11	19	47	13	5	5
Run 8, Alternative 44; Q = 1,400 cfs	9	28	39	13	4	5
Run 9, Alternative 20; Q = 1,020 cfs	10	21	45	13	4	5
Run 10, Alternative 37; Q = 2,000 cfs	8	33	35	12	4	4
Run 11, Grand Bayou Geometry Modifications, Q = 1,202 cfs	11	10	41	16	22	6
Run 12, Grand Bayou Geometry Modifications, Q = 2,000 cfs	7	28	32	12	13	4
Run 13, Bayou Terrebonne Geometry Modifications, Q = 1,202 cfs	10	17	46	13	4	9
Run 14, Bayou Terrebonne Geometry Modifications, Q = 2,000 cfs	8	31	35	12	4	7
Run 15, Davis Pond Sensitivity; Q = 1,020 cfs	14	1	54	18	6	6
Run 16, Myrtle Grove Sensitivity; Q = 1,020 cfs	12	14	48	15	5	5
Run 17, Grand Bayou Geometry Modifications, Q = 970 cfs	10	10	43	12	22	4
Run 18, Grand Bayou Geometry Modifications, Q = 1,400 cfs	8	22	36	12	16	4

TABLE 3-3
Analysis of Flows into Barataria Basin

Simulation Number and Description	2 Month Average Flow into Head of Bayou Lafourche (cfs)	2 Month Average Flow into Barataria Basin (cfs)	Change in Diversion Flow from Baseline (cfs)	Change in Flow to Barataria from Baseline (cfs)	Percent of Bayou Lafourche Diversion Flow into Barataria Basin
Run 5, Baseline	235	882	N/A	N/A	N/A
Run 6, Alternative 1	1,533	1,272	1,298	390	30%
Run 7, Alternative 2	973	1,022	737	140	19%
Run 8, Alternative 3	1,403	1,211	1,168	330	28%
Run 9, Alternative 4	1,024	1,045	789	163	21%
Run 10, Alternative 5	2,003	1,465	1,768	584	33%
Run 11, Grand Bayou Geo, Q1	1,024	961	789	80	10%
Run 12, Grand Bayou Geo, Q2	2,003	1,384	1,768	502	28%
Run 13, Bayou Terrebonne Geo, Q1	1,024	1,013	789	132	17%
Run 14, Bayou Terrebonne Geo, Q2	2,003	1,427	1,768	545	31%
Run 15, Davis Pond Sensitivity	1,024	891	789	9	1%
Run 16, Myrtle Grove Sensitivity	1,024	995	789	114	14%
Run 17, Grand Bayou Geo, Q3	973	953	737	71	10%
Run 18, Grand Bayou Geo, Q4	1,403	1,137	1,168	255	22%

3.1.8 Model Limitations and Suggestions for Improvement

The two-dimensional hydrodynamic and salinity transport models developed for this study are currently the best tools available for studying flows and salinity transport in the Barataria and Terrebonne estuaries. The model, however, can be improved upon for more detailed studies. Current limitations and proposed areas for refinement are listed below. Several of the proposed refinements would require extensive surveying of the system.

- Improve representation of Terrebonne Basin barrier island system
- Improve bathymetric representation of marsh areas in Terrebonne Basin
- Improve bank elevations controlling exchange between one-dimensional channels and two-dimensional marshes
- Improve mesh quality to limit mass conservation errors and model instabilities
- Refine coverage of model mesh using GIS land use layer to remove areas representing agricultural areas and upland areas

3.1.9 Conclusions

The RMA models developed for the Bayou Lafourche Freshwater Reintroduction Project enable the determination of the distribution of various diversion flows throughout the Terrebonne and Barataria Basins. The model has been calibrated and verified for both wet and dry periods. Model performance is satisfactory, and areas for further refinement have

been identified. The application of the model results discussed herein to the determination of wetlands benefits will be discussed in subsequent sections.

The model demonstrates that the distribution of freshwater diversions into Bayou Lafourche is strongly influenced by the GIWW, which generally flows from west to east when averaged over tidal cycles. During the wet season, flows on the GIWW are above average and diversion flows into Bayou Lafourche are primarily carried into the Barataria Basin, with little flow continuing south below the GIWW into the southern Terrebonne wetlands. During the dry season, the GIWW flows are lower in magnitude and the influence of the GIWW flows on the regional hydraulics decreases. A smaller percentage of the diversion flows enters Barataria Basin in the dry period; more of the diversion travels towards the west in the GIWW and actually reduces the Atchafalaya River flow into Terrebonne Basin.

Subsequent applications of the model developed for this project should implement refinements discussed above in order to improve the predictive capabilities of the model.

3.2 Wetlands Value Assessment Methodology

Benefits to wetlands were assessed for the alternatives modeled, using a modified approach to the CWPPRA Environmental Work Group's Wetlands Value Assessment (WVA) methodology. CWPPRA's WVA methodology is a modification of the Habitat Evaluation Procedures developed by the USFWS in 1980. The project team used model simulation output data, as described in Section 3.1, as input parameters for the WVA model. This process is summarized below and explained in detail in Appendix N.

3.2.1 Wetlands Value Assessment Habitat Models and Variables

The main WVA wetland habitat models applicable to emergent marsh in the Louisiana coastal zone include the following:

- Fresh/intermediate marsh
- Brackish marsh
- Saline marsh

These models are represented by a series of equations which utilize six ecological variables to characterize both marsh and water conditions for the fresh, intermediate, brackish, and saline marsh models. These variables include the following:

- V1 – Percent of area covered by emergent marsh
- V2 – Percent of open-water area dominated by submerged aquatic vegetation
- V3 – Marsh edge and interspersion
- V4 – Percent of open water that is shallow (<1.5 feet)
- V5 – Salinity
- V6 – Aquatic Organism Access

A Suitability Index (SI) and Suitability Index Graphs (SIG) are developed for each variable to be used for each habitat model. The SI for each of the six variables (V1-V6) is entered into



FIGURE 3-3
FLOW DISTRIBUTIONS FOR
5, 10, 12, AND 14
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

set formulas to calculate the overall Habitat Suitability Index (HSI), per acre, for each target year of the proposed project.

The HSI formulations for emergent marsh and open water for the three applicable models are as follows:

Fresh/Intermediate Marsh

$$HSI(EM) = \frac{\left[3.5 \times (SIV_1^5 \times SIV_6^1) \right]^{1/6} \left(\frac{SIV_3 \times SIV_5}{2} \right)}{4.5}$$

$$HSI(OW) = \frac{\left[3.5 \times (SIV_2^3 \times SIV_6^1) \right]^{1/4} \left(\frac{SIV_3 \times SIV_4 \times SIV_5}{3} \right)}{4.5}$$

Brackish Marsh

$$HSI(EM) = \frac{\left[3.5 \times (SIV_1^5 \times SIV_6^{1.5}) \right]^{1/6.5} \left(\frac{SIV_3 \times SIV_5}{2} \right)}{4.5}$$

$$HSI(OW) = \frac{\left[3.5 \times (SIV_2^3 \times SIV_6^2) \right]^{1/5} \left(\frac{SIV_3 \times SIV_4 \times SIV_5}{3} \right)}{4.5}$$

Saline Marsh

$$HSI(EM) = \frac{\left[3.5 \times (SIV_1^3 \times SIV_6) \right]^{1/4} \left(\frac{SIV_3 \times SIV_5}{2} \right)}{4.5}$$

$$HSI(OW) = \frac{\left[3.5 \times (SIV_2 \times SIV_6^{2.5}) \right]^{1/3.5} \left(\frac{SIV_3 \times SIV_4 \times SIV_5}{3} \right)}{4.5}$$

The HSIs are multiplied by the acres (of each wetland habitat), and summed for the overall project area, generating a total wetland benefit in Habitat Units (HUs) for a project. The net benefit of a project can then be quantified by comparing the HUs between the future-with (FW) and future-without-project (FWO) scenarios. The difference between these two represents the “net benefit” attributable to the project in terms of habitat quantity and quality.

3.2.2 Average Annual Habitat Units

The net HUs from the FW and FWO are annualized (averaged out over the 20-year project life), and compared to determine the gain in Average Annual Habitat Units (AAHU)

attributed to the project. Net gains in AAHUs are then combined with annualized cost data to arrive at a cost per AAHU for the evaluated project. These values are compared to project alternatives, to identify the preferred alternative.

3.2.3 RMA Hydrodynamic Model Data

Specific channel flow and salinity data generated by the RMA hydrodynamic model for each project alternative was used to assess the V1 and V5 variables for each marsh model. RMA model run 5 represented a baseline condition, and changes in channel flow, surface water exchange, and salinity from the alternatives were compared to the baseline condition. All model and habitat data was entered into a GIS for spatial analysis. Differences, or shifts in baseline for each diversion alternative was geographically positioned within the GIS, and the acres calculated as areas of wetland benefits.

3.2.4 Selection of Benefit Areas

Benefit areas were selected based on changes in salinity regime, and nutrient and sediment loading. For the Barataria Basin, the benefits areas were quantified by tabulating the area in acres between a given isohaline for a specific alternative model run simulation (FW) and the same isohaline for the baseline simulation (FWO). For example, if the 2 parts per thousand (ppt) isohaline in Barataria Basin was shifted one mile south in run 6 compared to the baseline simulation, the benefit area was tabulated as the area in the polygon on mile thick over the width of the Barataria Basin, Figures 3-4 through 3-6 demonstrate this process for run 10 (alternative 47) and run 5 (baseline simulation). Figures 3-4 and 3-5 present salinity contours in seven ranges for runs 5 and 10, respectively. Figure 3-6 shows the areas that have experienced a reduction in salinity because of the increased flow associated with run 10. The red polygon indicates an area that had a salinity of greater than 2 ppt in the baseline simulation and a salinity of less than 2 ppt in run 10. The orange polygon indicates an area that had a salinity of greater than 4 ppt in the baseline and a salinity of less than 4 ppt in run 10. Acreages of potential benefit were tabulated in this fashion for each of the nine alternative simulations. Large expanses of open water, such as bays or lakes and upland areas have been removed from the benefit polygons presented in Figure 3-6. Open-water areas (Chabreck et al., 2001) were used to eliminate large expanses such as bays and large inland lakes because there were no anticipated benefits to these areas as it relates to protection of existing emergent marsh.

The method described above worked well within the Barataria Basin due to its large expanse of diverse coastal wetlands (fresh, intermediate, brackish, and saline), the large proportion of the diversion flows that entered the basin and influenced the salinity regime, and the relatively small salinity gradient in the basin. However, within the Terrebonne Basin, the baseline run indicated that the diversion flows would have only minor influences on the salinity regime, because the GIWW captured a major portion of the diversion flow and very little of the flow entered the intermediate, brackish, and saline marshes in southern Terrebonne Basin.

In the areas north of the GIWW, freshwater marshes dominate. Although the increased diversions into Bayou Lafourche could not provide any salinity benefits to these areas (because they are already fresh), the diversions could supply much needed sediment and nutrients. Since the standard WVA methodology does not expressly account for this type of

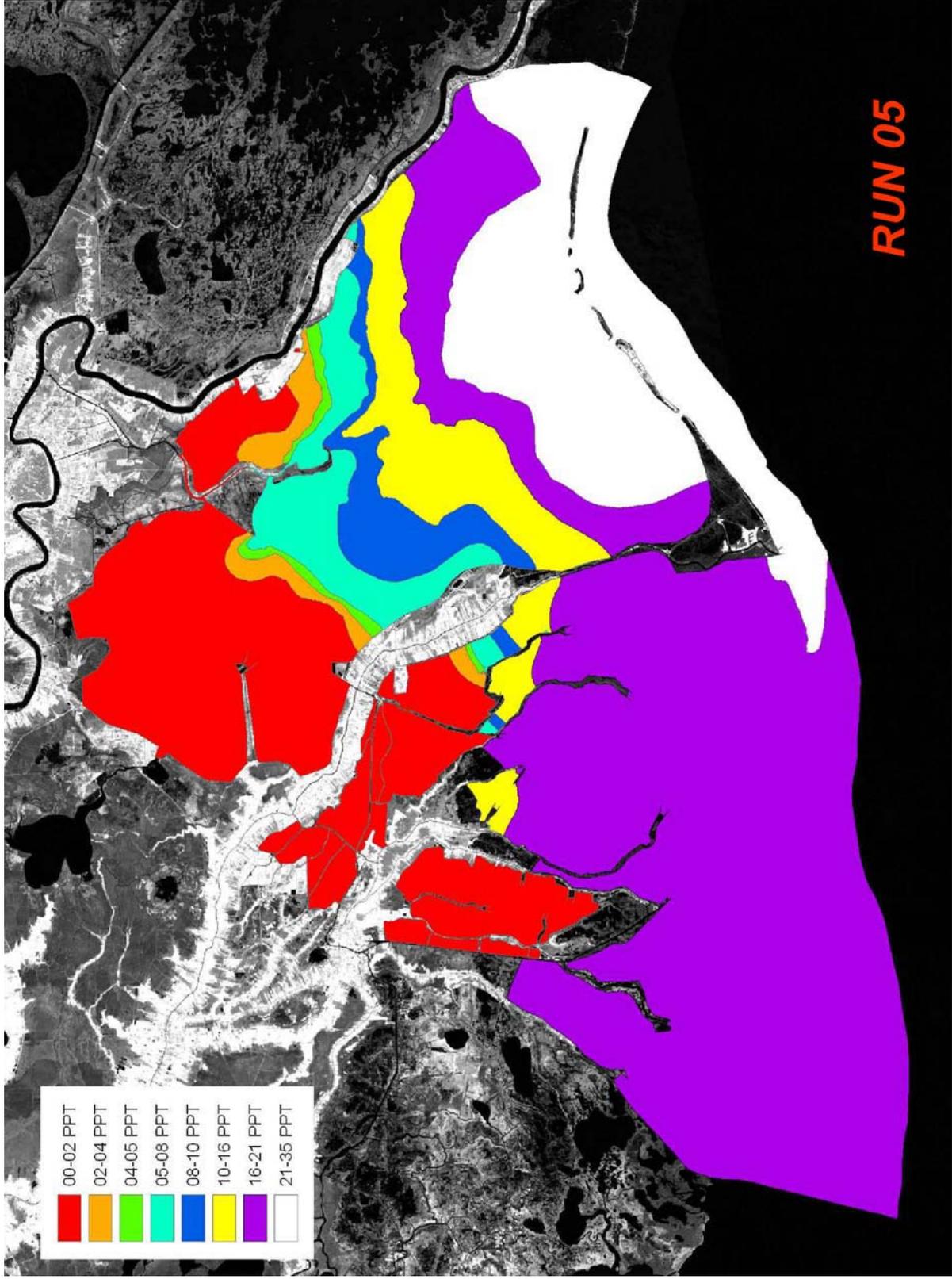


FIGURE 3-4
POTENTIAL AREAS OF WETLANDS BENEFIT
FOR RUN 5, USING RMA ISOHALINE REGIMES
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

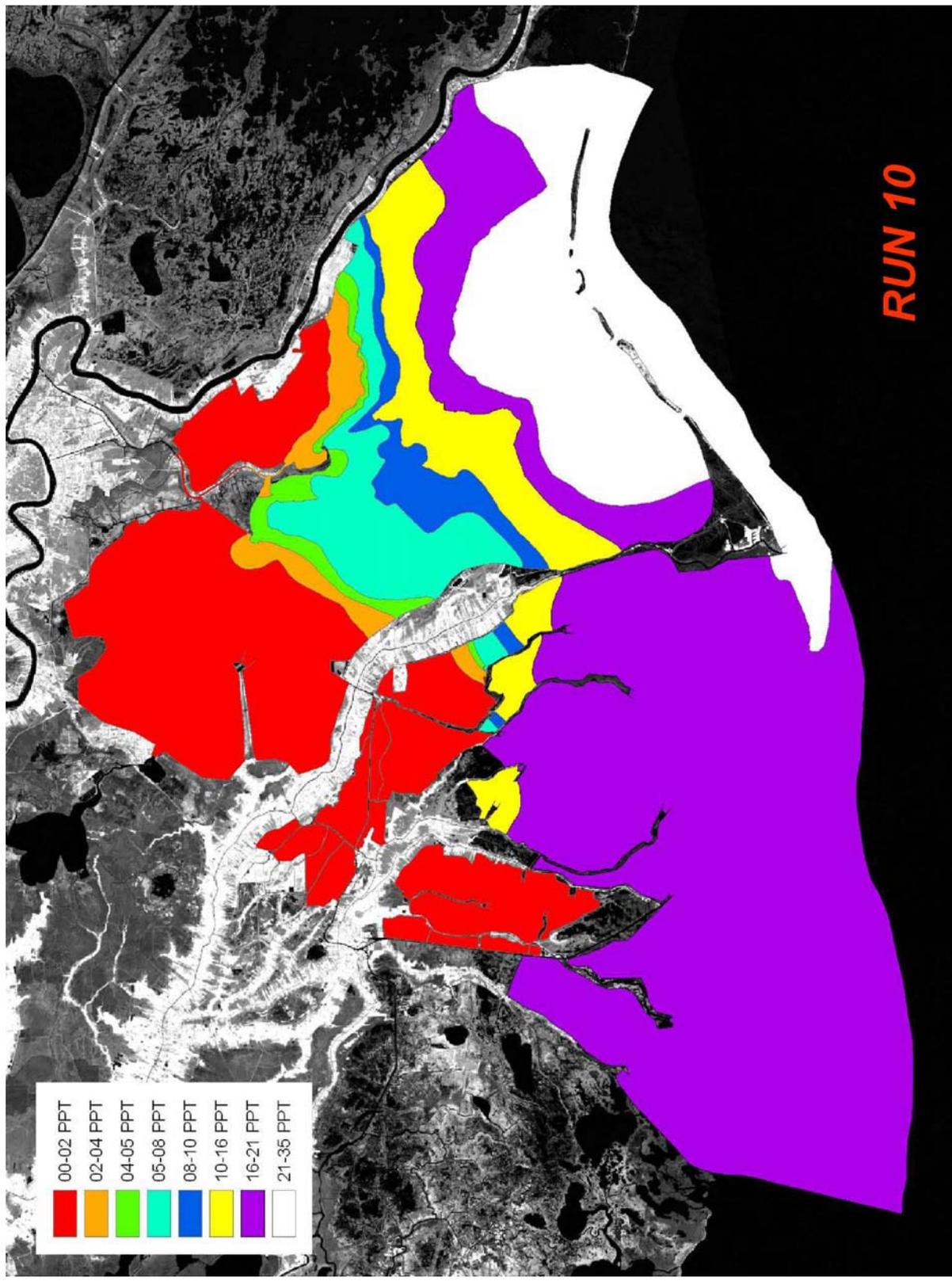
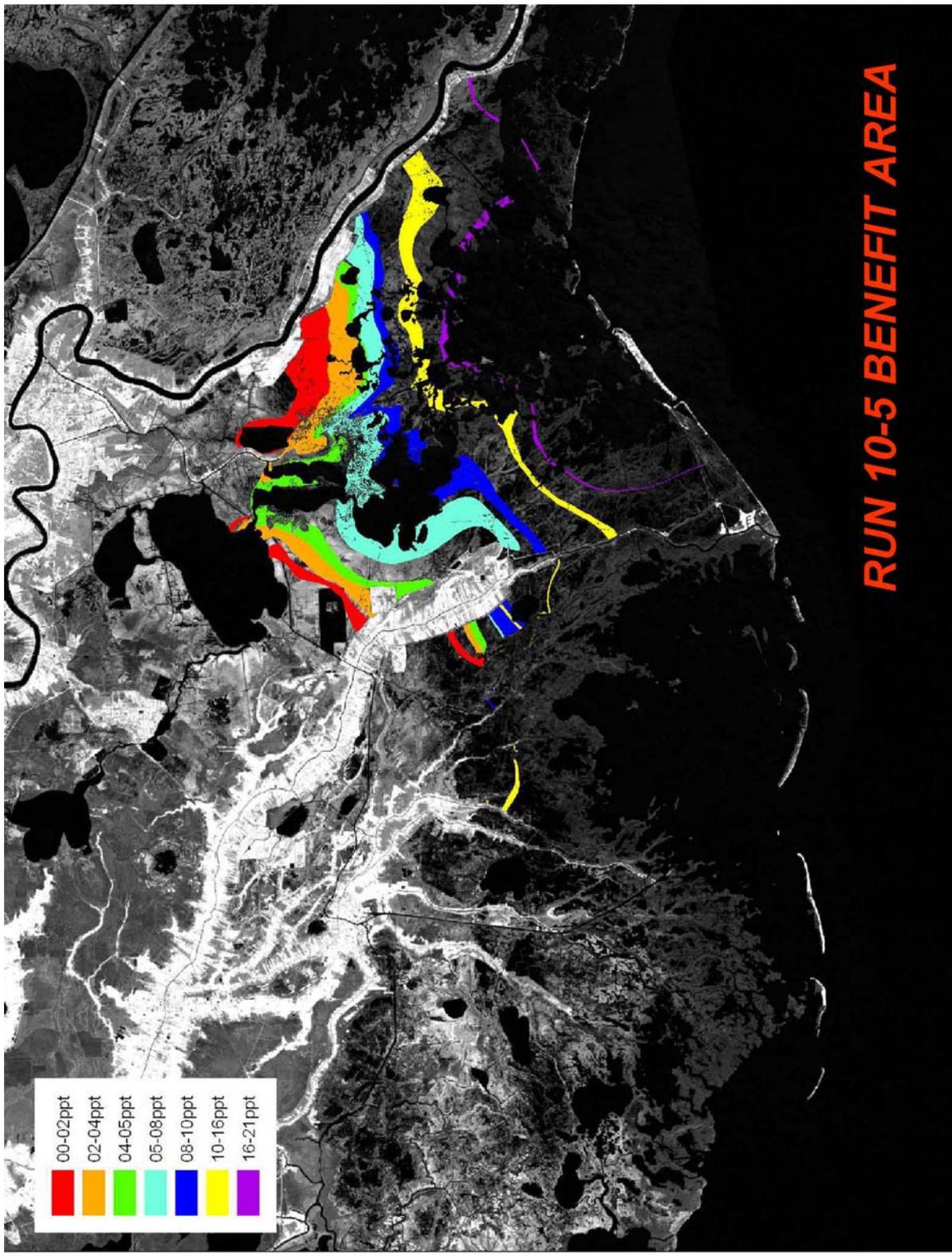


FIGURE 3-5
POTENTIAL AREAS OF WETLANDS BENEFIT
FOR RUN 10, USING RMA ISOHALINE REGIMES
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



RUN 10-5 BENEFIT AREA

FIGURE 3-6
SCREENED, FINAL MARSH AREAS OF
BENEFIT BY HABITAT TYPE FOR RMA RUN 10
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

benefit, an alternate approach was taken to calculate project benefits to marshes in Terrebonne Basin.

The first step in the calculation of wetland benefits associated with increased delivery of sediments and nutrients to marshes in Terrebonne Basin was the determination of potential benefit areas. Four main marsh areas were defined north of the GIWW, including Lake Fields, Hollywood Canal, Bayou L'Eau Bleu, and Lake Long. Three marsh areas were defined south of the GIWW, including GIWW South, Grand Bayou East-North, and Grand Bayou East-South. These seven areas are presented in Figure 3-7. A GIS-based analysis was conducted on these marsh areas to remove inland areas of open water, areas outside the relevant habitat zones as compiled by the U.S. Geologic Survey National Wetland Research Center (classified National Wetlands Inventory data), Chabreck, and the USFWS (Louisiana Coastal Wetland Conservation Plan Boundary), certain fastlands, and all locations above the 3-foot contour. The revised areas became the base areas from which HUs were calculated.

3.2.5 Nutrient and Sediment Benefits

Nutrient and sediment benefits within the project area were estimated by quantifying the nitrogen and fine sediment (clays) loading capacity of the Mississippi River water column near the location of the proposed diversion. A sediment accretion potential model was created and used to project sediment and nitrogen discharge within benefited marshes, and to estimate the acres of wetlands maintained annually as a result of the nitrogen and sediment loading of the increased freshwater flows. Details on the sediment accretion model can be found in Appendix N.

3.2.6 Salinity Reduction Benefits

Based on RMA Model output, salinity values were assessed within each isohaline regime indicating a reduction from the baseline run for a specific freshwater diversion alternative. These data were used as V5 for each WVA habitat model, and summed for each alternative. The net AAHUs attributed to freshwater reductions in salinity only were then calculated for each diversion alternative, for the entire project area (Terrebonne and Barataria Basins).

3.3 Results

Table 3-4 shows the total AAHUs resulting from reductions in salinity for both basins, and the sediment and nutrient benefits for the Terrebonne Basin. Table 3-5 presents the benefit acreage for both basins.

TABLE 3-4
Total AAHUs for each RMA Model Run Alternative for the Bayou Lafourche Diversion

RMA Model Run	Project Alternative	Diversion Flow (cfs)	Grand Bayou Geometry Modifications	AAHUs Salinity Barataria Basin	AAHUs Salinity Terrebonne Basin	AAHUs Nutrient and Sediment TE Basin	Total AAHUs
9	20	1,020	No	1,107	31	681	1,819
6	32	1,530	No	1,178	22	1,066	2,266
7	38	970	No	1,147	11	873	2,031
8	44	1,400	No	1,216	17	931	2,164
10	47	2,000	No	1,213	22	968	2,203
11	20	1,020	Yes	1,253	66	799	2,118
17	38	970	Yes	1,506	61	820	2,387
18	44	1,400	Yes	1,472	58	921	2,451
12	47	2,000	Yes	1,243	80	1,071	2,394

TABLE 3-5
Total Benefit Acres for the Bayou Lafourche Diversion – Salinity and Sediment/Nutrient Analysis

RMA Model Run	Project Alternative	Diversion Flow (cfs)	Grand Bayou Geometry Modifications	Benefit Acres in Barataria Basin (Salinity)	Benefit Acres in Terrebonne Basin (Salinity)	Benefit Acres in Terrebonne Basin (Sediment and Nutrients)	Total Benefit Acres
9	20	1,020	No	83,317	2,655	34,849	120,821
6	32	1,530	No	88,447	1,524	37,140	127,111
7	38	970	No	83,711	1,103	36,211	121,025
8	44	1,400	No	86,405	1,673	37,343	125,421
10	47	2,000	No	92,046	2,967	36,896	131,909
11	20	1,020	Yes	90,770	5,025	32,738	128,533
17	38	970	Yes	82,320	3,094	33,973	120,197
18	44	1,400	Yes	84,928	3,704	35,452	124,084
12	47	2,000	Yes	90,292	5,413	34,047	129,752

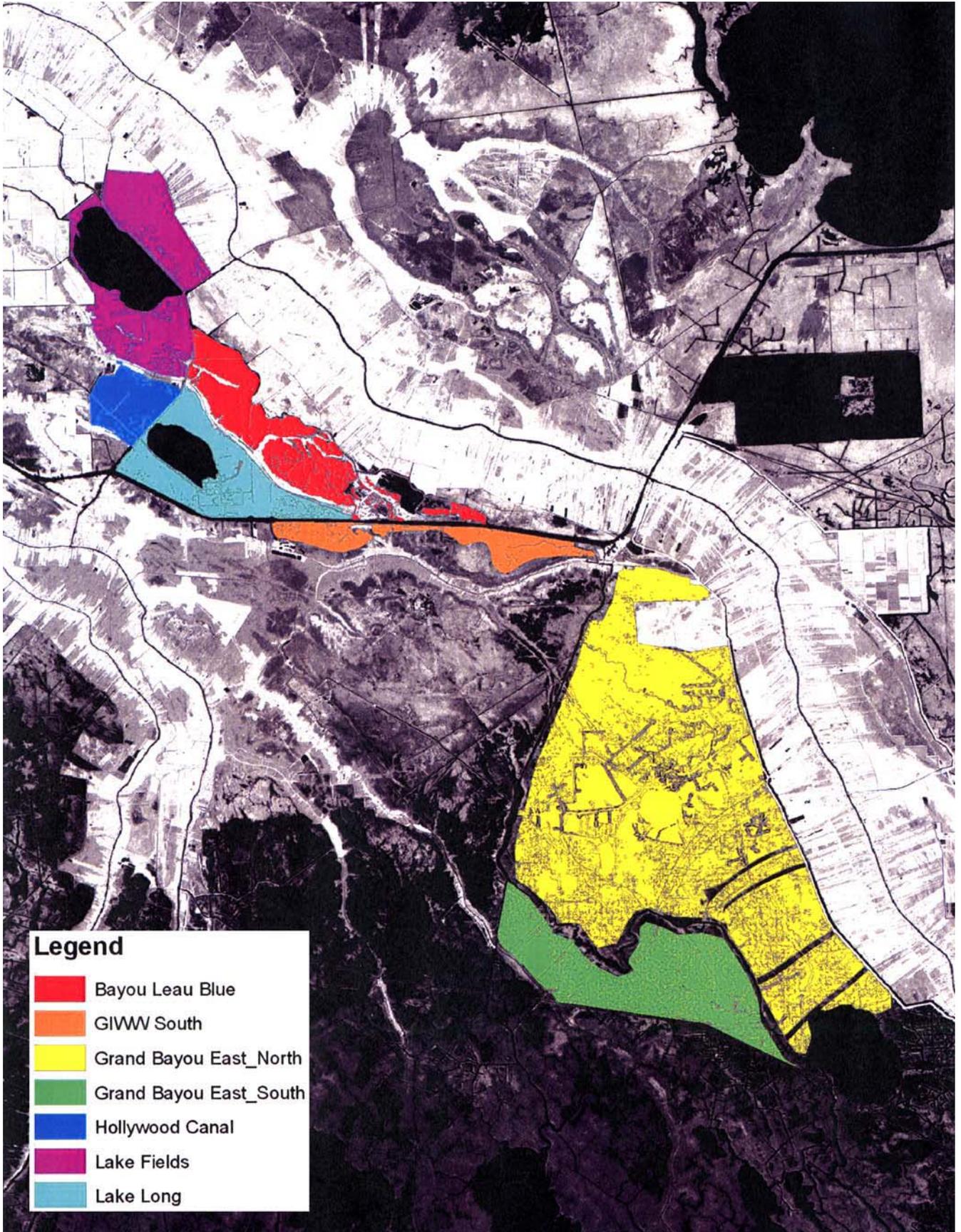


FIGURE 3-7
TERREBONNE BASIN NUTRIENT- AND
SEDIMENT-BASED BENEFIT AREAS
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

Comparison and Screening of Alternatives

4.1 Comparison Criteria

To objectively evaluate the remaining alternatives, criteria were developed to allow a side-by-side comparison and ranking of certain attributes of each alternative. Both quantitative and qualitative criteria were developed. Quantitative criteria were attributes that could be defined numerically; qualitative criteria were those attributes that are more subjective in nature and associated with long- and short-term benefits, impacts, and public perception.

4.1.1 Quantitative Criteria

4.1.1.1 Estimated Construction Cost

Construction costs were estimated for each alternative based on the level of development attained in the Phase 2 effort. The construction costs were separated into the following elements:

- Pump station (Donaldsonville or Smoke Bend locations)
- Dredging (not including excavation costs of the Smoke Bend bypass channel)
- Smoke Bend bypass channel
- Control structures (at Donaldsonville, Napoleonville and Thibodaux)
- Bridge replacements and modifications
- Utility relocations
- Bulkheads

Additional costs to the project are included for the following:

- Allowances and contingencies
- Structure Impacts (including land inundation)

Lower estimated costs are obviously favored to higher costs when comparatively ranking the alternatives. However, other criteria can influence the overall alternative as much or more than lowest cost.

Each of these cost elements are described briefly below. For more detail on cost estimating procedures and assumptions refer to Appendix L.

Pump Station. The costs for the Donaldsonville pump station are based upon a six-bay pump station with a maximum capacity of 1,500-cfs (250 cfs per pump). 1,000 cfs alternatives were estimated with only four pumps installed, but including the six bay pump station structure allowing for expansion to an ultimate capacity of 1,500 cfs. The Smoke Bend pump station cost is based upon an eight bay pump station structure allowing a 2,000 cfs capacity (8 pumps) for alternative 47. Smoke Bend alternative 44, was configured as a 6 bay pump station with a capacity of 1,500 cfs.

Dredging. Each alternative has a defined dredging template over the length of the project area and an associated dredged volume. Uncertainties on the final disposition of the dredged material removed and the amount of debris potentially encountered, required that several assumptions had to be made for cost estimating. Key assumptions include the following:

- Dredging is assumed to be performed by a mechanical dredge with a screen process on 75 percent of the total dredged volume. Of the 75 percent of material that is mechanically dredged, 70 percent will be conveyed using a high solids hydraulic pump and 5 percent of the dredged volume will be managed as debris. Dredging is assumed to be performed by a hydraulic dredge on 25 percent of the total dredged volume.
- Disposal of dredged material was a combination of in-water and upland options to handle 95 percent of the total dredged volume (remaining 5 percent was assumed to be debris).
- The following combination of dredged material management was assumed:
 - 45 percent in-water/marsh creation
 - 45 percent upland containment areas
 - 5 percent to Mississippi River
 - 5 percent debris to landfill
- The hydraulic dredge can pump approximately 5,000 feet without booster pumps. Based on information from dredging contractors, the use of booster pumps would increase the cost by about 50 percent.
- The cost estimate assumed 25 percent of the dredged quantity would be pumped an additional 5,000 feet using 12- to 16-inch lines.

Smoke Bend Bypass Channel. The Smoke Bend bypass channel work includes excavation of the new channel, new drainage structures, and a new inlet/outlet structure where the new channel intersects the Bayou Lafourche.

The excavated material represents a volume of 717,000 cy and 1,059,600 cy, for alternatives 44 and 47, respectively. The assumption is that this material would be disposed of by hauling to local storage areas, drying, and used as construction fill.

Control Structures. Three inflatable bladder control structures were included in the designs for all the remaining alternatives. The control structures are located in the general vicinity of Donaldsonville, Napoleonville and Thibodaux. Costs were based on a proprietary system offered by Obermeyer Hydro, Inc.

Bridge Replacements and Modifications. Bridge replacements and modifications could be categorized in two separate groups. The UPRR Bridge in Donaldsonville was proposed to be replaced due to the hydraulic constriction posed by its existing culvert system. Certain alternatives (Smoke Bend alternatives and alternative 15) did not require replacement of this bridge. This bridge is the most costly bridge replacement of the project.

There are six other bridges that might require replacement with the 8-foot depth dredging alternatives. Those bridges are described as follows:

- Highway 70, milepost (MP) 10.0
- Highway 1008, Franklin Ave. MP 16.3
- Highway 1010, Thomas Bridge MP 20.3
- Highway 1247, Labadieville Bridge MP 25.2
- Canal Bridge MP 34.1
- Lockport Bridge MP 56.3

In addition, there are also four bridges that require bracing with the 8-foot ALL dredging alternatives. Those bridges are described as follows:

- Highway 998, MP 6.2
- Highway 403, MP 10.6
- Highway 402, MP 15.1
- Tiger Dr. Bridge, MP 33.0

Utility Relocations. Numerous utilities require relocation (deepening) to accommodate the dredging requirements of the alternatives. The Design Drawings show the utility locations and which ones are assumed to require relocation for a 2-foot versus an 8-foot dredge depth. All utilities are assumed to be replaced by the HDD method. Costs for the relocations were developed by comparing HDD prices for similar projects with approximately the same length and depth of replacement.

Some of the costs estimated for utility relocation may be the responsibility of the pipeline owners in the areas of Bayou Lafourche that are classified as a navigable waterway. For this analysis, all defined utility relocation costs were assigned to the project alternatives, regardless of the waterway classification of the particular bayou reach.

Bulkheads. A total of 21,775 lineal feet of bulkheads were identified, based upon soil types, existing bank slopes, and depth of dredging. The standard detail for bulkheads includes sheet pile installation. The cost estimate is based upon a cost per square foot of steel sheet pile driven to a depth of 25 feet.

Contingencies and Allowances. Contingencies and allowances were defined, and applied to the subtotal of the costs developed for the pump station and diversion facilities; dredging; the Smoke Bend bypass channel; control structures; bridge replacements and modifications; utility relocations; and bulkheading. The contingency items and associated mark-ups include the following:

- Field Detail Allowance – 5 percent
- Mobilization/Bonds/Permits/Insurance – 5 percent
- Contractor Overhead – 10 percent
- Contractor Profit – 6 percent
- Construction Contingency – 30 percent

Structure Impacts. The local impact to structures from the water level rise associated with each of the alternatives has been considered as a unique cost item of the project. The demolition, relocation, or replacement cost was established from a field survey of potentially impacted structures. Photographs, structure classification, and location were used to estimate a structure impact cost that was accumulated by alternative.

Because the costs associated with the structural impacts was expected to be a negotiated value with individual property owners, and was not a direct construction cost, the structure impact cost item did not include contractor markups or contingency.

4.1.1.2 Benefits

Gaining benefits to wetlands is one of the primary goals of the project, and is reflected in the following project purpose statement:

The purpose of the project is to nourish and protect the marshes of the Barataria and Terrebonne Basins through the reintroduction of freshwater, sediments, and nutrients from the Mississippi River. The proposed project has the added benefits of ensuring long-term freshwater supply to the communities and industries served by the Bayou Lafourche Freshwater District, by limiting saltwater intrusion and enhancing water supply.

Additionally the CWPPRA Task Force stipulated, as a condition of funding for this phase of the design, that updated estimates of costs and benefits of the project and alternative designs be included in this design report. Specifically mentioned in the motion, was that the benefits address the project's wetland conservation goals.

Wetland benefits were, therefore, analyzed and calculated for each of the alternatives. Wetland benefits were quantified in terms of AAHUs. The RMA hydrodynamic model was a key tool used in this analysis which is described in detail in Section 3 and Appendix F of this report. The wetland benefits analysis is presented in detail in Appendix N.

To compare and rank alternatives, only wetland benefits were used. Water supply and vegetation control benefits have been quantified in terms of cost in Appendix M. However, these benefits are the same for each alternative and do not differentiate a preference of one alternative over another.

4.1.1.3 Cost Effectiveness

Cost effectiveness was characterized by two criteria. The first criterion is defined as the alternative estimated construction cost divided by the alternative diversion flow rate in cfs (cost/cfs). This criterion was used in earlier alternative screening evaluations, presented in the Phase 1 Design Report. It can indicate, for example, how hydraulically efficient one alternative is compared to another. It is a criterion that indicates how efficiently the alternative conveys flow based on dollars invested and allows comparisons between alternatives with different diversion flow rates.

The other criterion is defined as the alternative estimated construction cost divided by benefits (Cost/AAHU). This criterion indicates how efficiently the dollars that are invested in a particular alternative, are creating a unit of benefit. This criterion allows comparisons between alternatives with different benefit yields.

4.1.1.4 Project Efficiency

Project efficiency, for this analysis, is defined as the number of unit benefits created per unit flow rate of diversion flow (AAHUs/cfs). There is not necessarily a proportional relationship between diversion flow and benefits. However, this criterion is useful in

indicating an optimal project size (in terms of diversion flow) and can be compared with other cost-effectiveness criteria to estimate the optimal level of project investment.

4.1.1.5 Water Level Impacts

Water level impacts are defined as the estimated cost, to private bayou-side property, due to impacts from project-related water level rise. This includes property inundation and impacts to structures. While water level impacts are included in the estimated construction costs, it was decided that this criterion best characterized the impacts to property owners.

4.1.2 Qualitative Criteria

4.1.2.1 Scoring System

A scoring system was proposed to compare and rank a variety of defined qualitative criteria applied to the alternatives. Because qualitative criteria are inherently subjective in nature, a relatively simple system was devised for efficiency. Qualitative criteria applied to the alternatives were scored on a scale from 1 to 5, with 5 being most favorable and 1 being least favorable. These scores were added up for each criteria applied to a particular alternative. No weighting factors were applied to the criteria, meaning each criterion's score influenced the overall score of an alternative equally.

4.1.2.2 Maintenance

Each alternative will require varying levels of maintenance. Each alternative is comprised of complex systems that will require ongoing maintenance throughout the alternatives useful life. Individual systems common to all alternatives requiring maintenance include, but are not limited to the following:

- Forebay and sedimentation basins (dredging)
- Pump station and diversion facilities (electrical, mechanical, structural, and controls)
- Control structures (electrical, mechanical, structural, and controls)
- Conveyance improvements (channel and bulkhead maintenance, dredging)

The basic assumption in ranking the maintenance criterion is that the more complex the alternative (as judged by increasing construction cost/diversion flow rate/dredging volume/length of bulkheads), the more maintenance the particular alternative will require. Maintenance requirements ultimately translate directly into annual costs which the BLFWD will incur.

4.1.2.3 Construction Impacts

Impacts to the public from construction related activities from a project of this magnitude will be significant. Impacts will include such things as: traffic restrictions, increased road wear from heavy vehicles, noise, and dust. Obviously, construction activities close to densely populated areas will have more impact on the public. Therefore, the following assumptions were made prior to ranking each alternative for construction impacts:

- It is more favorable to minimize public exposure to construction activities
- More dredging and bulkheading exposes public to more construction activities

- The UPRR Bridge replacement exposes public to more construction activities
- Construction of the diversion facilities at a remote site (Smoke Bend) minimizes public exposure to construction activities

4.1.2.4 Dredge Volume

Dredge volume was identified as an indicator of overall project complexity, impacts and costs. Whereas there will be benefits derived from the beneficial reuse of dredged material, this criterion reflects the fact that the dredging volume associated with a particular alternative has a substantial influence on the cost, public impact and complexity of the project alternative. Therefore it is assumed that smaller dredging volumes are more favorable than large dredging volumes.

4.1.2.5 Expandability

Expandability relates to an alternative's ability to be upgraded in the future should greater diversion flow volumes be desired. As discussed in this section, the pump station facilities located at Donaldsonville or Smoke Bend can both be expanded in the future. The Smoke Bend facilities more readily expansion to capacities above 1,500 cfs than do Donaldsonville pump station facilities. The Donaldsonville structure will allow an ultimate capacity of 1,500 cfs. The Donaldsonville site is somewhat constrained and based on the water level impacts associated with a high volume discharge in the bayou at Donaldsonville; 1,500 cfs is likely the maximum flow rate that could ever be justified. The Smoke Bend site could more readily be expanded to greater capacities due, in part, to the remote and open site at Smoke Bend.

4.1.2.6 Stormwater Control/Flood Protection

Drainage and flood control issues are a significant concern for people living in the low lying areas of Southeast Louisiana. It has been assumed that the proposed alternatives will not exacerbate existing drainage problems. However, as discussed in Appendix J, the greater the dredge volume of a particular alternative, the greater the flexibility the system has in providing storage and control of high-intensity storm runoff. Therefore, it is assumed that alternatives with more dredged volume are more favorable than alternatives with less dredged volume for this criterion.

4.1.2.7 Diversion Flow

This criterion assumes that an overall goal of the proposed Bayou Lafourche diversion is to increase the amount of freshwater available to the marshes of Barataria and Terrebonne Basins. This criterion is independent of cost or benefit developed previously. It assumes that for long-term coastal restoration efforts, the alternatives with greater diversion flows are ranked more favorably.

4.1.2.8 Permitting/Right-of-Way/Environmental Impact

This criterion accounts for impacts to private property, complexity of permitting, and overall environmental impacts. The criterion therefore includes the following assumptions:

- Smaller, less-costly project alternatives are considered more favorable
- Less dredging is considered more favorable

- Less public impact due to construction is considered more favorable
- Smoke Bend alignment is less favorable (more property acquisition required)
- Less water level impacts are more favorable

4.2 Alternative Evaluation

4.2.1 Quantitative Rankings

4.2.1.1 Estimated Construction Cost

Table 4-1 presents the results of the cost ranking, showing more costly alternatives in descending order.

TABLE 4-1
Costs of Alternatives

Alternative	Flow (cfs)	Estimated Construction Cost (Nearest Million) (\$)
15	1,025	170,000,000
38	970	184,000,000
44	1,400	251,000,000
20	1,020	261,000,000
32	1,530	331,000,000
47	2,000	379,000,000
Least Rise	1,000	379,000,000

Ranking the alternatives by cost shows that alternative 15 is least costly, and Least Rise, the most costly, is just slightly more expensive than alternative 47.

4.2.1.2 Benefits

Table 4-2 presents the results of the benefit ranking, showing alternatives with less resultant AAHUs in descending order. AAHUs were not calculated for alternatives 15 and Least Rise due to the lack of model simulation runs for these two alternatives.

TABLE 4-2
AAHU Ranking of Alternatives

Alternative	Flow (cfs)	AAHUs
32	1,530	2,266
47	2,000	2,203
44	1,400	2,164
38	970	2,031
20	1,020	1,819
15	1,025	NA
Least Rise	1,000	NA

4.2.1.3 Cost Effectiveness

Cost effectiveness was measured by two criteria, Cost/cfs and Cost/AAHUs. The rankings are shown in Tables 4-3 and 4-4.

TABLE 4-3
Cost Per Flow Ranking of Alternatives

Alternative	Flow (cfs)	Cost/cfs (\$)
15	1,025	166,000
44	1,400	179,000
38	970	190,000
47	2,000	190,000
32	1,530	216,000
20	1,020	256,000
Least Rise	1,000	379,000

TABLE 4-4
Cost Per Benefit Ranking of Alternatives

Alternative	Flow (cfs)	Cost/AAHU (\$)
38	970	90,600
44	1,400	116,000
20	1,020	143,500
32	1,530	146,100
47	2,000	172,000
15	1,025	NA
Least Rise	1,000	NA

4.2.1.4 Project Efficiency

Project efficiency, defined as benefits per unit of flow (AAHUs/cfs), are ranked by descending level of efficiency in Table 4-5.

TABLE 4-5
Project Efficiency Ranking of Alternatives

Alternative	Flow	AAHUs/cfs
38	970	2.09
20	1,020	1.78
44	1,400	1.55
32	1,530	1.48
47	2,000	1.10
15	1,025	NA
Least Rise	1,000	NA

4.2.1.5 Water Level Impacts

Water level impact costs for each alternative are ranked in Table 4-6.

TABLE 4-6
Water Level Impacts Ranking of Alternatives

Alternative	Flow (cfs)	Water Level Rise Impacts (\$)
Least Rise	1,000	1,164,000
44	1,400	4,086,000
47	2,000	4,086,000
38	970	4,674,000
20	1,020	4,674,000
32	1,530	4,674,000
15	1,025	4,687,000

4.2.1.6 Summary of Quantitative Rankings

Table 4-7 and 4-8 summarize the information presented in Tables 4-1 through 4-6.

TABLE 4-7
Summary of Quantitative Values

Alternative	Flow (cfs)	Cost (\$)	AAHUs	Cost/cfs (\$)	Cost/AAHU	AAHUs/cfs	Water Level Impacts (\$)
15	1,025	170,000,000	NA	166,000	NA	NA	4,687,000
20	1,020	261,000,000	1,819	256,000	143,500	1.78	4,674,000
32	1,530	331,000,000	2,266	216,000	146,100	1.48	4,674,000
38	970	184,000,000	2,031	190,000	90,600	2.09	4,674,000
44	1,400	251,000,000	2,164	179,000	116,000	1.55	4,086,000
47	2,000	379,000,000	2,203	190,000	172,000	1.10	4,086,000
Least Rise	1,000	379,000,000	NA	379,000	NA	NA	1,164,000

TABLE 4-8
Summary of Quantitative Rankings

Alternative	Flow (cfs)	Cost	AAHUs	Cost/cfs	Cost/AAHU	AAHUs/cfs	Water Level Impacts
15	1,025	1	NA	1	NA	NA	4
20	1,020	4	5	5	3	2	3
32	1,530	5	1	4	4	4	3
38	970	2	4	3	1	1	3
44	1,400	3	3	2	2	3	2
47	2,000	6	2	3	5	5	2
Least Rise	1,000	7	NA	6	NA	NA	1

4.2.2 Qualitative Rankings

As discussed in Section 4.1.2, qualitative criteria were developed and scores applied for the particular criteria for each alternative. Table 4-9 summarizes the results of the scoring on the basis of the qualitative criteria.

TABLE 4-9
Summary of Qualitative Scoring

Criteria	Alternative						
	15	20	32	38	44	47	Least Rise
Maintenance	5	4	3	5	3	2	2
Construction Impacts	5	3	2	4	4	2	1
Dredge Volume	5	4	3	5	4	2	1
Expandability	2	3	3	3	5	5	3
Stormwater Control/ Flood Control	2	3	4	2	3	5	5
Diversion Flow	3	3	4	3	4	5	3
Permitting/ROW/ Environmental Impacts	5	3	2	4	3	1	1
Total Score	27	23	21	26	26	22	16

The overall qualitative scores for the alternatives were ranked (1 being best) as shown in Table 4-10.

TABLE 4-10
Summary of Qualitative Rankings

Alternative	Flow (cfs)	Rank
15	1,025	1
20	1,020	3
32	1,530	5
38	970	2
44	1,400	2
47	2,000	4
Least Rise	1,000	6

4.3 Preferred Alternative Recommendation

4.3.1 Review of Quantitative and Qualitative Rankings/Screening of Remaining Alternatives

4.3.1.1 Initial Screening

The information in this section was presented to the LDNR and EPA project management team in draft form on February 13, 2006. It was agreed that alternatives 15 and Least Rise be eliminated from further consideration for the following reasons:

Alternative 15

- Raises water level to mean water target upstream of UPRR Bridge. This impact was determined to be unacceptable to LDNR because of the amount property taken by the increased water line.

Least Rise

- Most costly and least cost efficient of all the alternatives.

Consideration for the funding currently available for coastal restoration projects requires that overall project costs be highly scrutinized. Therefore, it was assumed that only the three lowest-cost alternatives would be given further consideration. By eliminating alternative 15, the Least Rise alternative, and the remaining two highest-cost alternatives (32 and 47), the quantitative and qualitative ranking summaries were re-tabulated to reflect the remaining alternatives with adjusted rankings. Therefore, these new rankings present the relative differences between the three remaining alternatives only.

4.3.1.2 Bypass Channel Elimination

Based on alternative screening to the level presented in Tables 4-11 and 4-12, alternative 44 is the only remaining Smoke Bend Bypass Channel alternative. Alternative 44 is at the mid-point of estimated construction costs for the remaining three alternatives. It ranks in the first or second position for most of the criteria in Table 4-11 and is tied for the number one position in Table 4-12. Therefore, it is certainly a strong alternative given the criteria used. However, based on LDNR's communications with the owner of the property where the bypass channel would be sited, it is not anticipated that the property would be available for purchase by the State without the use of public eminent domain authority. Also, based on recent communications with the City Administration in Donaldsonville, there is renewed interest in increasing the flow through the Donaldsonville reach of Bayou Lafourche. The remaining Smoke Bend alternative (44) was, therefore, screened from further consideration.

TABLE 4-11
Summary of Quantitative Rankings

Alternative	Flow (cfs)	Cost	AAHUs	Cost/cfs	Cost/AAHU	AAHUs/cfs	Water Level Impacts
20	1,020	3	3	3	3	2	2
38	970	1	2	2	1	1	2
44	1,400	2	1	1	2	3	1

Note:

Alternatives 15, 32, 47, and Least Rise eliminated.

TABLE 4-12
Summary of Qualitative Rankings

Alternative	Flow (cfs)	Rank
20	1,020	2
38	970	1
44	1,400	1

Note:

Alternatives 15, 32, 47, and Least Rise eliminated.

4.3.2 Selection of Preferred Alternative

Based on the remaining alternatives and the associated quantitative and qualitative criteria rankings, it is apparent that **alternative 38** stands out as the remaining, best performing alternative for the criteria selected. The basic design and descriptive criteria for alternative 38 are presented in Table 4-13 for reference.

4.3.3 Future Design Refinements to Recommended Alternative

Design refinements should be undertaken during the next phase to optimize this alternative, particularly with respect to cost effectiveness and public acceptability. Reducing estimated project costs will be emphasized during the next phase of design.

The UPRR Bridge should be evaluated to see if it is possible to remove the hydraulic constriction caused by the existing culverts. If the existing culverts could be replaced by more efficient culverts, using a bore and jack or microtunneling, the bridge (existing embankment) might not have to be replaced, potentially saving millions of dollars.

TABLE 4-13
Alternative 38 Phase 2 Design Criteria Summary

Performance Criteria

Operational Flow = 970 cfs
Estimated AAHUs Created = 2,031

Diversification Facilities

Intake Facilities

Forebay-type
Vertical sheetpile walls with tie-back system

Screening (trash/debris):

Log boom (river side), Manually cleaned bar rack at pump intake

Pump Station

Initial Capacity: 1,000 cfs
Expandable Capacity: 1,500 cfs
Number of Pumps: 4
Pump Type: Axial Flow
Pump Horsepower (ea.): 700
Pump Control: 2 pumps – constant speed; 2 pumps – adjustable speed drives
Emergency Back-up Capability: Existing pump station has two pumps with auxiliary diesel motors for backup in case of electrical power outage (capacity = 170 cfs)
Facility length (feet): 140

Existing Pump Station

Initial Capacity: 340 cfs
Number of Pumps: 4
Pump Type: Axial Flow
Pump Horsepower (ea.): 250
Upgrades Proposed:
Vacuum system replacement
Refurbishment of 1 pump

Discharge Facilities

Discharge Piping Diameter (inches): 78
Discharge Piping Material: Steel
Number of Discharge Pipes (pre-expansion installation): 6
Discharge facility length (feet): 66

Sedimentation Basin

Location: RM 0.6 on Bayou Lafourche
Design settling velocity (fps): 0.02
Max. settling volume (annual cy): 5,600
Min. basin length (feet): 400

Conveyance Channel Improvements

Dredging

Dredge Template: 2-foot and 0-foot @ RM 29
Dredge Volume (cy): 2,900,000
Side-Slopes: 2.5H:1V
Bottom Widths (range, feet): 34 - 95

TABLE 4-13

Alternative 38 Phase 2 Design Criteria Summary

Final Disposition of Dredge Sediments (Assumptions)
45 percent in-water/marsh creation
45 percent upland containment areas
5 percent to Mississippi River
5 percent debris to landfill
Bridge Replacements/Modifications
Bridge Replacements
UPRR Bridge
Modification Type: Shoofly, bypass alignment
Bridge Modifications
Bracing at Hwy 998, Hwy 403, and Hwy 402
Utility Replacement/Relocation
Number Assumed: 40
Size Range (inches dia.): 2 - 36
Method: Horizontal Directional Drilling
Control Structures
Number Assumed: 3
Type: Inflatable bladder w/steel weir plate
Approximate location: Palo Alto Bridge, Napoleonville, Thibodaux
Length (feet): 140 - 160
Height (feet): 10.5 - 11.0
Thibodaux weir
Demolition of weir

Monitoring Systems
Water Level:
Continuous recorders, pressure transducers
SCADA data system
Water Quality:
Continuous probe type sensors (pH, conductivity, dissolved oxygen, redox, turbidity, total organic compounds)
SCADA data system

LDNR has also expressed concern that not dredging below RM 29, near Thibodaux, may not be acceptable to the public (alternative 38 dredging stops at RM 29, just upstream of the weir). It is therefore possible that extended dredging may be included in the refinement of alternative 38, or there may be a tradeoff by reducing the amount of dredging upstream of the weir and increasing the dredging downstream of the weir. However, because of the backwater effect of the Gulf of Mexico, this approach may have a limited benefit.

The freshwater district has indicated that the stormwater control features of the control structures may have limited benefit. This needs to be confirmed with additional hydrologic analysis of the basin. If the BLFWD assertion is correct, a less-costly structure could be used to provide the spill prevention feature.

Implementation of Recommended Alternative

5.1 Agency and Public Coordination

This section identifies and summarizes coordination requirements with key agencies and stakeholders. Close, proactive coordination with the pertinent agencies and the public is instrumental to assuring timely and cost-effective progress from project planning through project construction.

5.1.1 Coastal Wetlands Planning, Protection, and Restoration Act Task Force/ U.S. Army Corps of Engineers Coordination

CWPPRA was passed by congress in 1990 to fund wetland enhancement projects nationwide, designating approximately \$50 million annually for work in Louisiana. The projects funded by CWPPRA all focus on marsh creation, restoration, protection, or enhancement.

Phases 1 and 2 engineering and design were partially funded through CWPPRA. It is anticipated that the final design of this project will also be partially funded through CWPPRA. CWPPRA's organizational structure includes a Planning and Evaluation Subcommittee that oversees four separate work groups that evaluate proposed projects for their merits and make recommendations to the Planning and Evaluation Subcommittee for continued funding. These work groups include the Environmental and Engineering Work Groups, the Economics Work Group and the Monitoring Work Group. Initial discussions with CWPPRA, upon release of this Phase 2 document, will likely focus on the engineering and benefits analysis, and be held with the Environmental and Engineering work groups.

Coordination with USACE will likely begin immediately upon release of this document, for both permitting issues (Section 404 permit) and general engineering review and coordination. If the current version of the Water Resources Development Act (WRDA) passes Congress, and the Louisiana Coastal Area plan is authorized, there is a possibility that management of the Bayou Lafourche project may be transferred from LDNR to USACE. Considering the strain on Corps resources from the 2005 hurricane season, the Corps may partner with LDNR to continue their management of the execution of the Bayou Lafourche project.

5.1.2 National Environmental Policy Act Coordination

Assessing project alternatives through the NEPA process is required by federal rule to fully consider environmental consequences and integrate public input into the decision-making process. EPA is responsible for performing the required NEPA analysis and preparing the necessary environmental documentation related to this project. The environmental benefits associated with the range of project flows will be weighed against environmental impacts through the NEPA analysis.

NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the impacts of their proposed actions and reasonable alternatives to those actions (<http://www.epa.gov/compliance/nepa>). The Bayou Lafourche project scope and schedule has proceeded in communication and coordination with EPA and their environmental process.

Depending on the timing for funding and initiation of final design activities, the NEPA process will either proceed concurrently with final design or be completed by the time final design is started. It will be important to continue coordination between LDNR and EPA, during the public comment period, and during development of proposed mitigation measures associated with the preferred alternative.

5.1.3 Permitting

Project permitting falls into the general category of construction permits and environmental permits.

Construction permits will include those required from state, parish, city, or town governments to encroach on public roads or rights of way. This could include dredging pipeline alignments that cross public roads. Railroad crossings, such as the borings proposed under the railroad for the Smoke Bend pump station discharge pipelines, will require encroachment permits. Modification of the UPRR crossing in Donaldsonville will require some type of permit, unless UPRR prosecutes this work using their own resources.

Occupational Safety and Health Administration gas classifications will be required for the HDD work to relocate pipelines impacted by dredging. Depending on who does the utility relocations, permits from the impacted utilities may be required. Many utilities will require that the work be done by their own forces.

Building permits will be required for the structures on the project, included the pump station, discharge structure, and control structures.

Environmental permits will be required and will be essentially driven by the dredging activities. Permitting and regulatory agency coordination required due to dredging operations are summarized in Table 2-3 and described in more detail in Appendix I.

5.1.4 Real Estate

The project will require property in three forms: (1) fee; (2) permanent easements; and (3) temporary easements. These are described in this section.

Fee property is typically taken for a project where permanent facilities are to be located. For this project, facilities requiring fee property would likely include the pump station outlet structure and control structures (three locations).

Permanent easements are typically acquired for permanent linear facilities such as pipelines. For this project, permanent easements would likely be required for the pump station discharge piping. Permanent slope easements would likely be acquired for the areas that are bulkheaded, to provide a means of maintaining the bulkheads, if required. Some permanent easements may be required for dedicated marsh creation areas.

Temporary easements would be acquired to facilitate construction, but would then expire after construction is complete and disturbed areas are restored. These types of easements would likely be required in the following areas:

- Adjacent to the pump station site and discharge structure site.
- Access to Bayou Lafourche for dredging. Preliminary locations of these easements are shown on the Phase 2 Drawings, on the channel sheets. An example of this is shown on Figure 5-1, where the access corridors for dredging reach 1, 2 and 3 are shown.
- Staging areas for construction of utility relocations.
- Staging areas for discharge of dredging material into marshes or into the Mississippi River.
- Staging areas for construction of berms on cane fields.

It is assumed that reuse of dredged material on cane fields would not require easements because this would be part of the agreement with the landowner and/or grower.

To facilitate the acquisition of the necessary real estate to construct and maintain the project, it is recommended that LDNR possess eminent domain authority. Without this authority, negotiations for these lands will be difficult, time consuming, and may delay the project for years. It is also recommended that a ROW acquisition specialty firm be employed to manage appraisals and negotiations of the needed real estate.

The costs of acquiring these rights of way are not included in the overall project costs.

In addition to property needed for the permanent facilities or construction, water level rises will inundate some property and impact structures. The expected area of the land impacted is described in Table 5.1. The areas shown are based on preliminary bank contours developed for the Phase 1 report, which will be more accurately surveyed as part of the final design work. Because of the dramatic change in water level impact above and below the Thibodaux weir, those areas are shown separately. The structures and docks impacted by the water level rise are also shown on Table 5.1.

The above data are also discussed in the Cost Estimate technical memorandum, Appendix L.

5.1.5 Public Involvement and Outreach

Public involvement and outreach activities to date have included initial scoping meetings for the NEPA effort, the production and updating of a project web site, and presentations to local city councils, rotary clubs, interest groups, and radio stations by both the LDNR and staff from the Barataria Terrebonne National Estuary Program. Continued public outreach is assured through the NEPA process, during the Public Comment period for the Draft Environmental Impact Statement. This section emphasizes the need for continued and even increasing public involvement efforts as the program moves into the final design stage.

The Mississippi River Water Reintroduction into Bayou Lafourche project is truly a unique project in America. The uniqueness of this project requires a proactive outreach program. The project will literally be constructed and implemented within a backyard view of

thousands of community residents. Unlike other diversion projects in Southeast Louisiana, most of which are constructed in remote locations, the Bayou Lafourche project is truly an “urban” project that will be the most publicly visible diversion project constructed to date. A proactive public involvement program can save time and money and promote public good will through education of and communication with the affected public. A well-informed community is a fundamental part of building support for large infrastructure projects.

Additionally, the Bayou Lafourche project will undoubtedly be competing for limited funds with other coastal restoration projects and the myriad of post-Katrina restoration and protection efforts. Successfully funding the Bayou Lafourche project will in large part depend on committed community support, which can best be achieved through proactive communication and effective public education on the benefits and impacts of the project.

5.1.5.1 Tools and Techniques To Focus Resources and Effort

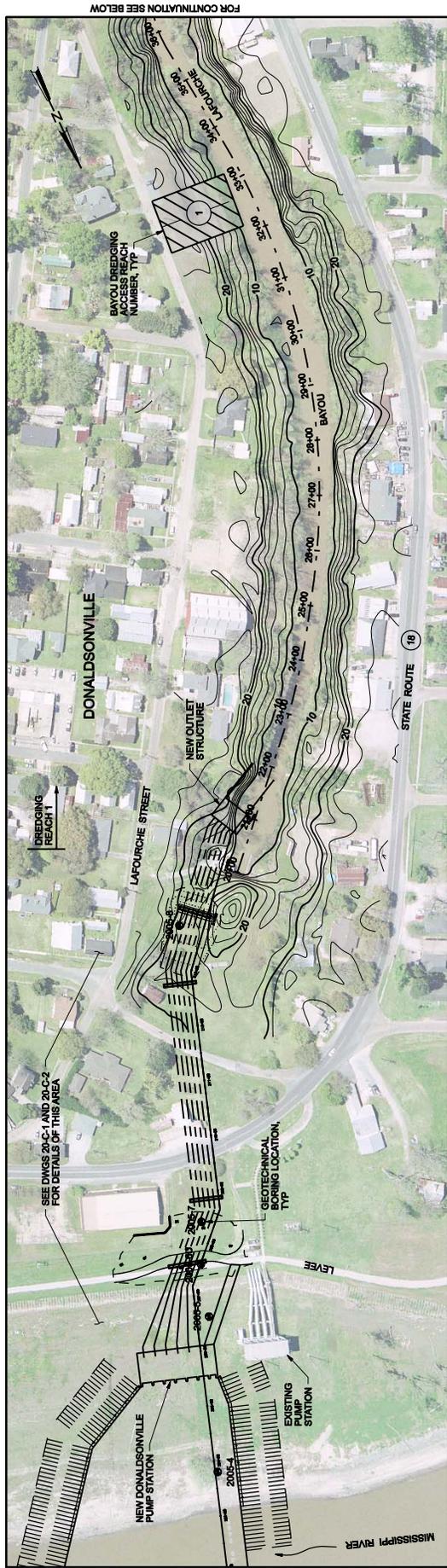
Successful project planning, design, and implementation require effective tools and techniques to identify and involve the affected public, including community members, elected representatives, and regulatory agencies. For the Bayou Lafourche project, effective coordination with landowners will be critical to prevent delays and potential claims. Contractor access to a minimum of 30, and up to over 50 miles of the bayou, will be needed for exploration and testing, dredging, structure demolition, and bank stabilization construction. Dredging operations will create noise, disrupt traffic, and generally inconvenience the public for a minimum of 1 year (16 hours per day) and potentially up to more than 2.5 years. Access to and acquisition of certain properties will be required to implement the project. Consensus building for project support among the affected community and key property owners is vital for project success.

Basic components and typical issues involved in development of an effective public involvement and outreach program are listed below for consideration in developing a public involvement strategy during final design. Many of the items listed have implemented and consideration should be given to continuing and expanding these practices.

Public Education. Developing and distributing clear, concise information materials such as fact sheets, newsletters, videos, and 3-dimensional visual simulations. Public education campaigns should be consistent and informative. Regular forums or newsletters (web updates) can be extremely helpful in keeping the community engaged and interested in project progress.

Web Site. LDNR currently manages a web site that provides information on the Bayou Lafourche project. Web sites are an inexpensive and effective means to accurately interact with the public. Web sites can provide information to help the public understand the project, keep people informed about progress, and provide a place to submit input. It can also visually document project progress with photos and illustrations; reducing fax, printing, and mailing costs. Web sites however, do not reach people who are not inclined toward the technology, and should be supplemented by public meetings and educational opportunities.

Consensus Building. Development of public involvement tools, mediation, facilitated decision-making, needs identification, priorities ranking. Public Involvement specialists can



- NOTES:
1. CONTOUR LINES ARE ONLY SHOWN BETWEEN THE ADJACENT ROADS TO THE MAIN CHANNEL.
 2. CONTOURS WERE DEVELOPED FROM LIDAR DATA WHICH IS CONSIDERED ACCURATE TO ± 1.2 FT.

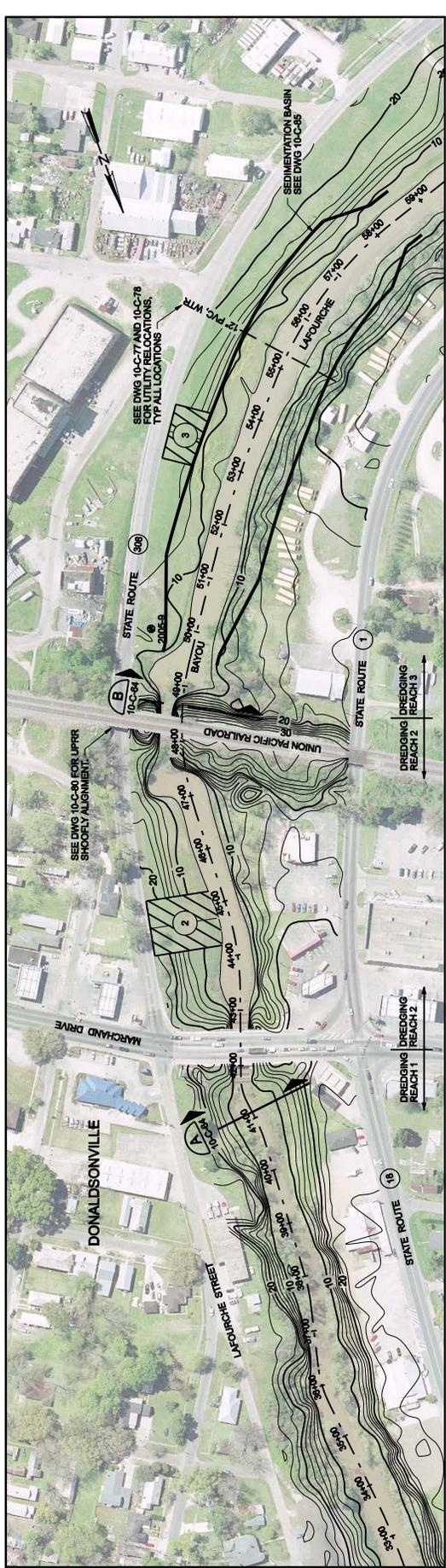


FIGURE 5-1
TYPICAL DREDGING REACH
ACCESS CORRIDORS
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

assist in consensus building exercises for strategic level meetings such as those with property owners, and the local sugar cane industry.

TABLE 5-1
Additional Land Area Inundated and Structures Impacted by Alternative

Alternative	Donaldsonville					Smoke Bend	
	15	20	32	38	Least Rise	44	47
Reach: Donaldsonville to Palo Alto Bridge							
Structures	7	7	7	7	0	0	0
Docks	0	0	0	0	0	0	0
Land (acres)	9	7	7	7	0	0	0
Reach: Palo Alto Bridge to Thibodaux weir							
Structures	91	91	91	91	0	91	91
Docks	81	81	81	81	0	81	81
Land (acres)	94	94	94	94	0	94	94
Reach: Thibodaux weir to Lockport							
Structures	30	30	30	30	12	30	30
Docks	156	156	156	156	134	156	156
Land (acres)	66	66	66	66	33	66	66

Public Relations. Public awareness campaigns, media strategies, focus groups, opinion surveys for routine and crisis issues are all methods to bolster relations between the project administrators and the public. Addressing public concerns quickly and accurately will assist in minimizing the spread of negative opinions about project-related issues.

Community Response. Accurate responses to community concerns and timely notification of project changes and decisions increase trust and cooperation between the team and the community. Maintaining continuous, open lines of communication demonstrates that the project team is listening and responding to community concerns.

Public Presentations. Presenting information at public forums and meetings is often an intimidating task. Preparation for such presentations includes development of high-quality graphics and other presentation tools to ensure accurate presentation of facts within an appropriate delivery style.

Project Decision Making. Experts in decision-making techniques, meeting facilitation, and dispute resolution to assist in reaching consensus with the public, is often invaluable for successful implementation of projects of this size.

Documenting Community Concerns. Cooperative decision making requires careful documentation and consideration of community concerns. Building trust with the community means listening carefully and responding to concerns. Tracking those concerns throughout the project improves interactions with the community.

5.2 Summary of Recommendations

This section summarizes the major remaining issues that require resolution in the next phase of the engineering and design effort, and offers recommendations on how best to address these issues.

5.2.1 Evaluation and Selection of Dredged Material Reuse Alternative

Further analysis is required to verify assumptions listed in this Phase 2 Design Report. Regulatory agency communication is required to discuss permitting approach, conclusions from previous environmental sampling, and proposed next steps of the project. Additional analysis will be required to determine the environmental acceptability of the dredged material management options, depending on the reuse alternative selected.

5.2.1.1 Regulatory Agency Coordination

Permitting requirements associated with dredging are listed in detail in Table 2-3 of this report. It is recommended that coordination with USACE and LDEQ begin as soon as possible, to initiate the 404 permit and 401 Water Quality Certification processes to verify remaining material quality and sampling requirements.

5.2.1.2 Public, Landowner and Agency Coordination for Material Management Preferences

In-depth communications should be initiated with the Sugar Cane League, to verify requirements and conditions for applying dredged material to agricultural sites. For agricultural application significant land areas will be needed for staging, dewatering, and application, so discussions with landowners should be initiated as soon as possible. For potential marsh creation sites, landowners of potential sites should be contacted to verify that permission is obtainable for use of the particular property.

As material sampling requirements are met and quality determinations are verified, communication with the public via public involvement programs should be initiated to address concerns regarding management of the dredged material. Dredged material removal is typically an issue of concern for the public, and a proactive informational program will help facilitate better cooperation with property owners and the general public.

The dredged material should be thought of as resource and there may be competitive interests regarding its final disposition. Agricultural use, levee construction and marsh creation are some of the obvious competing interests. Coordination early on with federal, state, and private entities that may benefit from the use of the material will allow the state to make the best decisions regarding its final use.

5.2.1.3 Refinement of Debris Quantity

The amount of debris anticipated and encountered will affect the overall approach and cost of the dredging operations. Further consultation with dredging contractors to verify the best approach for quantification and management of debris is recommended.

5.2.1.4 Refinement of Dredged Material Management Plan

The following issues related to the dredging plan require refined definition and resolution before development of contract documents for the dredging work can begin.

Determination of the preferred management plan will depend, in part, on the following factors:

- Overall project cost and available funding.

- Louisiana Coastal Resources Program evaluation for dredged material use as wetland enhancement, restoration or creation.
- Potential need as construction fill for priority projects (e.g., Morganza to the Gulf levee construction).
- Potential desire and demand for material as a potential enhancement to agricultural lands.
- Ability to obtain easements or access to upland containment areas; dredge material pipelines and return-water pipeline routes; and marsh areas for marsh creation sites.
- Ability to apply material in proposed final disposition alternative based on regulatory acceptance of material quality.
- Ability to offset overall project costs through compensation for dredged material.

The recommendations listed above are intended to further define the many variables for an accurate understanding of costs, dredging approach, the best suited dredged material management option.

5.2.2 Drainage Evaluation

For the Phase 2 design, a local drainage evaluation was completed to investigate the existing flooding problems and to discuss the project with the local drainage managers. Details of the drainage evaluation can be found in Appendix J.

The local drainage concerns surrounding the project are focused on increased water levels and the expected impact on local drainage issues including flooding. In some parts of the bayou there are existing flooding and drainage problems that have been documented by drainage and flood control managers. Figure 5-2 shows the water level profile expected for alternative 38 in comparison to the existing water level in Bayou Lafourche. In 1997, CEEC completed a reconnaissance study of the storm drain outfalls and found more than 400 discharges along the bayou between Donaldsonville and Lockport. Of these 400, there were 47 identified as having capacity limitations where increased water levels could impair the hydraulic performance of the drain.

There are two important features of the project that will be used as mitigating measures and could also reduce existing drainage problems. First, the bayou will be dredged to increase the conveyance capacity. Dredging can substantially increase the storage capacity within the bayou if water levels are managed properly. Second, the coordination of the pump station diversion and control structure operations can be used to manage the water levels and available storage based on where the most severe runoff occurs.

Interviews with local officials and reviews of existing studies indicate that drainage and flooding problems need not be worsened by increasing the flow capacity of the bayou, provided that the appropriate level of engineering analysis and controls are applied to the project. However, a more in-depth understanding of the flooding and drainage problems related to the existing bayou drainage area and the proposed project will be necessary to develop a project acceptable to the local residents and the managers of the drainage authorities. Appendix J, discusses the local drainage concerns, provides summaries of

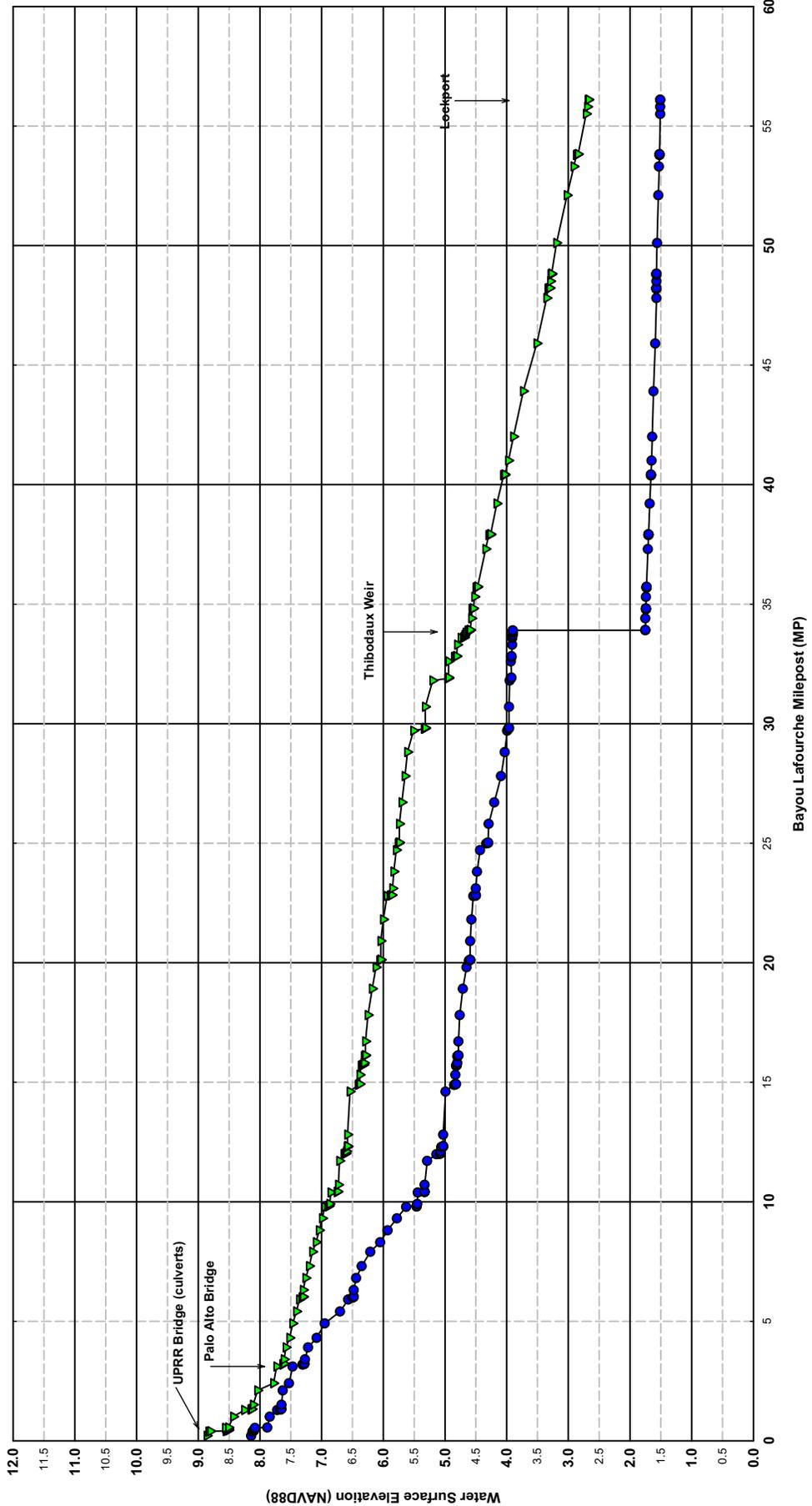
meetings with the local flood control managers, and shows the location and elevation of problematic stormwater outfalls (culverts).

The following activities should be considered for a drainage planning and design scope to be incorporated into the final design of the project alternative:

- Survey the 47 identified culverts documented in the 1997 CEEC drainage study. Confirm and document location, size, crown elevation, invert elevation, inlet and outlet configuration and condition, material type, and length.
- Investigate additional storm drain outlet problems downstream of Lockport. Meet with local drainage managers to discuss expected project water levels, related flood impacts on outlets, and potential mitigation. Survey additional problem outlets and document location, size, crown elevation, inlet and outlet configuration and condition, material type, and length.
- Coordinate with LDNR and local drainage authorities to verify and select the design storm condition.
- Coordinate with USACE to incorporate results as they become available from the flood and hurricane feasibility study being conducted from Donaldsonville to the Gulf of Mexico.
- Define the contributing runoff areas. Develop drainage area maps along the bayou and delineate areas contributing directly to the bayou. Combine drainage areas into defined tributary reaches along the bayou, develop rainfall-runoff data for design storm(s), and use as flow input to HEC-RAS model.

Develop rainfall-runoff peak flows and/or hydrographs using either a Rational formula or SCS method approach.

- Use HEC-RAS model in either steady-state or dynamic mode to evaluate historical water levels in the bayou during storm events and future water levels for the selected alternative.
- Use results from two-dimensional modeling to investigate the impact of the project on the bayou water levels downstream of Lockport. Prepare detailed water level profiles for the bayou between Lockport and Larose for the selected alternative.
- Compare the existing flood-water elevations with future elevations throughout the bayou. Focus on the areas where the previously identified 47 outfalls are located (CEEC, 1997). Perform trial-and-error analysis using various pump station flows, design storm inflows, and dredged geometry to determine what pump flow will lower water surface below historical elevations.
- Investigate one or two low-lying problem areas with local authorities. Review the authorities' understanding of the problems and control points (silted-in ditches, crushed pipes, blocked waterways). Discuss potential improvements in connection with what is planned for the future operation of the bayou.



Legend
 ● Existing
 ▲ Altern. #38, 2'-0" RM29, 970 cfs

FIGURE 5-2
WATER SURFACE PROFILE - ALTERNATIVE 38
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

- Consider installing water level recorders in the problem areas and the bayou to develop coordinated water levels during storm events. Use this information to approximate impacts from changes in bayou water levels and suggest improvements.
- From the results of the impact analysis in the surrogate area, propose operational plans and facility improvements to mitigate for drainage problems exacerbated by the project.
- Adapt the improvement concepts in the surrogate basin to other problem areas along the bayou. Review plans with local drainage authorities and LDNR for buy-in while recognizing that the improvements must be tied directly to the Bayou Lafourche Project.
- Include adopted drainage facility improvements in the final design.

5.2.3 Conveyance Features

Refinements to the recommended alternative are likely to occur during the next phase of design. Such refinements will include incorporating more detail into existing concepts or modifications of existing concepts to improve cost efficiency. Areas of focus for the conveyance related features are discussed below.

5.2.3.1 Dredging Template

The dredging template and quantity needs to be optimized to obtain the most hydraulically efficient channel system, and to minimize costs. Currently the recommended alternative 38, has the minimum dredge scenario of all those analyzed, 2-foot and 0-foot @ RM 29. LDNR has indicated that some amount of dredging may be desired beyond RM 29. This may be accomplished by reducing the amount of dredging in other areas, to keep total dredge costs constant, or by increasing the overall volume and dredge costs. The dredging template should be refined during final design to reflect overall cost, hydraulic efficiency and water level impact and drainage concerns.

5.2.3.2 Bridges

Roadway Bridges. Alternative 38 requires 2 feet of dredging which, based on the evaluation presented in Appendix B, Bridge Evaluation, will likely require bracing of three bridges. Prior to proceeding with the development of final design details, the following actions should be taken:

- The existing timber pile size, supporting and bracing member size and condition should be verified in the field.
- Each bridge cross section should be field surveyed for the specific dredging template to be constructed.
- Each bridge should have structural and geotechnical analyses performed.
- At least one boring should be drilled in the bayou to estimate new soil strength properties.

Union Pacific Railroad Bridge. Alternative 38 also includes the replacement of the UPRR Bridge. As a potential cost saving measure, investigations should be undertaken to determine if it is feasible to microtunnel larger capacity culverts under the existing railroad

embankment, to eliminate the existing hydraulic constriction and avoid replacing the entire bridge.

In-depth communication with Union Pacific should be undertaken immediately upon initiation of the final design to verify options for bridge modifications or replacement.

5.2.3.3 Utilities

Based on a final determination of the extent of dredging required below RM 29, verify responsibility for relocation for any utilities below the existing Thibodaux weir (covered under Section 10 of the Rivers and Harbors Act of 1899). Responsibility for relocation may be responsibility of owner. A more detailed investigation into pipeline locations will be required to verify all potentially affected utilities.

5.2.3.4 Bulkheading

In areas that will likely require bulkheading (0.5 mile upstream and approximately 21 miles downstream of Thibodaux) additional borings should be taken at steep slope locations to further refine the slope stability. A larger selection of bulkheading material types and systems should be evaluated during final design as only steel sheet piling was reviewed for this effort.

5.2.3.5 Diversions/Channel Modifications

Several modifications to the general project concept have been suggested over the course of the Phase 1 and 2 design efforts. These modifications include the following:

- Bayou Terrebonne Diversion (from Bayou Lafourche)
- St. Louis Canal Modifications (from the GIWW)
- Grand Bayou Modifications (from the GIWW)

The Grand Bayou modifications are discussed in this report, but not formally proposed as part of the preferred alternative at this time. The Bayou Terrebonne Diversion and the St. Louis Canal modifications will have preliminary investigations initiated upon finalization of this report. These potential projects, in particular the Bayou Terrebonne diversion, should be incorporated into the Bayou Lafourche final design effort to insure overall project compatibility, should they be viable projects with available funding.

5.2.3.6 Control Structures

To reduce the high initial estimated cost of the proposed project, the need for three control structures on Bayou Lafourche should be further evaluated during the final design effort. The structures allow control of water surfaces for storm or toxic spill events. It might be feasible to eliminate one of the proposed control structures and maintain adequate functionality for storm water and toxic spill operations.

5.2.3.7 Real-Time Monitoring Systems

The scope for real-time monitoring systems should be evaluated during the final design to ensure that a monitoring system is developed that meets the needs of the BLFWD. Currently, a toxic spill advanced warning system is being managed by the LDEQ. It should be assessed whether this system meets the needs of BLFWD.

Another function of a real-time system is associated with water level monitoring. In light of efforts to minimize project costs and complexities, water-level monitoring should be evaluated before committing to the technology.

5.2.4 Pump Station

5.2.4.1 Hydraulic Modeling

Physical modeling of the wet well is the recommended approach for a facility of this size and nature. The wet well design used in this Phase 2 report is based on the established parameters of the Hydraulic Institute and represents an approach for intake design that results in minimal adverse effects on pump hydraulic performance. The wet well design is determined using pump flow and dimensional characteristics as well as other dimensional and geometric recommendations established by the Hydraulic Institute. The wet well design may be refined and modified from the Hydraulic Institute recommendations during the final design based on physical model testing or other proven design or research accepted by the designers.

Physical modeling for pump stations of this size reduces the risk of improperly designed wet wells and possibly reduces construction costs through structure modifications from the strict use of Hydraulic Institute recommendations. Hydraulic phenomena, such as submerged or free surface vortices, pre-swirl of flow entering the wet well, excessive velocity distributions, and entrained air affect pump performance and, in particular, large propeller type pumps. Physical modeling can provide assurance that such phenomena are not present in the design.

It is also recommended that the forebay and outlet structure be modeled to determine optimum physical dimensions and hydraulic conditions for each of the structures.

5.2.4.2 Equipment Evaluations

Equipment evaluations are a route part of final design for any pumping facility and will need to be undertaken for the pumps, drives, electrical, and control equipment. The potential need or preference for mechanically cleaned intake screens should be evaluated during final design. These will increase the overall pump station cost but can represent savings in labor for screen cleaning and maintenance. Results of the forebay modeling should help indicate whether mechanically cleaned intake screens are a cost-effective investment for the diversion facilities.

5.2.4.3 Architecture/Visitor Center

Currently the pump station is laid out as very basic structure, on par architecturally with the existing Donaldsonville pump station. There is potential for significant architectural upgrades from this most basic design. Obviously this has to be balanced with available funds.

A concept that has been previously suggested is to take advantage of Donaldsonville's location (near the tourist and visitor attractions of antebellum homes and New Orleans) and build a visitor's center at the new diversion facilities to showcase the Bayou Lafourche project, coastal land loss issues, and state and federal wetlands restoration efforts. This has been done with utility facilities throughout the country and can be a very effective strategy for public education.

5.3 Funding

Continued funding will be required for final design services, and ultimately, constructing the project. It is anticipated that funding for final engineering design services will be authorized by CWPPRA for an overall minimum share of 50 percent. The remaining funds will be provided by the state, with the likely source being the Wetlands Trust Fund.

Funding for the construction of the project may be provided through a separate line item in the WRDA, slated for congressional authorization this year. The federal share through WRDA would likely be 75 percent.

5.4 Schedule

The estimated schedule through final construction of the facilities is attached as Figure 5-3. Expedited delivery methods, for example through a design build approach, can typically yield time savings of 30 to 40 percent. It is assumed, however, that a design-build approach will not be undertaken for the Bayou Lafourche project and a traditional, design-bid-build approach will be taken. The traditional, design-bid-build delivery model is presented in Figure 5-1.

SECTION 6.0

References

Barras, J., Beville, S., Britsch, D., Hartley, S., Hawes, S., Johnston, J., Kemp, P., Kinler, Q., Martucci, A., Porthouse, J., Reed, D., Roy, K., Sapkota, S., and Suhayda, J., 2003. Historical and projected coastal Louisiana land changes: 1978-2050: USGS Open File Report 03-334, 39p.

CH2M HILL, Inc. 2005. *Phase 1 Design Report for the Mississippi River Water Reintroduction into Bayou Lafourche Project*. November.

Chabreck, R.H., G. Linscombe, S. Hartley, J. Johnston, and A. Martucci. 2001. *Coastal Louisiana marsh vegetation types*. USGS National Wetland Research Center

Coastal Engineering and Environmental Consultants (CEEC). 1997 *Bayou Lafourche Freshwater Diversion Preliminary Dredging Plan* (Preliminary Dredging Plan).

Coastal Management Division/LADNR, and US Fish and Wildlife Service (USFWS), 19980323, Louisiana Conservation Plan Boundary, Geographic NAD83, LDNR, USFWS (1998) [cwcplan]: Coastal Management Division, LDNR, Baton Rouge, LA.

Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). 1993. *Louisiana Coastal Wetlands Restoration Plan*. November.

Louisiana Geological Survey. 2002. Oil Spill Research and Development Program. *Louisiana Pipeline Crossing GIS data [CD-ROM]*. Louisiana Oil Spill Coordinator's Office, Baton Rouge, Louisiana.

U. S. Army Corps of Engineers. 1987. Engineering and Design Manual - *Confined Disposal of Dredged Material* (EM 1110-2-5027). September.

U.S. Environmental Protection Agency (EPA). 2004. *Bayou Lafourche Sediment Study*. June.

U.S. Environmental Protection Agency (EPA). 1998. *Evaluation of Bayou Lafourche Wetlands Restoration Projects: Coastal Wetlands Planning Protection and Restoration Act Project PBA-20*. September.

U.S. Fish and Wildlife Service. 1980. Fish and Wildlife Service Manual - Habitat Evaluation Procedures (formerly 102EMS), 870 FW 1. March.

USGS National Wetlands Research Center, 1999, 1988 Gulf of Mexico Coastal Louisiana Habitat Data as Raster Image, UTM 15 NAD83, NWRC (1999) [nwiHab88].

Appendix A
Water Sampling Data Report

Draft Report

**Mississippi River
Water Reintroduction into
Bayou Lafourche – Quality
Monitoring Program**

Prepared for
Louisiana Department of Natural Resources

February 2006

CH2MHILL

Executive Summary

The quality monitoring program for the Bayou Lafourche Freshwater Diversion study collected data to support hydrodynamic modeling. Parameters monitored during the study included surface water elevation, salinity, velocity, and stream discharge. These data were used to calibrate and verify the performance of the hydrodynamic model used in the assessment of feasibility of alternatives for reintroducing Mississippi River water into Bayou Lafourche.

This report presents the procedures used to conduct the study, the resultant data, and the quality control procedures that were implemented throughout the program. Following is a summary of each report section.

Section A1. Field Deployment and Service Events

Section A1 presents the work conducted to deploy data collection platforms (DCP), and service them during the data collection phase of the project. Data were collected using a combination of 18 existing DCPs and DCPs installed by CH2M HILL. Several of the stations had DCPs in operation, which are maintained by federal or state agencies. The existing DCPs were used where appropriate to provide necessary data. DCPs installed and maintained by CH2M HILL for the duration of the data collection period supplemented the existing stations to meet project objectives.

Parameters monitored included surface water elevation, salinity, velocity, and discharge. CH2M HILL installed six multi-parameter monitoring sondes (CTD) to measure temperature, surface water elevation, and specific conductivity from which salinity is derived. In addition, CH2M HILL installed six acoustic doppler current profilers (ADCP) to measure velocity. Data were acquired from these devices for ten months and will be used to calibrate and verify the performance of the hydrodynamic model.

The data collection effort began on February 10, 2004, when the CH2M HILL field team mobilized to Houma, Louisiana. Six ADCPs and six CTDs were installed beginning on February 11, 2004. Four ADCPs and four CTDs were installed in conjunction with each other while the remaining two ADCPs and two CTDs were installed separately or in conjunction with existing equipment maintained by LUMCON or U.S. Geologic Survey (USGS). Installation was completed on February 19, 2004. Data collection was concluded on January 11, 2005, and the DCPs were disassembled and the station sites were returned to previous condition.

The Field Sampling Plan, Field Deployment Report, and site descriptions are contained in Section A1.

Section A2. Data Description

Parameters included in the project database are reported in standardized units to avoid confusion when comparing data between locations. Data were converted to the appropriate standard units as necessary.

Section A2.1 CH2M HILL Data

The parameters targeted for collection by instruments deployed by CH2M HILL as part of the sampling plan included the following:

- Temperature
- Specific conductance
- Water surface elevation (depth)
- Salinity
- Stream velocity, direction, and speed

The environmental parameters were measured with known precision (measurement error) and limits of accuracy specified by the instrument manufacturer. The precision and accuracy of the instrument for each parameter are listed in the Sampling and Analysis Plan (SAP) that is included as Attachment 1 of this data report. Water surface elevation is a derived parameter calculated from measured water column depth (water pressure) and land surface elevation. Salinity is calculated by the YSI 600LS instrument from conductivity and temperature. Data were shifted when necessary on water surface elevation, specific conductivity, and salinity.

Section A2.2 External Data

This section describes data received from other agencies (USGS, LUMCON, and USACE). The parameters collected by other agencies and received by CH2M HILL as part of the sampling plan included the following:

- Temperature
- Specific conductance
- Gage height/stage
- Salinity
- Stream velocity
- Stream discharge

Section A3. Data Validation and QA/QC

Data Collection Protocols

Protocols established in the SAP and based on those of LDNR were followed while in the field to ensure consistently valid data. The protocols are specified in the Standard Operations Procedures (SOP), included in section A3.2.1. The SOP includes protocols for mobilizing and demobilizing the equipment and data collection platforms; producing field documentation in the form of field event log books that include instrument calibration logs; cleaning and maintaining the YSI 600LS continuous monitoring instrument (CTD) and the

SonTek Argonaut Acoustic Doppler Current Profiler (ADCP); copying the accumulated data stored in the data recorders since the last field event; methods confirming the calibration on the instruments and checking all basic functions of the machinery.

QA/QC Methodology

After the data were downloaded from the instruments, the data went through a primary review using the manufacturer's software to plot and check ranges in the raw data. After the data were reviewed and validated, the data were imported into a "master database" that contains the entire cumulative record of data over time and station locations, and stored in the SQL database management software. The field team leader reviewed the data in the master database using the same protocols as were used in the primary QA/QC review. This protocol was repeated by the QA/QC officer to double check and review the work of the field team leader. The protocols are listed in Section A3.1.

The frequency of data sampling set for the YSI continuous monitoring instrument, every 15 minutes, resulted in 96 values per parameter per day per station, for a total of over 1.6 million individual pieces of data to review (8 parameters, 6 stations, 1 year) for conductivity, temperature and depth. Time series plots and univariate statistical analysis were used to summarize the large data files and highlight potential problems during the final review of the QA/QC procedure.

QA/QC Results

CH2M HILL ended a successful year of recording water parameters and flow data in January 2005, and the instruments and data collection platforms were demobilized on January 11, 2005. Success of the monitoring program to record regular water parameter readings varied from station to station because of frequency of instrument malfunction, and from season to season because of tidal and climatic fluctuations.

Modern technology combining high performance environmental monitoring instruments and continuous data recording devices that communicated with a field laptop computer produced large quantities of high quality data records free from the typographic errors that occurred in past days of environmental monitoring when paper and pencil were major tools of field crews. However, modern technology introduced its own problems when project staff attempted to combine the results of various instruments and computer hardware and software.

Data collection was continuous, but data gaps did result from instrument malfunction, collisions, vandalism, and periods when the instrument was removed from the water for maintenance, or the water level dropped below the instrument probes.

Station 1: Bayou Lafourche above Company Canal, lost data in February and March because of instrument malfunction, and a month of data in November and December because a boat collided with the DCP. The YSI was deployed again on December 10, but the Argonaut ADCP was not redeployed, so its data record ended November 9, 2004.

Station 2: Company Canal near Lockport, LA, the data record is complete except for a gap in data recording August 5-10, 2004 because of instrument malfunction.

Station 3: Lake Fields, instrument malfunction and consequent removal for servicing at the manufacturer's lab caused gaps in the data record between February 23 and March 10, 2004; between April 15 and April 23, 2004; between November 4 and December 2, 2004; in addition, numerous single data points had to be invalidated because of temporary malfunction.

Station 4: The Gulf Intracoastal Water Way, near Larose, LA, east of Bayou Lafourche: the YSI 600LS performed well and produced a consistent data record, except for a period in August, when the instrument was vandalized, causing a data gap from August 16 to September 2, 2004. The Argonaut ADCP performed consistently well, except a collision event caused a data gap from May 12 to 21, 2004.

Station 5: Bayou Lafourche, downstream of the Gulf Intracoastal Water Way: the YSI and Argonaut instruments consistently collected good quality data, but a high concentration of barge traffic caused a great deal of extra turbulence and chop, and its location downstream of a lock and dam flood gate caused several rapid changes in depth, velocity.

Station 7: Grand Bayou Marsh: The instruments in this very shallow marsh system experienced three short periods when the water level dropped below the instrument probes, resulting in data gaps. The YSI instrument malfunctioned and was removed from the field for servicing, after which additional time was lost from flooding from a hurricane storm event that prevented deployment of the instrument, resulting in a data gap from August 9 through September 20, 2004.

Station 8: Bayou Terrebonne, SE of Houma, LA: The YSI 600LS CTD and Argonaut ADCP continuous monitoring instruments performed consistently well during the year. There are no data gaps nor were there any disturbances to either instrument during the year-long monitoring period.

Station 16: Bayou Petit Caillou at Cocodrie, LA: The Argonaut ADCP continuous monitoring instruments performed consistently well during the year. There are no data gaps nor were there any disturbances to the instrument during the year-long monitoring period.

Section A4. Description of Electronic Deliverable

Section A4 contains a compact disk (CD) of the collected data in electronic format. Table A-22 in Section A4 contains a listing of all files contained on the CD.

The electronic deliverable is specific to the requested format in support of the hydrologic model. Two Microsoft Access 97 databases with the raw data are included: the internal data (CH2M_HILL.MDB) and external data (EXTERNAL_DATA.MDB). A series of Excel spreadsheet files of the flagged/processed data are also included.

Contents

	Page
Executive Summary.....	iii
Section	
A1 Field Deployment and Service Events	A1-1
A1.1 Introduction.....	A1-1
A1.2 Sampling and Analysis Plan for Water Quality	A1-1
A1.3 Field Deployment of Continuous Water Quality Instruments	A1-1
A1.4 CH2M HILL Station Descriptions and Survey data.....	A1-1
A1.5 External Gauge Summary and Survey Data.....	A1-1
A1.6 Field Service Events Summary	A1-2
A2 Data Descriptions	A2-1
A2.1 Introduction.....	A2-1
A2.2 Standard Units	A2-1
A2.3 Internal Data.....	A2-1
A2.3.1 Description of Measured Parameters	A2-2
A2.3.2 File Nomenclature and Inventory	A2-3
A2.3.3 Data adjustments	A2-8
A2.3.4 Data Gap Summary.....	A2-9
A2.3.5 Natural Phenomena in Data	A2-10
A2.4 External Data.....	A2-11
A2.4.1 Description of Measured Parameters	A2-11
A2.4.2 Description of Data Sources.....	A2-11
A3 Data Validation and QA/QC	A3-1
A3.1 Introduction.....	A3-1
A3.2 Data Collection Protocols	A3-1
A3.2.1 Water Quality Data Collection Standard Operations Procedures...	A3-1
A3.2.2 Raw Data Evaluation	A3-2
A3.2.3 Database Evaluation	A3-3
A3.3 QA/QC Methodology	A3-5
A3.3.1 Introduction	A3-5
A3.3.2 Methods	A3-5
A3.4 Results of the QA/QC and Data Summary	A3-8
A3.4.1 Results for Internal Data.....	A3-8
A3.4.2 QA/QC Results for External Agency Data.....	A3-22
A3.5 Figures – Time-series Graphs – CH2M HILL CDT and ADCP	A3-23
A3.6 Shift Factor Memorandum	A3-23
A4 Description of Electronic Deliverable	A4-1
A5 References.....	A5-1

Contents, Continued

Page

Attachments

1	Sampling and Analysis Plan for Water Quality	
2	Field Deployment of Continuous Water Quality Instruments	
3	Stations 1 through 8 Descriptions	
4	Stations 1 through 8 Information	
5	Remaining Station Descriptions	
6	Remaining Stations Information	
7	Water Quality Data Collection Standard Operating Procedures	
8	Current Speed and Direction Time-series Graphs	
9	Bayou Lafourche Water Sampling Program: Method for Calculating the Shift Factor	
10	Water Sampling Program Electronic Data	

Tables

A-1	Standard Units for Database Parameters.....	A2-1
A-2	Description of Positive Flow for ADCPs	A2-3
A-3	CTD File Inventory	A2-3
A-4	ADCP File Inventory	A2-6
A-5	Adjustment Factors for CTD Data Sondes Deployed by CH2M HILL	A2-8
A-6	Calibration Criteria for Continuous Water-Quality Instruments	A2-8
A-7	Parameter Shift Criteria and Maximum Allowable Limits for Continuous Water-Quality Monitoring Sensors	A2-9
A-8	Adjustment Factors Applied to Gauge Height Readings Reported by USGS	A2-12
A-9	Qualifier Codes Used to Mark Data as Invalid.....	A3-4
A-10	Station 1 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period.....	A3-8
A-11	Station 1 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period.....	A3-10
A-12	Station 2 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period.....	A3-11
A-13	Station 3 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period.....	A3-12

Contents, Continued

	Page
A-14 Station 4 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period	A3-14
A-15 Station 4 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period	A3-16
A-16 Station 5 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period	A3-17
A-17 Station 5 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period	A3-19
A-18 Station 7 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period	A3-20
A-19 Station 8 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period	A3-21
A-20 Station 8 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period	A3-21
A-21 Station 16 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period	A3-22
A-22 Electronic Data Deliverable Contents and Structure.....	A4-1

Figures

A-1 Internal Gage Map.....	A2-15
A-2 Relationship Between Velocity, Speed, and Direction Information Recorded by the Argonaut SL ADCP Instruments.....	A2-17
A-3 External Gage Map.....	A2-19

A1 Field Deployment and Service Events

A1.1 Introduction

Section A1 and Attachment 1 contain a compilation of project documents, technical memorandums (TM), and task summaries that have been submitted to Louisiana Department of Natural Resources (LDNR) or used internally during the Water Sampling Task.

A1.2 Sampling and Analysis Plan for Water Quality

The Sampling and Analysis Plan (SAP) for Water Quality gives the purpose and objectives of this Water Sampling Task. It also summarizes site selection and parameters that were measured. In addition, it contains the guidelines for field activities, data collection, data management, and Quality Assurance/Quality Control (QA/QC). This document was approved by LDNR prior to the initiation of data collection. (Attachment 1)

A1.3 Field Deployment of Continuous Water Quality Instruments

The Field Deployment of Continuous Water Quality Instruments TM is an internal document written at the completion of mobilization and initiation of data collection. The TM contains dates of mobilization and details of data collection platform establishment. (Attachment 2)

A1.4 CH2M HILL Station Descriptions and Survey data

The CH2M HILL Station Descriptions and Survey data is a compilation of station descriptions and surveys for sites established by CH2M HILL. Attachment 3 contains the station descriptions, which were written using the same format as those obtained from USGS. Attachment 4 contains the survey data collected by T. Baker Smith & Son, Inc. These data were used to compute water surface elevation from depths measured by the sondes.

A1.5 External Gauge Summary and Survey Data

The External Gauge Summary and Survey Data attachment is a compilation of station descriptions and surveys for existing sites maintained by U.S. Geologic Survey (USGS), LUMCON, and U.S. Army Corps of Engineers (USACE). Attachment 5 contains the stations' descriptions, which were obtained from each operating agency. Some USGS sites were not surveyed into NAVD88 or LDNR Primary Network. These sites required surveying to obtain a correction factor. Survey data collected by T. Baker Smith & Son, Inc., for these sites are presented in Attachment 6.

A1.6 Field Service Events Summary

The following paragraphs contain a summary of each field service event that occurred during the pilot study and subsequent monitoring period, which started February 19, 2004, and ended January 12, 2005.

Field Service Event 1

The first field service event occurred March 10 through 12, 2004. The acoustic doppler current profilers (ADCP) at Station 1 would not link up to the computer. SonTek, Inc., personnel made a field visit and corrected the issue. No data were logged with the ADCP during the first download period. A data gap from February 19, 2004, to March 12, 2004, resulted from the ADCP instrument malfunction. Also, a data gap resulted for the multi-parameter monitoring sonde (CTD) for Station 1 from March 10 to 12, 2004, because the CTD was not redeployed until the ADCP had been serviced. Also, Station 3 collected data every minute from February 14, 2004, through February 23, 2004. A data gap resulted for the CTD from February 23 to March 12, 2004.

Field Service Event 2

The second field service event of the data collection period occurred March 29 and 30, 2004. Downloads went as planned. Station 3's CTD was set to log every 15 hours instead of every 15 minutes.

Field Service Event 3

The third field service event for the data collection period occurred on April 15 and 16, 2004. One month of data with the exception of Station 3 has now been collected. Logging issues remained with the CTD at Station 3, and on April 19, 2004, this instrument was retrieved from the field and brought in for inspection. No apparent problems were found with the CTD, but YSI overhauled the instrument anyway. Logging issues resulted from sample intervals being set to 15 hours instead of 15 minutes. The overhauled instrument was re-deployed at Station 3 on April 23, 2004. From this point forward, field service events will be conducted every 4 weeks instead of 2.

Field Service Event 4

The fourth field service event of the data collection period occurred May 17 and 18, 2004. A data gap for both the CTD and ADCP at Station 4 from May 12 and 21, 2004, resulted from a collision event that occurred on May 12, 2004. The damage was not assessed until the fourth service event on May 17, 2004 and reinstallation could not take place until May 21, 2004. The station was reinstalled in the same place using a lower profile mount. In addition, protective hardware was installed around the DCP to help prevent future disturbances to the station.

Field Service Event 5

The fifth field service event of the data collection period occurred June 10-11, 2004. The stations were found in good condition with the exception of Station 5. Station 5's ADCP was found to have been involved in a minor collision event, which occurred 3 hours before servicing. As a result, only 3 hours of ADCP data were lost. The instrument mounting was returned to precollision position and redeployed.

Field Service Event 6

The sixth field service event of the data collection period occurred July 8-9, 2004. The stations were found in good condition. To complete the repairs caused by the collision before the fifth field service event, the ADCP at Station 5 was moved to a more secure location to reduce the chances of future incidents. Additionally, the heading at Station 16 was found to be off by approximately 20-30 degrees throughout the last data collection period. After examining the instrument, no apparent disturbances were found. After viewing the changes in the heading over the data collection period it was determined that a large fishing vessel that was parked within 1 to 2 meters of the instrument was affecting the compass readings. SonTek, Inc., was consulted regarding this issue and the data are still valid.

Field Service Event 7

The seventh field service event was conducted on August 5 to 6, 2004. The ADCP cable at Station 2 was shorted while changing the battery. YSI sent cable to Baton Rouge on Monday, August 09, 2004. The cable was successfully fixed to factory condition. On August 10, 2004, the ADCP was reinstalled and redeployed. As a result, a data gap exists from August 5 to 10, 2004.

Field Service Event 8

The eighth field event was conducted on September 2 to 3, 2004. Several issues arose during this field event. First, Station 4's CTD had been tampered with. The CTD was pulled completely out of the water to the top of the CTD well. A data gap from August 16 to September 20, 2004, resulted. The depth sensor at Station 5 would not stabilize, so it was brought in and sent to YSI, Inc., for evaluation. Finally, Station 7 reset after 3 days of data logging. The correct time was set and during deployment the instrument reset again. YSI, Inc. was contacted while in the field and the technician said the instrument needed to be brought in from the field. The two sondes were sent on Monday, September 6, 2004 and were received back from YSI, Inc on Friday, September 10, 2004. Due to Hurricane Ivan on September 15, 2004 redeployment of the sondes were delayed until September 20, 2004. The resulting data gap for Stations 5 is September 2 to 20, 2004, and the resulting data gap for Stations 7 is August 9, 2004 to September 20, 2004.

Field Service Event 9

The ninth field service event was conducted on October 7 and 8, 2004. Monitoring Station 16, located on Bayou Petit Caillou at Cocodrie, LA, was not downloaded or serviced due to coastal flooding. We attempted to get to the station but the waters were too high to continue safely. The other stations were successfully downloaded and serviced. After the coastal flooding had receded, Station 16 was serviced on October 13, 2004.

Field Service Event 10

The tenth field service event was conducted on November 4 and 5, 2004. All downloads went well. Only one issue arose on this event. The water elevation in Cocodrie, LA, was so low that interference on the ADCP was being shown within a couple meters in from the instrument. Usually approximately 3 feet of water are needed above the instrument and the

water was only 0.9 foot above at the time of the download. The instrument is already as low as it can be placed so it was not moved.

Field Service Event 11

The eleventh field service event was conducted on December 9 and 10, 2004. Downloads went as planned with the exception of Station 1. Station 1 is located next to a Bollinger construction shipyard, and upon watering the vessel, which has been under construction at the Bollinger Ship yard, the vessel struck the DCP at Station 1. The vessel is assumed to have been watered on November 9, 2004 at 10:30 a.m. The ADCP cable was cut during the collision and no data were collected from November 9, 2004, to December 10, 2004. A cable has been ordered, but this ADCP at Station 1 will not be reinstalled. The salinity and specific conductivity are still considered valid. However, a data gap will occur from November 9, 2004, to December 10, 2004, for depth and water surface elevation. The CTD was reinstalled on December 10, 2004 one bulkhead upstream from where it was previously located.

Field Service Event 12

The twelfth and final field service event was conducted January 10 through 12, 2005. The downloads went as planned. DCP deconstruction and site cleaning went well. The sites were downloaded and disassembled on January 10 and 11, 2005. An initial cleaning of each instrument was conducted at each site. Per guidelines of YSI, Inc., instruments were soaked in a vinegar bath over night. On the third day, January 12, 2005, instruments were removed from the vinegar bath and thoroughly cleaned. Once all instruments were cleaned, they were properly packed. All mounting hardware was also cleaned. All mounting hardware and six ADCP batteries were dropped off at the LDNR field office in Thibodaux, LA. Upon completion of the QA/QC process, the instruments were turned over to the LDNR field office on April 28, 2005.

A2 Data Descriptions

A2.1 Introduction

Data collection for this task occurred by two means: data from CH2M HILL-established DCPs and data obtained from existing DCPs maintained by USGS, LUMCON, and USACE. Data from CH2M HILL DCPs were collected with either an YSI, Inc. 600LS datasonde or SonTek/YSI Argonaut SL instrument. CH2M HILL parameters collected included temperature, specific conductivity, vented level, salinity, and stream velocity. Parameters obtained from LUMCON, USGS, and USACE included temperature, specific conductivity, water surface elevation, salinity, stream velocity, and stream discharge. Descriptions of each CH2M HILL parameter are included in this section along with file nomenclature, data gaps, and any natural phenomena affecting data. For external data, this section reviews the means of data collection along with a description of any data adjustments that were applied.

A2.2 Standard Units

All parameters included in the project database are reported in standardized units to avoid confusion when comparing data between locations. Data was converted to the appropriate standard units as necessary. Standard units are listed in Table A-1.

TABLE A-1
Standard Units for Database Parameters
Water Sampling Data Report

Parameter	Unit
Date	DD/MM/YYYY
Time	24 H; Central Standard Time (CST)
Depth / Vented Level	feet
Water Surface Elevation	feet, NAVD 88
Specific Conductivity	microsiemens per centimeter ($\mu\text{S}/\text{cm}$)
Salinity	parts per thousand (ppt)
Water Temp	Degrees Celsius ($^{\circ}\text{C}$)
Stream Velocity	Centimeters per second cm/s
Discharge	Cubic feet per second (cfs)

A2.3 Internal Data

This section describes data collected from instruments deployed by CH2M HILL as part of the Mississippi River Water Reintroduction into Bayou Lafourche project. Figure A-1 (all figures are at the end of this section) indicates the locations and types of data collected by instruments deployed by CH2M HILL.

A2.3.1 Description of Measured Parameters

The parameters targeted for collection by instruments deployed by CH2M HILL as part of the sampling plan included the following:

- Temperature
- Specific conductivity
- Vented Level
- Salinity
- Stream velocity, direction, and speed

Temperature

Temperature was measured using a YSI, Inc. 600LS datasonde. This instrument measured temperature with an accuracy of $\pm 0.15^{\circ}\text{C}$ at a resolution of 0.01°C .

Specific Conductance

Specific conductance (conductivity) will be measured with an accuracy of ± 0.5 percent or $2\ \mu\text{S}/\text{cm}$ (whichever is greater) with a resolution of four significant figures.

Vented Level

Depth (i.e., pressure) will be measured with an accuracy of ± 0.01 feet at a resolution of 0.001 foot. Each measurement will be an averaged reading taken over a continuous 60 second interval (minimum). Depth measurements will be used to calculate surface water elevation using contemporaneous measurements from the DCP and elevation survey.

Salinity

Based on the temperature, specific conductivity, and pressure measurements, salinity will be calculated with an accuracy of 1.0 percent, or ± 0.1 part per thousand (ppt), (whichever is greater) at a resolution of 0.01 ppt.

Velocity, Speed, Direction

Velocity was measured with an accuracy of ± 1 percent of measured velocity or ± 0.5 cubic meter per second (cm/s), (whichever is greater) at a resolution of $0.1\ \text{cm}/\text{s}$.

The SonTek/YSI Argonaut SL measures stream velocity in both the X and Y plane of the instrument. Instruments were horizontally oriented as shown on Figure A-2. The beam path was oriented across the channel flow (from bank to bank). The X-plane is perpendicular to the horizontal axis of the instrument while the Y-plane is parallel to the horizontal axis of the instrument. These are vector quantities; they are fully described by a magnitude and direction. Thus, the X-velocity measurement indicates the magnitude and direction of water movement in the channel. This is indicated by the high X-velocities relative to the Y-velocities for each instrument reading; there was very little water movement toward or away from the instrument. Speed is scalar and represents the integrated X- and Y-velocity measurements. Direction is simply the direction of water movement, in degrees, relative to the instrument orientation. Table A-2 describes positive flow for each station.

TABLE A-2
Description of Positive Flow for ADCPs
Water Sampling Data Report

Station	Direction of Positive (+) WaterVel1/X/E
Station 1	Downstream on Bayou Lafourche
Station 2	Northeast toward Bayou Lafourche on Company Canal
Station 4	Northeast away from Bayou Lafourche on GIWW
Station 5	Downstream on Bayou Lafourche
Station 8	Downstream on Bayou Terrebone
Station 16	Downstream on Bayou Petite Caillou

A2.3.2 File Nomenclature and Inventory

Data files for the YSI, Inc. 600LS CTD datasonde were named using the following convention:

XXYYMMDD.dat

XX = Station ID

YY = Last two digits of year file started recording

MM = Numeric month file started recording

DD = Numeric day of month file started recording

For example, data file 01040313.dat would refer to a file associated with Station 1 that started collecting data on March 13, 2004.

Table A-3 lists CTD datasonde files included in the project database.

TABLE A-3
CTD File Inventory
Water Sampling Data Report

Station	File	Begin Date	End Date	Records
Station 1	01040219	19-Feb-04	10-Mar-04	1898
Station 1	01040312	10-Mar-04	29-Mar-04	1630
Station 1	01040329	29-Mar-04	15-Apr-04	1629
Station 1	01040415	15-Apr-04	17-May-04	3071
Station 1	01040517	17-May-04	10-Jun-04	2303
Station 1	01040610	10-Jun-04	08-Jul-04	2682
Station 1	01040708	08-Jul-04	05-Aug-04	2677
Station 1	01040805	05-Aug-04	02-Sep-04	2695
Station 1	01040902	02-Sep-04	07-Oct-04	3354
Station 1	01041007	07-Oct-04	04-Nov-04	2689
Station 1	01041104	04-Nov-04	02-Dec-04	2685

TABLE A-3
 CTD File Inventory
Water Sampling Data Report

Station	File	Begin Date	End Date	Records
Station 1	01041203	02-Dec-04	10-Jan-05	3631
Station 3	00013748	23-Feb-04	16-Mar-04	11
Station 3	03040216	16-Feb-04	23-Feb-04	672
Station 3	03040329	29-Mar-04	15-Apr-04	28
Station 3	03040422	23-Apr-04	17-May-04	2321
Station 3	03040517	17-May-04	10-Jun-04	2300
Station 3	03040610	10-Jun-04	08-Jul-04	2675
Station 3	03040708	08-Jul-04	05-Aug-04	2671
Station 3	03040805	05-Aug-04	02-Sep-04	2689
Station 3	03040902	02-Sep-04	07-Oct-04	3346
Station 3	03041007	07-Oct-04	04-Nov-04	2675
Station 3	03041104	04-Nov-04	02-Dec-04	2679
Station 3	03041202	02-Dec-04	10-Jan-05	3729
Station 4	04040311	11-Mar-04	29-Mar-04	1727
Station 4	04040329	29-Mar-04	15-Apr-04	1631
Station 4	04040415	15-Apr-04	17-May-04	3086
Station 4	04040521	17-May-04	11-Jun-04	2031
Station 4	04040611	11-Jun-04	09-Jul-04	2653
Station 4	04040709	09-Jul-04	06-Aug-04	2701
Station 4	04040806	06-Aug-04	02-Sep-04	2595
Station 4	04040902	02-Sep-04	07-Oct-04	3360
Station 4	04041007	07-Oct-04	05-Nov-04	2762
Station 4	04041105	05-Nov-04	03-Dec-04	2688
Station 4	04041203	03-Dec-04	11-Jan-05	3746
Station 5	05040212	12-Feb-04	11-Mar-04	2657
Station 5	05040311	11-Mar-04	29-Mar-04	1746
Station 5	05040329	29-Mar-04	15-Apr-04	1633
Station 5	05040415	15-Apr-04	17-May-04	3076
Station 5	05040517	17-May-04	11-Jun-04	2409
Station 5	05040611	11-Jun-04	09-Jul-04	2654
Station 5	05040709	09-Jul-04	06-Aug-04	2694
Station 5	05040806	06-Aug-04	02-Sep-04	2594
Station 5	05040920	02-Sep-04	07-Oct-04	1663
Station 5	05041007	07-Oct-04	05-Nov-04	2762
Station 5	05041105	05-Nov-04	03-Dec-04	2688
Station 5	05041203	03-Dec-04	11-Jan-05	3755

TABLE A-3
CTD File Inventory
Water Sampling Data Report

Station	File	Begin Date	End Date	Records
Station 7	07040216	16-Feb-04	11-Mar-04	2326
Station 7	07040311	11-Mar-04	30-Mar-04	1787
Station 7	07040329	30-Mar-04	16-Apr-04	1637
Station 7	07040416	16-Apr-04	18-May-04	3073
Station 7	07040518	18-May-04	10-Jun-04	2218
Station 7	07040610	10-Jun-04	08-Jul-04	2685
Station 7	07040708	08-Jul-04	06-Aug-04	2746
Station 7	07040806	06-Aug-04	09-Aug-04	345
Station 7	07040920	09-Aug-04	08-Oct-04	1724
Station 7	07041008	08-Oct-04	04-Nov-04	2608
Station 7	07041104	04-Nov-04	02-Dec-04	2691
Station 7	07041202	02-Dec-04	10-Jan-05	3749
Station 8	08040213	13-Feb-04	11-Mar-04	2606
Station 8	08040311	11-Mar-04	30-Mar-04	1804
Station 8	08040330	30-Mar-04	16-Apr-04	1621
Station 8	08040416	16-Apr-04	18-May-04	3073
Station 8	08040518	18-May-04	10-Jun-04	2240
Station 8	08040610	10-Jun-04	08-Jul-04	2667
Station 8	08040708	08-Jul-04	06-Aug-04	2762
Station 8	08040806	06-Aug-04	03-Sep-04	2703
Station 8	08040903	03-Sep-04	08-Oct-04	3347
Station 8	08041008	08-Oct-04	04-Nov-04	2606
Station 8	08041104	04-Nov-04	02-Dec-04	2692
Station 8	08041202	02-Dec-04	11-Jan-05	3807

Acoustic Doppler Current Profilers

Data files for the SonTek/YSI Argonaut SL ADCP were named using the following convention:

STXXZZZ.dat

STXX = Station ID

ZZZ = Sequential numeric file number

For example, data file ST01005.dat would refer to data file 5 from Station 1.

Table A-4 lists ADCP files included in the project database.

TABLE A-4
 ADCP File Inventory
 Water Sampling Data Report

Station	File	Start	Stop	Samples	Diagnostics																			
					Cell Begin (meters)				Cell End (meters)				SNR1				SNR2				Heading (degrees)			
					Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum		
Station 1	ST01001	3/12/04 11:00	3/29/04 9:00	1626	2	2	18.5	19	55.5	75.7	44.7	76.1	94.2	95.5										
Station 1	ST01004	3/29/04 10:00	4/15/04 7:30	1624	2	2	18	18	57.2	79.6	55.9	79.6	94.1	95.4										
Station 1	ST01007	4/15/04 8:45	5/17/04 8:00	3071	2	2	18	18.5	55.5	81.7	54.6	80.8	94.3	95.6										
Station 1	ST01010	5/17/04 9:05	6/10/04 8:05	2302	2	2	18	18.5	54.2	80	53.3	79.1	94.2	95.5										
Station 1	ST01002	6/11/04 11:10	7/8/04 6:55	2577	2	2	18	18.5	46.9	77.8	52	77.8	94.2	95.5										
Station 1	ST01008	7/8/04 9:10	8/5/04 6:10	2678	2	2	18.5	18.5	54.2	83.4	53.3	83	94.1	95.4										
Station 2	ST02002	2/12/04 13:24	2/18/04 8:24	558	2	2	20	20.5	59.8	80.4	58.5	80.8	258.8	259.9										
Station 2	ST02005	3/10/04 14:38	3/29/04 9:53	1807	2	2	20	20.5	57.2	85.6	57.2	85.6	258.6	260.2										
Station 2	ST02007	3/29/04 10:40	4/15/04 9:10	1628	2	2	20	20.5	59.3	85.1	57.2	86.9	258.5	260.1										
Station 2	ST02011	4/15/04 10:20	5/17/04 10:50	3076	2	2	20	20.5	57.2	82.1	55	82.1	258.6	259.6										
Station 2	ST02014	5/17/04 11:45	6/10/04 10:45	2302	2	2	20.5	20.5	54.6	79.1	52.5	78.7	257.8	260.5										
Station 2	ST02019	6/11/04 14:00	7/8/04 10:00	2578	2	2	20	20.5	52.9	79.6	53.8	79.6	258.8	259.8										
Station 2	ST02022	7/8/04 10:50	8/5/04 7:20	2676	2	2	20	20.5	55	79.6	53.8	79.6	258.1	259.8										
Station 4	ST04001	2/15/04 14:29	3/11/04 11:14	2389	5	5	70	70.5	39.6	61.1	38.7	60.2	271.1	274.6										
Station 4	ST04004	3/12/04 12:30	3/29/04 12:45	1635	5	5	70	70.5	40.9	58.9	40	58.9	270.7	275.3										
Station 4	ST04007	3/29/04 13:45	4/15/04 12:45	1630	5	5	70	70.5	42.1	60.6	41.7	59.8	268.4	274.7										
Station 4	ST04010	4/15/04 13:50	5/17/04 17:20	3088	5	5	70	70.5	40.4	64.1	30.5	60.6	240.2	274.7										
Station 4	ST04013	5/21/04 12:15	6/11/04 15:45	2032	5	5	70	70.5	39.6	59.3	39.6	58.9	273.4	279.5										
Station 4	ST04016	6/11/04 16:40	7/9/04 7:25	2653	5	5	70	70.5	43.4	60.6	43	59.3	273.5	280.4										
Station 4	ST04020	7/9/04 8:25	8/6/04 11:40	2703	5	5	70	70.5	44.3	63.2	43.4	60.6	275.4	278.9										
Station 5	ST05001	2/15/04 15:26	3/11/04 8:56	2376	2	2	18	18.5	47.3	80.4	47.3	80.4	255.9	263.4										
Station 5	ST05003	3/11/04 9:45	3/29/04 13:45	1746	2	2	18	18	50.3	79.6	48.6	80	255.2	260.9										
Station 5	ST05006	3/29/04 14:55	4/15/04 14:25	1632	2	2	18	18	49.5	79.1	49	77.8	251.9	261										
Station 5	ST05009	4/15/04 15:25	5/17/04 15:40	3075	2	2	18	18.5	47.3	79.6	48.6	79.6	248.1	265.4										
Station 5	ST05012	5/17/04 16:45	6/11/04 17:00	2403	2	2	18	18.5	47.3	77.8	47.3	77.8	232.3	265.3										

TABLE A-4
ADCP File Inventory
Water Sampling Data Report

Station	File	Start	Stop	Samples	Cell Begin (meters)		Cell End (meters)		Diagnostics				Heading (degrees)	
					Minimum	Maximum	Minimum	Maximum	SNR1	Minimum	Maximum	Minimum	Maximum	Minimum
Station 5	ST05018	6/11/04 19:35	7/9/04 8:50	2647	2	2	18.5	18.5	47.7	78.3	48.2	77	254.9	272.4
Station 5	ST05025	7/9/04 11:35	8/6/04 12:50	2695	2	2	18.5	18.5	47.3	76.5	48.2	78.3	256.4	269.9
Station 8	STAT8001	2/13/04 12:16	3/11/04 14:46	2604	2	2	14	14.5	61.5	86	58.9	86	95.6	96.9
Station 8	ST08001	3/11/04 16:05	3/30/04 11:05	1806	2	2	14	14.5	60.2	86.4	53.3	86.4	95.2	97
Station 8	ST08004	3/30/04 11:49	4/16/04 8:34	1621	2	2	14	14.5	59.8	87.3	55.5	86.9	95	97
Station 8	ST08007	4/16/04 9:40	5/18/04 8:25	3069	2	2	14	14.5	60.2	86	55	85.6	94.7	96.3
Station 8	ST08010	5/18/04 10:15	6/10/04 17:45	2240	2	2	14	14	58	85.6	51.6	81.3	94.9	96.5
Station 8	ST08013	6/10/04 19:00	7/8/04 13:15	2667	2	2	14	14	52.9	86	47.3	85.1	93.9	96.3
Station 8	ST08016	7/8/04 14:25	8/6/04 8:40	2763	2	2	14	14	57.2	85.1	54.6	83.8	94.9	96.3
Station 16	ST16001	2/17/04 15:43	3/12/04 13:43	2298	2	2	20	20.5	21.9	80.8	24.5	81.3	100.9	198.7
Station 16	ST16003	3/12/04 14:35	3/30/04 12:50	1723	2	2	20	20.5	46	80.4	49	83	110	111.2
Station 16	ST16005	3/30/04 13:50	4/16/04 13:20	1632	2	2	20	20.5	48.2	80.4	48.2	82.6	109.9	111.3
Station 16	ST16008	4/16/04 14:15	5/18/04 14:30	3075	2	2	20	20.5	48.6	80.4	49	82.6	109.4	111.9
Station 16	ST16011	5/18/04 15:35	6/14/04 7:35	2562	2	2	20	20.5	37.8	80.8	29.2	78.7	108.5	126.5
Station 16	ST16014	6/14/04 8:25	7/8/04 17:40	2343	2	2	20	20.5	50.7	79.1	51.2	80	110.7	134.2
Station 16	ST16017	7/8/04 19:00	8/5/04 12:00	2662	2	2	20	20.5	47.7	83.4	48.2	82.6	110.9	134.1

A2.3.3 Data adjustments

Calculation of Water Surface Elevation

Depth measured and recorded by the YSI, Inc. 600LS was used to calculate water surface elevation (NAVD 88) using the following formula:

$$X = (M - D) + Z$$

X = water surface elevation (feet; NAVD 88)

M = surveyed mark elevation (feet; NAVD 88)

D = mark to instrument sensor distance (feet)

Z = vented level measured by YSI, Inc. 600LS (feet)

Essentially, the (M-D) value is the mark-to-sensor distance that is applied to the instrument data (Z) to get the water surface elevation at that location. This mark-to-sensor distance is used to adjust the data. Any time the mark is surveyed or the mark to instrument sensor distance is changed, a new mark-to-sensor distance is calculated for that location and applied to data recorded after the change. Table A-5 lists the mark-to-sensor distances for YSI, Inc. 600LS units operated by CH2M HILL for this project.

TABLE A-5

Adjustment Factors for CTD Data Sondes Deployed by CH2M HILL

Water Sampling Data Report

Station ID	Date	Mark Elevation (ft; NAVD 88)	Mark-to-sensor distance (ft)	Sensor elevation (ft; NAVD 88)
1	02/19/2004	3.35	5.417	-2.067
3	02/16/2004	5.77	6.396	-0.626
4	02/15/2004	4.52	5.516	-1.996
5	02/12/2004	4.29	6.125	-1.835
7	02/16/2004	4.86	5.167	-0.307
8	02/11/2004	3.71	4.557	-0.847
1	12/03/2004	3.39	7.570	-4.180
4	05/21/2004	4.71	5.516	-0.806

Shifting Data

Electronic shifts were applied to parameters exceeding the criteria in Table A-6 and verified for the current datum record during the initial data validation. Electronic shifts were linear interpolations of the recorded data since the previous datum record.

TABLE A-6

Calibration Criteria for Continuous Water-Quality Instruments

Water Sampling Data Report

Measured Physical Property	Calibration Criteria for Measurements
Temperature	±0.2°C between cleaned monitoring instrument and the calibration instrument
Velocity	N/A; field calibration not required (see text)
Specific Conductance	Percent difference exceeds 5.0 between cleaned monitoring instrument and the calibration instrument
Depth	Cleaned depth out of water is not 0.00 feet

Note:

N/A = Not applicable

Shifts for the current datum record were compared to the quality control limits in Table A-7. These quality control limits, or “maximum allowable limits” are generally 10 times the calibration criteria. If the difference between the monitoring sensor reading and the field calibration check instrument sensor reading differed by more than the maximum allowable limit during the cleaned sensor calibration check, the data records were flagged and the data were not considered usable.

TABLE A-7
Parameter Shift Criteria and Maximum Allowable Limits for Continuous Water-Quality Monitoring Sensors
Water Sampling Data Report

Measured Physical Property	Parameter Shift Criteria	Maximum Allowable Limits for Sensor Values
Temperature	N/A	2.0°C between cleaned monitoring instrument and the calibration instrument
Specific conductivity	±5% difference between dirty continuous recorder measurement and calibrated instrument	±50% between cleaned continuous recorder instrument and the calibrated instrument
Velocity	N/A	10 Counts (43dB) above reported noise levels
Depth	±5% difference between dirty depth reading and cleaned depth reading OR dirty depth out of water reading and cleaned depth sensor reading	0.1 foot between calculated surface water elevation from cleaned sensor depth reading and direct reading on staff gauge

Note:
N/A = Not applicable

A2.3.4 Data Gap Summary

Gaps in the data record that exceed 2 hours are listed below with explanation. A data gap is considered to be a period in which no data were recorded during the defined collection period, March 12, 2004, to January 10, 2005. Data gaps do not include periods in which data were recorded but subsequently discarded or removed during the validation process. Data removed and/or discarded during validation are discussed in Section A3. When data gaps occurred, null records were inserted into the corresponding file as placeholders to facilitate loading files into the LDNR SONRIS database management program. Null records were added for each missing 15-minute increment that contained date and time values, but were missing environmental parameters.

The data gaps throughout the database that exceeded two hours, along with the cause of the missing data, are listed below. Data gaps that lasted 2 hours or less were caused by removal of the monitoring instruments for cleaning and calibrating during field events. Such data gaps are not listed in the table, but null records with dates and times in 15-minute increments were added as placeholders to fill the shorter data gaps.

CH2M HILL ADCP Data Gaps:

- A data gap exists for Station 1 from initial deployment February 19, 2004, (initial deployment) to March 12, 2004. This was the result of instrument malfunction.

- Station 1 was struck during the watering of boat from Bollinger shipyard. A data gap for all parameters exists from November 9, 2004, to January 11, 2005.
- The ADCP cable at Station 2 was shorted while changing the battery. A data gap exists from August 5, 2004, to August 10, 2004
- A data gap exists for Station 4 from May 12, 2004, to May 21, 2004. This was the result of a collision event with the DCP.

CH2M HILL Surface Water Elevation and Salinity Data Gaps:

- A data gap exists for Station 1 from March 10, 2004, to March 12, 2004, because of instrument malfunction.
- Station 1 was struck during the watering of a boat from Bollinger shipyard. A data gap exists from November 9, 2004, to December 3, 2004.
- Station 3 collected data every minute beginning February 14, 2004, through February 23, 2004, Then the station stopped logging. A data gap exists February 23, 2004, to March 10, 2004.
- The recorder at Station 3 was incorrectly set to collect data every 15 hours rather than every 15 minutes, from March 11, 2004, through March 29, 2004.
- A data gap exists for Station 3 from November 4, 2004, to December 2, 2004, because of instrument malfunction.
- A data gap exists for Station 4 from 17:15 CST August 16, 2004 to 13:30 CST September 2, 2004, because of vandalism.
- A data gap exists for Station 5 from September 2, 2004, to September 20, 2004. Instrument was brought in for repairs on September 2, 2004, and redeployed on September 20, 2004.
- A data gap exists for Station 7 from 22:00 CST August 9, 2004, to 9:35 CST September 20, 2004, because of instrument malfunction and the instrument was brought in from the field for repairs.

A2.3.5 Natural Phenomena in Data

The following stations had natural and anthropogenic phenomena that could be seen in the data:

- Station 1: Experiences minor barge traffic. Periodic spikes in water surface elevation can be seen in the data.
- Station 2: Experiences minor barge traffic. Periodic spikes in water surface elevation can be seen in the data.
- Station 4: Located on the Intracoastal Canal, experiences heavy barge traffic. Barge traffic can be seen in the data set where water surface elevation fluctuates significantly for two to three data points.

- Station 5: Located downstream of a lock and dam by the Lafourche Water District. In periods of high flow on Bayou Lafourche after heavy rain storms, the lock is closed to prevent downstream flooding. This phenomenon can be seen in the data set where the stream velocity is zero when the lock is closed and will immediately increase to positive flow and increase water surface elevation when the lock is opened. This site experiences high barge traffic, which can be seen in the data set where water surface elevation significantly fluctuates for one to two data points.
- Station 8: Experiences minor barge traffic. Periodic spikes in water surface elevation can be seen in the data.
- Station 16: Experiences minor barge traffic. Periodic spikes in water surface elevation can be seen in the data.

In addition, a hurricane, two tropical storms, and a snow storm occurred during the monitoring period. Dates for each are listed below.

- Tropical Storm Charlie occurred August 11 - 12, 2004
- Hurricane Ivan occurred September 15 - 16, 2004
- Hurricane Ivan looped back September 22 - 23, 2004
- Tropical Storm Mathew occurred October 9 - 10 2004
- Christmas Snow Storm occurred December 24 - 25, 2004

A2.4 External Data

This section describes data received from other agencies (LUMCON, USGS, and USACE). Figure A-3 indicates the locations of data collection platforms of other agencies included in this sampling plan as well as the types of data received by CH2M HILL at each location.

A2.4.1 Description of Measured Parameters

The parameters collected by other agencies and received by CH2M HILL as part of the sampling plan included the following:

- Temperature
- Specific conductivity
- Gauge height/stage
- Salinity
- Stream velocity
- Stream discharge

A2.4.2 Description of Data Sources

U.S. Geological Survey

Data were received from 10 collection platforms operated and maintained by the USGS. The project datum record includes both published and provisional data as determined by the USGS. Data collected by USGS and included in the database between February 15, 2004, and September 30, 2004, are considered final or "published" data by the USGS. These data have been reviewed and validated following USGS QA/QC guidelines. LDNR was consulted and

data subsequent to September 30, 2004, were not collected because they were considered provisional by USGS and will remain in that status until February 2006. According to the sampling plan, CH2M HILL made no attempt to validate or flag data other than the visual and subject review described in Section A3 of this report.

Adjustments to U.S. Geological Survey Data

As noted in the sampling plan, the datum for reporting water surface elevations for this project is NAVD88. Elevation surveys were conducted for those USGS gauges not in NAVD88.

Five existing USGS gauges requiring adjustment into the South Louisiana Coast-Wide (SLCW) global positioning system (GPS) network were verified by CH2M HILL. Adjustment into the SLCW GPS network was necessary to adjust gauge height readings reported by USGS to the NAVD 88 datum presently used by LDNR. Survey data for these gauges are reported in Section A1.

CH2M HILL established a "correction" factor for all data from these stations used in the hydrodynamic modeling task (Table A-8). Gauge height readings from these gauges were converted to the SLCW GPS network NAVD88 datum by applying the correction factor to the gauge height reading reported by USGS.

In addition, six gauges operated by USGS for LDNR are in the LDNR primary network, but are not reported as zero gauge height at 0.0 feet NAVD88. Consequently, a correction factor was needed to adjust reported data, which was obtained from LDNR (Table A-8).

TABLE A-8
Adjustment Factors Applied to Gauge Height Readings Reported by USGS
Water Sampling Data Report

Station ID	Agency Station ID	Station Name	Station Operator	Correction Factor* (ft)	Correction Factor Source
2	07381350	Company Canal at Hwy 1 at Lockport, LA	USGS	-0.132	CH2M HILL
6	07381235	Gulf Intracoastal Waterway (GIWW) West of Bayou Lafourche at Larose, LA	USGS	-0.204	CH2M HILL
9	07380401	Bayou Lafourche SW of Donaldsonville, LA	USGS	-0.04	CH2M HILL
10	07381000	Bayou Lafourche at Thibodaux, LA	USGS	-0.242	CH2M HILL
11	295501090190400	Davis Pond Freshwater Diversion near Boutte, LA	USGS	-7.1	LDNR
12	295190901217	L. Cataouatche at Whiskey Canal S of Waggaman, LA	USGS	-3.45	LDNR
13	073802375	Lake Salvador near Lafitte, LA	USGS	-8.03	LDNR
14	073802515	Barataria Bay Pass E of Grand Isle, LA	USGS	0	LDNR
15	07381328	Houma Navigation Canal at Dulac, LA	USGS	0.189	CH2M HILL
17	07381331	GIWW at Houma, LA	USGS	-0.04	LDNR
16	NA	Bayou Petit Caillou at Cocodrie, LA	LUMCON	-4.27	LUMCON
18	NA	Gauge #1 GIWW W of Minors Canal	USACE	0	Assumed

Notes:

*Correction factor is applied to gauge height reading reported by Station Operator

NA = Not applicable

LUMCON

Data were received from the collection platform operated by LUMCON at the LUMCON Marine Center dock via the website. Downloads from the website were incorporated into the database.

Adjustments to LUMCON data. Station 16, which is maintained by LUMCON, is adjusted into the LDNR Primary GPS Network, but does not have a zero gauge height at 0.0 feet NAVD 88. A correction factor of -4.27 feet was applied to the gauge height reading reported by LUMCON (Table A-8). In addition, gauge height was reported in meters (m). As such, the gauge height reading was converted to standard units, feet, before the correction factor was applied.

The data reported by LUMCON were in coordinated universal time (UTC). The date and time stamp for each record was adjusted to CST by CH2M HILL when imported into the project database.

U.S. Army Corps of Engineers

Data were received from the data collection platform operated by USACE - New Orleans District located on Minors Canal west of the GIWW (Station 18). Data were requested from this gauge by the modeling subconsultant, FTN Associates, Ltd., after the Final Sampling Plan was submitted to LDNR. Data were not adjusted because information regarding gauge height and other relevant information (Table A-8) were lacking.



FIGURE A-1
INTERNAL GAUGE MAP
 WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

LEGEND

● INTERNAL GAUGE

0 12 24 MILES

1 INCH EQUALS 12 MILES

WB022008009RDD_15 (3/8/06)

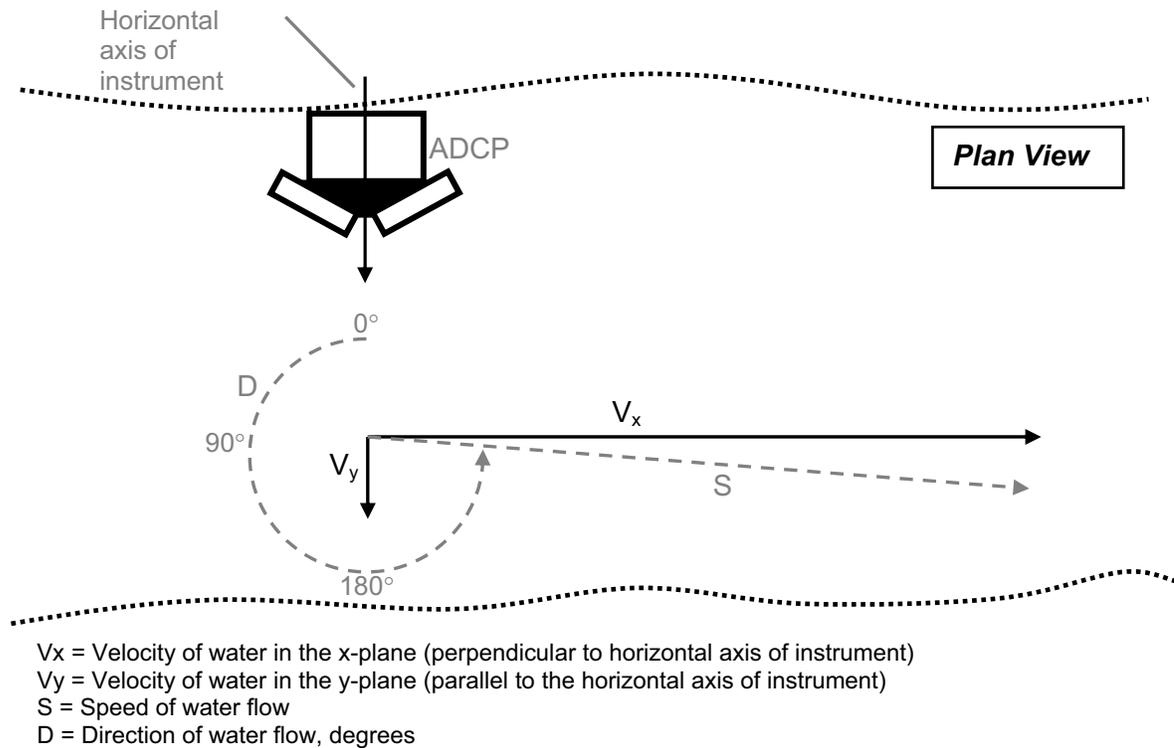


FIGURE A-2
RELATIONSHIP BETWEEN VELOCITY, SPEED, AND DIRECTION
INFORMATION RECORDED BY THE ARGONAUT SL ADCP INSTRUMENTS
 WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

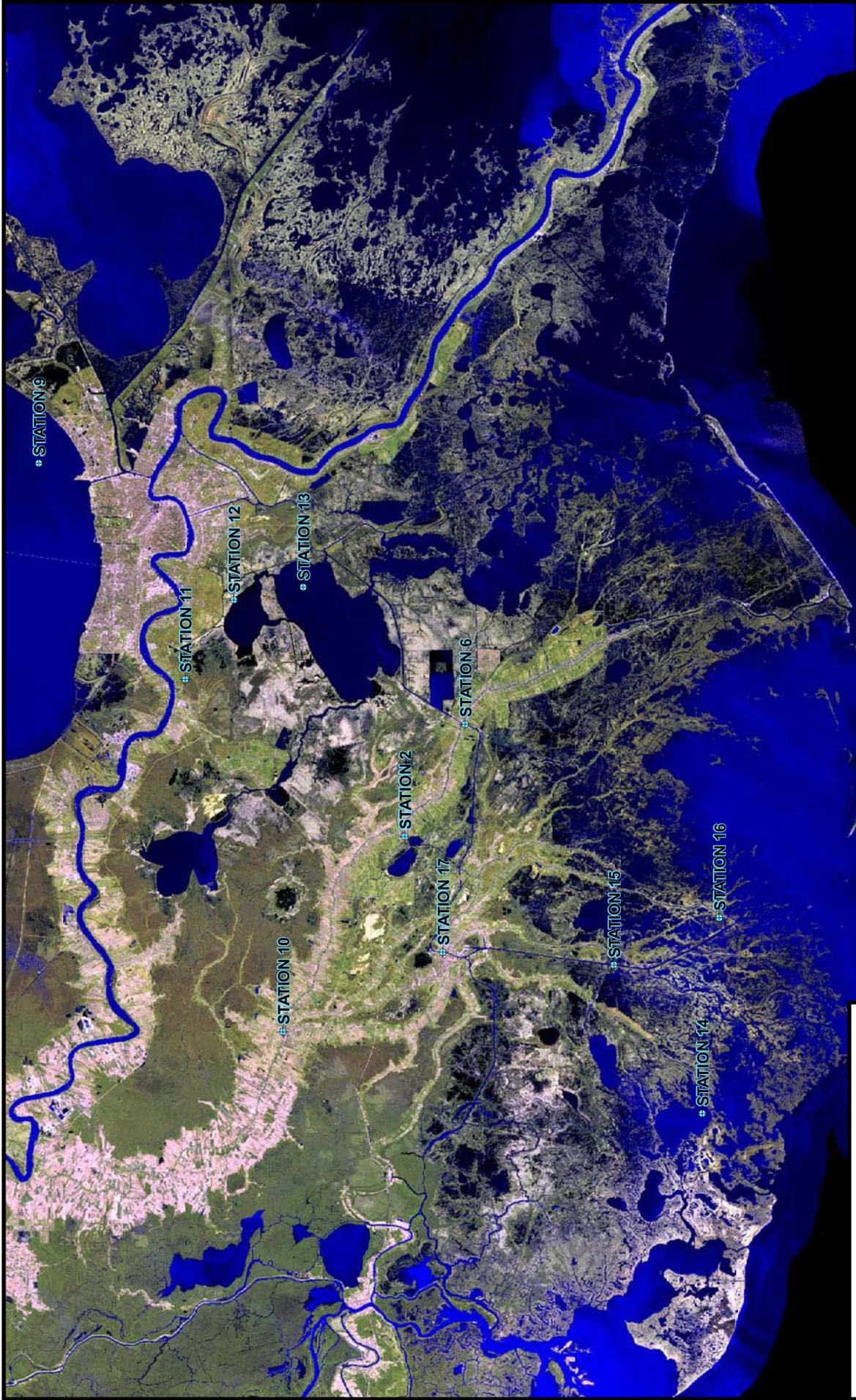


FIGURE A-3
EXTERNAL GAGE MAP
 WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

A3 Data Validation and QA/QC

A3.1 Introduction

This section contains protocols used to standardize data collected in the field. Attachment 7 contains the standard operating procedure (SOP) followed during implementation of field-related activities, i.e., mobilizing resources, maintaining field documentation, calibrating equipment, collecting data, and documenting changes that occurred in the field. In addition, this section contains the initial review of data with manufacturer-issued software. Once data were validated, they were uploaded into the database.

In addition, detailed information on QA/QC findings and results, and simple univariate statistics summarizing the full year of data for each station are presented. Time-series graphs (Attachment 8) are presented to illustrate data from the environmental variables for rapid inspection by researchers, modelers, and decision makers associated with LDNR. Finally, a shift factor memorandum to LDNR explaining the shift factors for each station is in Attachment 9.

A3.2 Data Collection Protocols

Data Collection Protocols include the guidelines that were followed while in the field through secondary QA/QC. The initial review of data with manufacturer-issued software was conducted accordingly. Once data were validated, they were uploaded into the database. The protocol for data validation within the database was conducted by the person who performs the raw data evaluation within the manufacturer-issued software, and repeated by a second person.

A3.2.1 Water Quality Data Collection Standard Operations Procedures

The key to producing a database of accurate and precise environmental monitoring data includes a well planned set of SOPs for field work to collect the data, and careful attention to those procedures in the field. Appendix 3-A contains the SOP used to conduct the water quality data collection task, which was written and approved by LDNR at the start of the program. Those portions of the SOP that are relevant to the QA/QC procedures are listed here. The table of contents of the SOP points to the specific sections mentioned.

The SOP incorporates QA/QC procedures in the field, without which the quality and validity of data could not be confirmed. The SOP contains instructions for keeping field logs and calibration records (Sections A3.1 and A3.2); sets procedures to clean and maintain the continuous monitoring instruments in the field (Sections A4.3.4 and A4.4.6); establishes how to calibrate each probe to collect each type of water quality data (Sections A5.1 and A5.2); describes how to collect readings using the deployed continuous monitoring instrument and the calibration instrument for comparison in the QA/QC data review; (calibration logs, Section A3.2); and how to copy data accumulated and stored in the continuous recorder since the previous field event (Sections A4.3.1, A4.3.2, A4.4.2- A4.4.5).

A3.2.2 Raw Data Evaluation

CTD Protocols

The following evaluation procedures were conducted using the software provided by YSI, Inc., for processing data downloaded from the continuous monitoring recorder. The software is titled EcoWatch. The following criteria used to qualify data are based on those used by LDNR:

1. Verified that temperature graphs smoothly. Data spikes have been defined to include data points that vary (either plus or minus) 10 percent or more from adjacent data points in the time sequence. Verify by inspecting/comparing raw data values. If the data point varies 10 percent or a default or null value was recorded, the data point(s) are flagged with the appropriate qualifier.
2. Verified that SpCond graphs smoothly. Data spikes have been defined to include data point(s) that vary 50 percent or more from adjacent data points in the time sequence. Verify by inspecting/comparing raw data values. If the data point varies 50 percent or recorded a default or null value, the data point(s) are flagged with the appropriate qualifier.*
3. Verified that salinity graphs smoothly. Data spikes have been defined to include data point(s) that vary 0.1 ppt or more from the adjacent data points in the time sequence. Verify by inspecting/comparing raw data values. If the data point varies 0.1 ppt or recorded a default or null value, the data point(s) are flagged with the appropriate qualifier.*
4. Verified that depth graphs smoothly. Data spikes have been defined to include data point(s) that vary 0.1 ft or more from the average of the two data points adjacent in the time sequence. Verify by comparing with the calculated average of the two adjacent points of raw data values. If the data point varies 0.1 foot or recorded a default or null value, the data point(s) are flagged with the appropriate qualifier.**
5. Verified that the battery charge declines smoothly. Data spikes indicate an instrument malfunction. Verify by inspecting/comparing raw data values. If the data point varies 0.5 volt or recorded a default or null value, the data point(s) are flagged with the appropriate qualifier.
6. Verified that the dates and times were recorded correctly. An inappropriate date and/or time indicates an instrument malfunction. Verify by inspecting/comparing raw data. If the date and/or time is inappropriate or a default or null value is recorded then the data point(s) are flagged with the appropriate qualifier. If the record had an unusual time or date that proved to be an extra recording, the entire record was deleted from the project database, because these records are malfunctions and tend to have extreme outlier values in the environmental parameters, that is, values that are out of the normal range for a particular variable.
7. Note any data gaps and the circumstances.

* = Salt water intrusions were not flagged.

** = Depth spikes due to barge/waterway traffic were not flagged for those stations located on high-traffic waterways.

ADCP Protocols

The following evaluation procedures were conducted in ViewArgonaut (software for data processing provided by the SonTek, Inc.):

1. Checked to ensure that the signal strength remained 10 counts above the reported noise level and that the two signals did not flatten or separate.
2. Checked the heading, pitch, and roll measurements (compass) of the instrument to verify that the orientation was not altered.
3. Verified that the noise ratios were stable and at similar levels.
4. Verified that the flow (velocity and direction) shifts and changes are “normal.”***
5. Verified that the instrument cell end value shows that the beam extended to the complete distance in the channel needed to detect current velocity accurately. If the cell end value is low, checked the field log to see whether a large object, such as a boat was blocking the electronic beam under water.

*** = Station 5 was on the downstream side of the flood gate and the flow was dependant on the operational status of the gate. Low-flow data (while the gate was closed) were not flagged.

A3.2.3 Database Evaluation

Once the raw instrument recorder data have undergone the primary QA/QC review in the YSI and SonTek programs, it is ready to import into a database management program. In this case, the data files were entered sequentially into the database management program, with each file appended to the end of the file from the previous monitoring program. All of the data were entered together cumulatively in a single database. Because the data files became so large as they were entered into the database over time, only the most powerful database management software could be used to manipulate the data in one file. The database management program used to store these data is the SQL.

At this stage, the data must be checked to determine if they were imported properly into the SQL database; the data must undergo further QC analysis; and must be formatted properly for use in the database program and ultimately for use by water quality modelers and statistical analysts.

Database Validation

1. Verify that electronic calibration forms transfer from the “Lite” database (field database) to the master database. Also check that all calibration forms are completed.
2. Open the raw ADCP and CTD instrument files and verify that the number of records in the database equals the number of samples collected by the instruments in the field. If any records of samples are missing, the file may not have been imported properly. This can happen, for example, if the field widths and locations on the electronic records from the data recorder are different than that programmed into the database management software, the recorders will not be read properly by the program and will need to be corrected, or the program corrected and then data imported again. If additional records

are imported unexpectedly, try to determine their nature and decide whether to invalidate them using the data qualifier codes listed in Table A-9.

3. Print out ADCP and CTD data reports. Review variables in the data report to verify that they are correct. If a variable is incorrect, the calibration sheet may have been incorrectly input. For the CTD data report, verify with the calibration sheets whether the shift was conducted if applicable for depth and specific conductivity.
4. Print out all ADCP and CTD graphs for visual evaluation of data. Identify any visible outliers seen in the graphs. Note any visible data gaps. Confirm the visual evaluation of the data series using analytical methods described in the QA/QC Section A3.3.
5. Open ADCP Data. Qualify any data that was noted in the raw data analysis and visual data evaluation via graphs in the database. Also flag any data that were noted in the field book was affected by instrument malfunction or interruption. Note data gaps and add null placeholder records that have date and time values exclusively.
6. Open CTD instrument data. Using the shift factors for depth and specific conductivity, check to ensure the shift was done correctly. Next, using the mark elevation and mark to sensor distance, check the Shifted Depth to WSE elevation conversion. Next, evaluate outliers found in raw data analysis and graphic data analysis to see if they are in the bounds allowed by the Sampling Plan. Qualify any data that were noted in the raw data analysis and graphic data evaluation that exceed the bounds set in the Sampling Plan. Also flag any data noted in the field book that were affected by instrument malfunction or interruption. Take note of data gaps and add null place holders in records.

TABLE A-9
Qualifier Codes Used to Mark Data as Invalid
Water Sampling Data Report

Data Qualifiers	Explanation	Example
DCPMOVE	Data collection platform disturbance.	Boat collision, vandalism.
INSTSPIKE	Instrumentation spike; unknown cause; single record.	Negative specific conductivity reading.
INSTFAIL	Instrumentation failure; unknown cause; multiple records.	Instrument stops recording, recording interval incorrect (e.g., every 15 hours).
CALFAIL	Calibration failure; data record exceeds maximum allowable limit.	±50% between cleaned recorder and calibrated instrument (Table 7 of SAP).
RCDFAIL	Data recorder failure; unknown cause.	Incorrect date.
USERERR	Data recorder failure; user error.	Incorrect interval settings or units setting error.
DRYPROBE	CTD out of water because of tidal fluctuation, or other cause.	Station 7 is very shallow, probes were dry three times during the year.

Exceptions to the protocols for identifying invalid data points included the following three exclusions:

- Station 5 was on the downstream side of the flood gate and the flow was dependant on the operational status of the gate. The low-flow data (while the gate was closed) were not flagged.

- Salt water intrusions were not flagged.
- Depth spikes due to barge/waterway traffic were not flagged for those stations located on high-traffic waterways, but left in until the QA/QC final review when professional judgment could be applied to determine the difference between instrument spikes and barge wake, and apply data qualifier flags as appropriate. Stations 4 and 5 fell into this protocol exception category.

A3.3 QA/QC Methodology

A3.3.1 Introduction

The purpose of the final review task of the QA/QC program is to check CTD data to confirm that no problems were missed during the primary or secondary QA/QC; confirm that data edits performed in earlier processing by the staff were applied without electronic error and with expected results via the SQL master database program; and to make final decisions on whether anomalous data that meet the standard quality requirements described in the SOP of the monitoring program should be invalidated, a task that ultimately must rely on professional judgment.

A3.3.2 Methods

During final review, the analyst must check the final edited version of the database to ensure that edits were applied correctly in the database, and that no problems were missed during earlier reviews.

Specific tasks the analyst performs during the final review include the following:

- Check that data “shifts” to correct for drift caused by bio-fouling were properly applied and solved the problem
- Confirm that any data flagged as invalid by the first two stages of QA/QC were correctly classified
- Check that environmental data were within proper ranges, according to the standard protocol outlined by parameter
- Check data conversions, such as water surface elevation from depth, to be sure that they were correctly performed, and that no necessary conversion was missed
- Check negative values for depth or other parameters, because there should be none except in water surface elevations where elevation of the water surface is actually expected to be below sea level
- Decide whether to invalidate or accept data that looks suspicious but that met all of the standard protocols to be classified as valid data in the primary or secondary QA/QC
- Check for missing data

The frequency of data sampling using the continuous monitoring sonde is every 15 minutes, resulting in 96 values per parameter per day per station, for a total of over 1.6 million

individual pieces of data to review (8 parameters, 6 stations, 1 year). Only statistical methods that summarize large data files and highlight potential problems can perform the final review.

The most efficient method to perform a rapid overview of the data that will result in indicating most of the remaining data problems is the use of classic time-series graphs. The method we used was to plot all data for the entire year consequently in time series by station, with conductivity, shifted conductivity, salinity, and shifted salinity on the same plot using a double y-axis format; and with depth, shifted depth, and temperature on another plot also using a double y-axis. Visual inspection of the data indicated most of the problems that remained in the files. Following the plotting, the analyst used various basic statistical calculations to either confirm that a problem existed and to determine the cause and possible solution of the problem; or to determine that the apparent anomaly represented valid data, although perhaps unusual or at the extremes of the acceptable range for the parameter of interest. The resulting statistical quantities calculated were then compared with protocols for acceptance of the data, or professional judgment was used to make a final decision on the validity of the data when the standard protocols did not resolve the question.

The following problems, their indicators, and corresponding diagnostic tests cover most of the problems or anomalies found in the water sampling data from Bayou Lafourche:

Corrections for biofouling, checking shift factors. Visually checking the time series to compare each set of original parameter values (conductivity, depth), with the shifted values of the parameter, was performed file by file, with one quarter-year of data per graph. When a series of shifted data appears not to make a smooth transition between monitoring periods, but rather there appears a step-like vertical shift at the transition, the data values must be checked. Calculate the percent change between the last data value of the file that contains shifted data, and the first point of the next monitoring period of the shifted parameter, as long as the monitoring instrument was not out of the water more than one hour for servicing during the field event. Repeat the same procedure for the original data of the same field parameter during the same time period, and compare the percent change in the two time series. If the percent change in the original data values of the field parameter between monitoring periods is less than that of its shifted data values, then back-shift the data by substituting the original data values in the shifted field parameter column.

If the monitoring sonde was out of the water for much more than an hour, this diagnostic test will not work, because the rapid change between files seen in the graph is probably due to changing environmental conditions during the unmonitored gap between monitoring periods.

The method described above during the final data review to check for biofouling and the calculation of a shift factor to correct the data is based on a comparison of the "dirty reading," i.e., the last reading of the monitoring sonde in the period before the sonde probe was cleaned, and the "clean reading," the first reading made after calibration and/or cleaning of the probe. The method used during the field event to determine the need for calibration and shifting the data after biofouling followed the SOP that required comparing the "dirty reading" of the monitoring instrument with the "clean reading" of the field calibration instrument. The use of a second instrument to confirm the correct calibration of

the monitoring instrument and calculation of the shift factor for application of the shift procedure is an important element of a well-planned QA/QC program. In this case, however, a rented calibration instrument was used, making the readings of the calibration instrument suspect because of the age of the instrument and its previous use. In some cases where biofouling occurred, the shift factor calculated using data from the rented calibration instrument did not solve the problem. In such cases, the clean reading of the continuous monitoring instrument was used to substitute into the formula to calculate the shift factor, i.e., the constant used to determine the amount of interpolation to correct the data drift.

A detailed discussion of QA/QC procedures in the field, especially regarding biofouling problems was presented in a technical memorandum. A copy of this memorandum is attached at the back of Section A3 of this data report, Section A3.6, after the graphs of the CTD and ADCP data.

Outliers, i.e., extreme values. Identify which extreme values are valid data points, and which are errors caused by instrument malfunction on single readings, referred to as “instrument spikes.” The analyst visually inspected graphs of the data to find points that seemed to be isolated outliers, that appeared as a single vertical line away from the trend line, either greater or less in magnitude than the points immediately before and after the outlier. To quantify the magnitude of the outlier, the analyst calculated the average of the points immediately before and after the outlier, and the difference between the outlier and the average of the two adjacent points. If appropriate, convert the value to the percent difference between the outlier and the average of the adjacent points.

The primary QA/QC procedure involved the use of software to automate the data review. This program included calculation and reporting of the magnitude of the each outlier, using the method described above. If the magnitude of the outlier exceeded the acceptable variance limit stated in the SOP, the data point was reported in most cases, and the technician flagged with point with a qualifier code. This automated checking was not performed on depth readings in channels where a high level of barge and boat traffic occurred frequently. Stations 4 and 5 have high levels of barge traffic, and did not have automated checking for depth outliers. The final review was particularly important for these stations.

Negative depth values. When a negative value was found in the depth records, the analyst attempted to determine the cause. Possible explanations of negative depth values could include a shift factor that was applied incorrectly or without need; the conversion factor to calculate WSE was incorrect; or the probes of the continuous monitoring instrument might have been out of the water for a short period of time because of extreme tidal fluctuations. If it is determined that the sonde probes were out of the water for any length of time, then all of the field parameters were flagged with data qualifier codes. Other problems caused by analytic methods were corrected. The only situation when negative depth values are acceptable is at stations where the bottom surface of the channel is actually below sea level. This has occurred and is most often attributed to the sinking of the ground level in the area of the city of New Orleans.

Anomalous depth readings in blocks. Another problem that would not be identified by the primary QA/QC protocol would be unusual changes in average depth or other parameters that lasts for an extended block of time. Although the block is still in range, and may not

violate any protocols for biofouling or outliers, the data may still appear anomalous, and only professional judgment can identify the problem and suggest a solution. An example of such a problem occurred at Station 5, that has a flood gate that is often lowered or raised to change the water level rapidly to ease the passage of barges.

Data gaps. Check the data to determine if missing data was caused by an instrument failure, or whether a portion of the ASCII format data file produced by the continuous monitoring recorder was lost during the procedure of importing the files to the SQL master database.

Parameter ranges: violations in intervals stated in the SOP for each environmental parameter. Data can occur outside of the normal range for a particular parameter, and is easily detected in time series graphs. This can occur for a number of reasons, such as if the wrong scale for units was chosen in the setup program for the continuous recorder; if unit conversions were made incorrectly; or if the width of fields for the parameters did not match those programmed in the database program. The final case can cause portions of the data fields to be lost during the importing procedure. Depending on the cause, the resulting incorrect data may appear in different ways.

A3.4 Results of the QA/QC and Data Summary

In this section, detailed information on QA/QC findings and results, and simple univariate statistics summarizing the full year of data for each station are presented. Presentation of the data in graphs allows the discussion of how problems found during the QA/QC process impact the data record as illustrated in graphic format. Time series graphs are also presented in Attachment 8 to illustrate data from the environmental variables for rapid inspection by researchers, modelers, and decision makers associated with LDNR.

A3.4.1 Results for Internal Data

QA/QC results and data summaries presented in this section cover CTD and ADCP data collected for the Bayou Lafourche Water Sampling Program. It also includes graphs of these data.

Station 1 – Conductivity, Depth, Temperature, and Salinity

This station is located in a relatively narrow channel on the east side of Bayou Lafourche, just upstream of Company Canal, attached to a seawall in Bollinger Ship yard in Lockport, Louisiana. The DCP is located in the shallow littoral zone of the channel, with depth ranging from 2.3 to 5.8 feet, with a median of 3.5 feet (Table A-10).

TABLE A-10

Station 1 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Temperature °C	Conductivity (Shifted)	Salinity (Shifted)	Depth (Shifted)	Depth (NAVD 88)
Minimum	6.8	144.0	0.1	2.3	-0.2
Median	26.0	350.0	0.2	3.5	1.3
Average	24.4	348.1	0.2	3.6	1.3
Maximum	33.2	769.0	0.4	5.8	3.7
Standard Deviation	5.84	74.14	0.04	0.63	0.54

This section of the Bayou is tidal fresh, with salinity ranging from 0.1 to 0.4 ppt, and a median salinity equal to 0.2 ppt. Daily tidal fluctuation can be seen, with an amplitude change of approximately 0.1 foot, but with only one high and one low tide per day. Long-term cyclic changes in depth can be seen during the spring due to climatic processes, when depth oscillations can last from 1 to 2 weeks, with amplitudes ranging from 1 foot to 1.5 feet. Long-term patterns in depth fluctuation are not as regular in other seasons of the year. Large storm events can also be seen. The largest flood event reached the maximum flood stage in 4 days, with a rise in water levels of 2 feet.

The instrument at Station 1 was consistently reliable, except for a brief period, March 10 through March 12, when the instrument malfunctioned and failed to collect any data. Some biofouling of the YSI conductivity probe was seen occasionally. However, the depth gauge did not experience biofouling or any instrument drift.

In spite of the relatively good performance of the YSI 600LS monitoring sonde during the year, the following anomalies, caused by natural and anthropogenic phenomena, and instrument malfunction were manifested in the data record:

1. The YSI 600LS malfunctioned in March 2004, causing a data gap from 8:30, March 10, to 8:30, March 12 for all environmental parameters. Placeholder records have been inserted to fill the gap.
2. There are a few small instrument spikes in depth between June 2 and July 25. Passing barges most likely cause these.
3. The worst storm events of a very active 2004 hurricane season can be seen between August and December. Tropical storm Charlie, can be seen in the depth record with a low but extended peak in mid-August. Hurricane Ivan hit the coast twice; both times causing large flood events that can be seen in the depth record, with peaks on September 15 and 24. Tropical storm Matthew occurred in mid-October 2004, and caused a very large flood event that can be seen in the depth record as a large peak, unprecedented for the year, while the conductivity and salinity dropped considerably. Bayou water level rose 0.5 foot on October 7, 1 foot on October 8, and another 0.5 foot on October 9. Maximum flood stage was reached in 4 days with a total rise in water levels of 2 feet. The Bayou returned to normal flow over 8 days. Finally, an unusual cold front caused a snow storm December 24 through 26 and a marked drop in water temperature to 6.8°C. Similar effects of these storm events can be seen in the other Station's records.
4. A boat hit the DCP as it was leaving the shipyard on November 9, at 10:30. The collision shifted the DCP and the depth of the CTD monitoring instrument in the water changed. As a result, depth data from November 9, 10:45, through December 10 had to be invalidated. Conductivity, salinity, and temperature data were unaffected, and data for these parameters have been retained in the Access, Excel, and SQL databases. Data including depth have been retained in the raw recorder files in text format.
5. The YSI conductivity probe became fouled during three monitoring periods. Data had to be corrected for instrument drift using a shift factor to linearly interpolate the data so that the salinity and conductivity data at the end of each of the monitoring period matched relatively well with the data collected in the next period after the YSI sonde was calibrated.

6. The database program automatically shifted data during three other monitoring periods to correct for instrument drift caused by biofouling. However, inspection of the data showed that the shift procedure was applied by the database program without need, perhaps because the calibration instrument was off. In each case, the last conductivity reading of the original, unshifted data was less than 5 percent different from the first reading made during the following monitoring period, whereas the last conductivity reading of the shifted data was greater than 5 percent different from the first reading of the unshifted data after the instrument was returned to the water. In each case, the conductivity and salinity data were “back-shifted,” i.e., the shifted conductivity and salinity readings during those monitoring periods were replaced by the original readings that were not shifted.

Station 1 – Current Velocity, Speed and Direction – Acoustic Doppler Current Profiler

This station is located in a relatively narrow channel on the east side of Bayou Lafourche, just upstream of Company Canal, attached to a seawall in Bollinger Ship yard in Lockport, Louisiana. The DCP is located in the shallow littoral zone of the channel, with depth ranging from 2.3 to 5.8 feet, with a median of 3.5 feet (Table A-11).

TABLE A-11

Station 1 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Velocity in X	Validated Speed	Validated Direction
Minimum	-17.1	0	0
Median	4	4.1	90.7
Average	4.0	4.33	102.5
Maximum	28.9	28.9	356.2
Standard Deviation	3.15	2.78	52.38

This section of the Bayou is tidal fresh, and daily tidal fluctuation can be seen, with an amplitude change of approximately 0.1 foot, but with only one high and one low tide per day. The current speed and direction data show that the direction of flow reverses daily while speed drops to zero during the slack tide during low-flow periods such as in April, compared with high-flow storm events when current speed remains very high and current direction remains approximately constant (90 to 95 degrees) in the positive downstream direction for several days straight, such as April 30 through May 4 and October 8 through 17.

Validated speed ranges from 0 to 28.9 centimeters per second (cm/s) with a median of 4.1 cm/s. This variable is a scalar quantity, being purely a measure of speed with no regard for flow direction. The validated direction ranges from 0 to 356 degrees, with a median of 90.7 degrees. The velocity in the X direction (parallel to the channel) ranges from -17 to 28.9 cm/s, with a median of 4.0 cm/s. The velocity variable is negative when current flows upstream with the incoming tide. The sign of the velocity (\pm) shows the direction of flow, because this is a vector quantity combining both speed and direction.

Specific data gaps and problems seen in the data. Several instrument malfunctions and natural phenomena occurred that caused gaps in the data record. Otherwise, the Argonaut current profiler collected consistently high-quality data. These problems are as follows:

1. During the first field event, the Argonaut profiler would not link to the field event computer, so that data logged during the monitoring period could not be downloaded. A technician from the instrument manufacturer had to be called out to the field to fix the malfunction. Because of the malfunction, a data gap exists for Station 1 CTD and ADCP data from initial deployment on February 19, 2004, to March 12, 2004. By data file naming protocol, data file 01040312 should begin on March 12, 2004, which was the actual deployment date. However, placeholders were added to the file to fill in the time gap between data files, so data file 01040312 begins on March 10, 2004, but actual data begins on March 12, 2004.
2. The DCP was struck by a boat on November 9. This collision cut the cable to the ADCP Argonaut, and no data were collected for the rest of that monitoring period. The project manager decided not to redeploy the Argonaut, so November 9 is the last day of velocity sampling at this site.
3. Extreme storm events can be seen in the record as velocity increased dramatically in response to the hurricane and two tropical storms that drenched the area between August and November 2004. The dates for these events are listed in Section A2.3.5.

Station 2 – Current Velocity, Speed and Direction – Acoustic Doppler Current Profiler

Station 2 is located in the upstream, north side of Company Canal in Lockport, Louisiana. The DCP, established by USGS, is attached to the fender of the Highway 1 Bridge. The SonTek Argonaut current profiler was attached to the DCP alongside the USGS instruments.

The hydrology of this station is very similar to that of Station 1. It is tidal fresh, with a single daily tidal fluctuation. The range for the velocity in the X-direction (parallel to the channel) ranges from a minimum of -40.2 cm/s, to a maximum of 61.4 cm/s (Table A-12). The validated speed ranges from 0, typical for a tidally influenced stream, to 61.6 cm/s. The validated direction has a median of 268.3, with a minimum of 0 and maximum of 358.5 degrees.

TABLE A-12

Station 2 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Velocity in X	Validated Speed	Validated Direction
Minimum	-40.2	0	0
Median	-2.9	4.8	268.3
Average	-2.27	5.77	215.97
Maximum	61.4	61.6	358.5
Standard Deviation	6.89	4.51	91.86

Specific gaps and problems seen in the data. The Argonaut profiler consistently sampled data with a very good level of performance. Only one problem arose during the year-long monitoring period.

The seventh field service event was conducted on August 5 and 6, 2004. The ADCP cable at Station 2 was electrically shorted while changing the battery. The cable was sent to Baton Rouge via YSI, Inc., on Monday, August 9, 2004. The cable was successfully repaired to factory condition. On August 10, 2004, the ADCP was reinstalled and deployed. As a result, a data gap exists from August 5-10, 2004.

Station 3 – Conductivity, Depth, Temperature, and Salinity

Station 3 is located on the northeast bank of Lake Fields, in the town of Lake Fields, Louisiana. The DCP is nine feet out from an existing retaining wall along the bank of the lake. The depth at the station ranges from 0.9 foot to 4.3 feet, with a median of 2.0 feet (Table A-13).

TABLE A-13

Station 3 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Temperature °C	Conductivity (µS/cm)	Salinity (ppt)	Depth (feet)	Depth (NAVD 88)
Minimum	3.1	146.0	0.062	0.9	0.3
Median	27.2	214.3	0.010	2.0	1.4
Average	25.2	239.1	0.112	2.1	1.4
Maximum	36.4	894.8	0.466	4.3	3.6
Standard Deviation	6.21	78.06	0.042	0.48	0.48

The lake is freshwater, with salinity ranging from 0.1 to 0.5 ppt, and a median salinity equal to 0.1 ppt. Regular daily depth fluctuation can be seen, with an amplitude change of approximately 0.1 foot, with only one high and one low surface elevation change per day. Although the lake is not tidally influenced directly, the lake is open to flow from Bayou Lafourche via Company Canal. Long term cyclic changes in depth can be seen during the spring and early summer, due to climatic processes, when depth oscillations can last from one to two weeks, with amplitudes ranging from 0.5 to 1.0 foot. Long term patterns in depth fluctuation are not as regular in other seasons of the year. Large storm events can also be seen. The largest flood event reached the maximum flood stage in four days, with a rise in water levels of 2.3 feet.

The YSI 600LS instrument at Station 3 was plagued with many technical problems, some human error and many electronic malfunctions. Data gaps caused by malfunctions and incorrect sampling intervals are detailed below. Some biofouling of the YSI conductivity and depth probes was seen occasionally.

Specific gaps and problems seen in the data. The YSI 600LS technical problems and anomalies caused by natural and anthropogenic phenomena that caused evident disturbance in the data record are as follows:

1. Initially, the sampling time was set incorrectly to read every minute, providing a huge amount of data with high resolution, but not formatted to sampling protocol. This period lasted from February 14 to 23, 2004. Because this was the pilot phase of the program and the data are valid, they have been included in the database unmodified.
2. Data gaps occurred between February 23 and March 10, 2004, caused by instrument malfunction; the instrument was brought in from the field for inspection and service, causing a data gap between April 15 and 23, 2004; and a third data gap also caused by instrument malfunction occurred between November 4 and December 2, 2004.
3. The instrument had a tendency to assign incorrect dates to sample readings at the beginning of recorder files, and often sampled at several minutes off the standard 15-minute interval. When the recorder collected readings a few minutes off the 15-minute increment, the minutes reported were shifted to the missing time interval.
4. The recorder was incorrectly set to collect data every 15 hours rather than every 15 minutes, from March 10 through April 14, 2004.
5. There are many large instrument spikes caused by instrument malfunction during single sample readings in conductivity, temperature, and depth throughout the data record.
6. The worst storm events of a very active 2004 hurricane season can be seen between August and December. Tropical storm Charlie can be seen in the depth record with a low but extended peak in mid-August. Hurricane Ivan hit the coast twice; both times causing large flood events that can be seen in the depth record, with peaks on September 15 and 24. Tropical storm Matthew occurred in mid-October 2004 and caused a very large flood event that can be seen in the depth record as a large peak, unprecedented for the year, while the conductivity and salinity dropped considerably. The lake water level rose 2.3 feet over several days. Finally, an unusual cold front caused a snow storm December 24 through 26 and a marked drop in water temperature to 3.1°C.
7. The YSI conductivity probe became fouled during four monitoring periods. The depth gauge was fouled during one monitoring period. These data had to be corrected for drift in the readings using a shift factor to linearly interpolate the data so that the salinity and conductivity data at the end of each of the monitoring periods matched up relatively well with the data collected in the next period after the YSI sonde was calibrated.

Station 4 – Conductivity, Depth, Temperature and Salinity

Station 4 is located in the GIWW, northeast of Bayou Lafourche on the east shore of the waterway, in Larose, Louisiana. The DCP houses both the YSI 600LS CTD instrument and the Argonaut current profiler.

The DCP is located in the shallow littoral zone of the channel, with depth ranging from 0.6 foot to 4.6 feet, with a median of 2.1 feet (Table A-14). Frequent barge traffic on the GIWW caused numerous spikes in the depth data that can be attributed to barge wakes.

TABLE A-14

Station 4 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Temperature °C	Conductivity (μ S/cm)	Salinity (ppt)	Depth (feet)	Depth (NAVD 88)
Minimum	7.65	200.0	0.1	0.6	-0.2
Median	25.86	335.0	0.2	2.1	1.3
Average	24.6	588.3	0.3	2.1	1.3
Maximum	32.36	5,844.0	3.2	4.6	3.8
Standard Deviation	5.69	684.32	0.37	0.47	0.47

This section of the Bayou is tidal fresh with occasional salt water intrusion. Salinity ranges from 0.1 to 3.2 ppt, with median salinity of 0.2 ppt. This portion of the GIWW switches between straight freshwater flow and tidal influence. The ADCP record shows the flow changing directions with tidal influence on a daily basis for parts of the year, but with freshwater flow other parts of the year. Tidal influence occurred mostly in the fall, and high freshwater flow occurred in the spring and summer, and during known storm events. Daily tidal fluctuation can be seen, with an amplitude change of approximately 0.1 foot, but with only one high and one low tide per day. Long-term cyclic changes in depth can be seen during the spring due to climatic processes, when depth oscillations can last from 1 to 2 weeks. Long-term patterns in depth fluctuation are not as regular in other seasons. Large storm events can also be seen. The largest flood event reached the maximum flood stage in 4 days, with a rise in water levels of over 2 feet.

The YSI 600LS at Station 4 was consistently reliable, with high performance throughout the year. The only problem that occurred with the instrument was vandalism. Someone pulled the instrument completely out of the water and left it on the river bank, although it continued to record data. All data records from this period were deleted from the database, leaving a large data gap. Some biofouling of the YSI conductivity and depth probes was seen occasionally.

Specific data gaps and problems seen in the data. In spite of the relatively good performance of the YSI 600LS continuous monitoring instrument during the year, the following anomalies, caused by natural phenomena and human interference caused some disturbances in the data record:

1. The YSI 600LS was vandalized in August, causing a data gap from 17:50, August 16 to September 2, 2004 for all environmental parameters. Placeholder records have been inserted to fill the gap.
2. Heavy barge traffic caused numerous spikes in depth records, but a few larger spikes in the depth record were thought to be suspicious and were marked as instrument spikes, i.e., single point malfunctions, for the following dates:
 - April 8, 2:00, Depth = 1.707
 - June 13, 3:00, Depth = 1.600
 - September 17, 17:15, Depth = 1.794
 - November 8, 7:00, Depth = 1.33

- November 1, 10:15, Depth = 2.179
 - November 9, 7:15, Depth = 1.184
 - December 10, 18:30, Depth = 1.478
 - December 27, 19:15, Depth = 0.633
3. The database manager had difficulties importing the raw data recorder file number 04040215 into the SQL database, possibly because there was some problem with the parameter field locations in the raw file not matching those programmed into the database, from February 15, 2004, to March 11, 2004. This period was the trial monitoring period, and so was not required to be included in the database. Staff decided to leave the entire file out of the master database, but exported it with the rest of the raw files from the continuous monitoring recorder to be included in the set of files collectively referred to as the electronic deliverable.
 4. The worst storm events of a very active 2004 hurricane season can be seen between August and December. Tropical storm Charlie can be seen in the depth record with a low but extended peak in mid-August. Hurricane Ivan hit the coast twice; both times causing large flood events that can be seen in the depth record, with peaks on September 15 and 24. Tropical storm Matthew occurred in mid-October 2004, and caused a very large flood event that can be seen in the depth record as a large peak, unprecedented for the year, while the conductivity and salinity dropped considerably. Maximum flood stage was reached in 4 days with a total rise in water levels of 2.5 feet. The bayou returned to normal flow over eight days. Finally, an unusual cold front caused a snowstorm December 24 through 26 and a marked drop in water temperature to 7.8°C. Similar effects of these storm events can be seen in all of the station records.
 5. The YSI conductivity probe and depth gauge became fouled during several monitoring periods. The data had to be corrected for instrument drift using a shift factor to linearly interpolate the data so that the salinity and conductivity data at the end of each of the monitoring periods matched up relatively well with the data collected in the next period after the YSI sonde was calibrated.
 6. The database program automatically shifted data during two other monitoring periods to correct for assumed instrument drift caused by biofouling. In one case, inspection of the data showed that the database program applied the shift procedure without need, perhaps because the calibration instrument was off. In this case, the last conductivity reading of the original, unshifted data was less than 5 percent different than the first reading made during the following monitoring period, whereas the last conductivity reading of the shifted data was greater than 5 percent different from the first reading of the unshifted data after the instrument was returned to the water. To confirm that this was the case, the percent difference between the conductivity at the end of the file and beginning of the next. For file number 04040329 ending April 15, 2004, shifted conductivity jumps from 318 to 346 $\mu\text{S}/\text{cm}$ in the next file, a difference of 8.8 percent. In this case, the conductivity and salinity data were “back-shifted,” i.e., the shifted conductivity and salinity readings during those monitoring periods were replaced by the original readings that were not.
 7. In a second case, the Station 4 conductivity was shifted by the database program under questionable conditions. In file number 04041007, that ended on November 5,

conductivity increased from 2,166 to 2,740 (27 percent); whereas shifted conductivity changes from 1,914 to 2,740 $\mu\text{S}/\text{cm}$ (43 percent). The change between files for shifted conductivity was larger than that for conductivity. In this case, the large difference in conductivity between files was caused by a longer than average period that the probe was out of the water during the field event, so it is expected that there would be a large difference in conductivity over 1 hour, when there are wide, rapid fluctuations in conductivity as was seen during this period. The file was shifted back.

Station 4 – Current Velocity, Speed and Direction

Station 4 is located in the GIWW, northeast of Bayou Lafourche, on the east shore of the waterway, in Larose, Louisiana. The DCP houses both the YSI 600LS CTD instrument and the Argonaut current profiler.

The DCP is located in the shallow littoral zone of the channel, with depth ranging from 0.6 foot to 4.6 feet, with a median of 2.1 feet (Table A-13). Frequent barge traffic on the GIWW caused numerous spikes in the depth data that can be attributed to barge wakes.

This section of the bayou is tidal fresh with occasional salt water intrusion. Salinity ranges from 0.1 to 3.2 ppt, with a median salinity of 0.2 ppt. This portion of the GIWW switches between straight fresh water flow and tidal influence. The ADCP record shows the flow changing directions with tidal influence in the river on a daily basis for parts of the year, but with freshwater flow other parts of the year. Tidal influence occurred mostly in the fall, and high freshwater flow occurred in the spring and summer, and during known storm events. Daily tidal fluctuation can be seen with an amplitude change of approximately 0.1 foot, but with only one high and one low tide per day. Long-term cyclic changes in depth can be seen during the spring due to climatic processes, when depth oscillations can last from 1 to 2 weeks. Long-term patterns in depth fluctuation are not as regular in other seasons. Large storm events can also be seen. Ranges, means, and medians for velocity in the X-direction, validated speed, and direction are presented (Table A-15).

TABLE A-15

Station 4 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Velocity in X	Validated Speed	Validated Direction
Minimum	-73.9	0.0	0.0
Median	14.3	15.3	98.2
Average	13.7	16.1	117.5
Maximum	60.2	74.6	357.9
Standard Deviation	12.16	9.49	57.26

Specific data gaps and problems seen in the data. The fourth field service event of the data collection period occurred May 17 and 18, 2004. A data gap at Station 4 from May 12 through 21, 2004, resulted from a collision that occurred on May 12, 2004. The damage was not assessed until the fourth service event on May 17, 2004 and reinstallation could not take place until May 21, 2004. The station was reinstalled in the same place using a lower profile mounting.

Station 5 – Conductivity, Depth, Temperature, and Salinity

Station 5 is located on the northeast side of Bayou Lafourche, on the east shore of the waterway, in Larose, Louisiana. The DCP houses the YSI 600 instrument. The DCP is mounted on the downstream fender of the bayou floodgate. The floodgate is a lock and dam, operated by the Lafourche Water District. In periods of high flow, after heavy rains, the lock is closed to prevent downstream flooding. This dam and lock operation has the capacity to rapidly change the water level in the bayou to allow the passage of barges. This phenomenon can be seen in the data, as the stream velocity drops to zero when the lock is closed and will immediately increase to positive flow and increase WSE when the lock is opened.

Station 5 has similar hydrological patterns as nearby Station 4; it is tidal fresh, with a daily cycle of tidal fluctuation with an amplitude of approximately 0.2 to 0.3 foot. The average salinity is 0.2 ppt (Table A-16), with occasional saltwater intrusions causing a rise in salinity to as much as 7 ppt during the 2004/2005 monitoring year.

TABLE A-16

Station 5 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Temperature °C	Conductivity (µS/cm)	Salinity (ppt)	Depth (feet)	Depth (NAVD 88)
Minimum	7.66	197.4	0.1	1.7	-0.1
Median	25.05	327.0	0.2	3.2	1.4
Average	23.89	542.8	0.3	3.1	1.3
Maximum	32.67	12,248.0	7.0	4.9	3.0
Standard Deviation	6.092	784.33	0.42	0.42	0.42

Specific data gaps and problems seen in the data. The CTD YSI 600LS instrument gave relatively good performance, producing consistently good quality data. Despite the very good performance of the instrument during the year, the following anomalies, caused by natural phenomena and human interference caused some disturbances in the data record:

- This site experiences high barge traffic that causes spikes in the depth data seen as a drastic change in WSE elevation for one to several data points. However, extremely large outliers with only one spike rather than a group, were judged to be instrument spike malfunctions. Consequently they were flagged with data qualifier codes and deleted from the final record. The following are the deleted depth points:
 - 3/03, 19:15, Depth = 2.94, marked as INSTSPIKE.
 - 3/12, 8:30, Depth = 2.02, marked as INSTSPIKE.
 - 4/21, 9:15, Depth = 2.47, marked as INSTSPIKE
 - 5/05, 6:15, Depth = 2.73, marked as INSTSPIKE.
 - 6/18, 8:30, Depth = 3.06, marked as INSTSPIKE.
 - 8/02, 23:30, Depth = 2.70, marked as INSTSPIKE.
 - 9/27, 12:45, Depth = 1.89, marked as INSTSPIKE.
 - 11/02, 18:15, Depth = 3.97, marked as INSTSPIKE.
 - 11/02, 10:15, Depth = 3.93, marked as INSTSPIKE.
 - 11/03, 10:00, Depth = 4.01, marked as INSTSPIKE.

- The dam and lock were closed leading up to the extreme flood event caused by tropical storm Matthew in October. The affect of this operation change in the dam affected the depth data as the depth at Station 5 dropped rapidly to approximately 1.8 feet by September 29, remained very low until October 6, then increased very rapidly on October 7 within an hour. The ADCP data show that the dam and lock were closed from September 20 to 26, then opened until October 5. After October 5, the extreme flood may have overtopped the dam, during the tropical storm, as the water speed (cm/s) increase from zero to over 50 cm/s. The Station 5 depth record shows that the depth rises 0.9 foot in less than 1 hour on October 7, 15:15 to 16:00 hours. These data, before and after the large jump in average depth, were confirmed valid. This is the same period when the other stations show a smooth rise to a very high peak in depth, followed by a smooth decrease in depth over 1 week, as the flood waters rose and fell naturally.
- The water surface elevation (Depth NAVD) dropped below sea level on September 29, shown as negative Depth-NAVD values. These data are confirmed valid.
- File number 05041105: salinity and conductivity were shifted without need. Back-shift file number 05041105 conductivity and salinity, ending with December 3, 2004.
- A data gap exists for Station 5 from September 2 to 20, 2004. The instrument was brought in for repairs on September 2, 2004 and redeployed on September 20, 2004.
- Biofouling occurred during two monitoring periods when the conductivity probe was affected. Fouling also occurred during three monitoring periods when the depth gauge was affected. For each of these periods, the appropriate time series were shifted to correct for instrument reading drift.

Station 5 – Current Velocity, Speed, and Direction – ADCP

Station 5 is located on the northeast side of Bayou Lafourche, on the east shore of the waterway, in Larose, Louisiana. The DCP houses the SonTek Argonaut current profiler. The DCP is mounted on the northeast, downstream fender of the Bayou floodgate. The floodgate is a lock and dam, operated by the Lafourche Water District. In periods of high flow, after heavy rains, the lock is closed to prevent downstream flooding. This dam and lock operation has the capacity to rapidly change the water level, current speed and direction in the Bayou to allow the passage of barges as well.

Station 5 has similar hydrological patterns as nearby Station 4; it is tidal fresh, with a single daily cycle of tidal fluctuation, with an amplitude of approximately 0.2 to 0.3 foot. The current speed and direction data show that the direction of flow reverses daily while speed drops to zero at the slack tide during low-flow periods such as in August; compared with high-flow storm events when current speed remains very high and current direction remains approximately constant (70 to 78 degrees) in the positive downstream direction for several days straight, as can be seen in the figures, and calculated using the median as 76 degrees (Table A-17). Examples of such events can be seen on March 6 to 10, May 2 to 6, and October 14 to 17 and November 2 to 6, when the dam remains open.

TABLE A-17

Station 5 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Velocity in X	Validated Speed	Validated Direction
Minimum	-32.3	0.0	0.0
Median	10.8	15.6	76.2
Average	12.2	18.3	126.3
Maximum	94.8	93.1	358.3
Standard Deviation	18.16	14.04	87.35

The effects of closing the dam during a storm event can be seen in the ADCP data. When the dam and lock are closed, the current speed drops nearly to zero and the direction of the bayou current switches between upstream and downstream flow with the daily tidal fluctuation. When the lock is opened the current direction will immediately increase to positive (downstream) flow, the speed will be very high and the water surface elevation will increase by as much as 1 foot in a few hours. One of these events was captured in the data in early October, when the dam was closed prior to tropical storm Matthew. It appears that the bayou water may have run over the dam occasionally, as the flow slowed to 0.5 to 1.0 cm/s, with spikes up above 50 cm/s, to a maximum of 93 cm/s (Table A-17) when the tropical storm was in the area around October 10 through 12. Then, when the floodgate was opened again, the speed increased to a consistently high rate of flow on October 14, 2004.

Specific data gaps and problems seen in the data. The SonTek Argonaut current profiler performed consistently well during the year. There are no data gaps nor were there any disturbances to the instrument during the year-long monitoring period.

Station 7 – Conductivity, Depth, Temperature, and Salinity

Station 7 is located in Grand Bayou Marsh, approximately 3 miles northeast of Pointe Au Chein, Louisiana. The YSI 600LS continuous monitoring instrument was installed on an existing DCP operated by the USGS.

The marsh is very shallow. The only time depth was greater than 3.0 feet was during the tropical storm that occurred in October. The median and average depth both equal 1.4 feet (Table A-18). The marsh is a mesohaline system. The range of salinity is 1.7 to 13.9 ppt, with an average salinity of 6.3 ppt. The marsh is influenced by the Gulf, with daily tidal fluctuations that have an amplitude ranging from approximately 0.1 to 0.4 foot between low and high tides.

The marsh is so shallow that the water level dropped below the instrument probes. This happened twice in December during a low flow-period that lasted several days.

TABLE A-18

Station 7 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Temperature °C	Conductivity (Shifted) (µS/cm)	Salinity (Shifted) (ppt)	Depth (Shifted) (feet)	Depth (NAVD 88)
Minimum	2.3	3,133.0	1.7	0.0	-0.3
Median	25.3	10,777.0	6.1	1.4	1.1
Average	24.3	11,063.4	6.3	1.4	1.1
Maximum	36.8	23,003.7	13.9	3.9	3.5
Standard Deviation	6.08	3,496.72	2.12	0.47	0.47

Specific data gaps and problems seen in the data. The YSI instrument had some malfunctions that caused a large data gap, but performed well during the rest of the year-long monitoring program. The only problems that occurred were caused by water level dropping below the probes, plus a minor malfunction in the instrument. Specific problems, dates and the effects on the data record include the following:

1. The YSI instrument computer reset its time twice in the field, and was brought in for repair in September. The malfunction began August 9 and lasted the rest of the monitoring period. Because of the hurricane that came through the area, the field team was not able to deploy the instrument again for more than 2 weeks. As a result, a data gap exists from September 2 to 20, 2004.
2. The water level of the marsh dropped below the probes for 2 days, beginning December 14 through December 16. The values from the environmental data were marked as invalid and deleted from the final files.
3. The depth NAVD 88 had negative values on December 24, although the water level had not dropped below the probes. These values truly measured water surface elevations below sea level, and are considered valid.

Station 8 – Conductivity, Depth, Temperature, and Salinity

Station 8 is located on the fender of the LA 58 Bridge on the upstream, eastside of Bayou Terrebonne, Montegut, Louisiana. It turns directly south, branching off of Bayou Lafourche and is much closer to the Gulf of Mexico. It is also tidal fresh, with a median salinity of 0.2 ppt, but with much more pronounced tidal fluctuations, and more frequent saline intrusions that range up to 10 ppt (Table A-19). It has a single daily tidal cycle, with a much larger amplitude than those observed in Bayou Lafourche, with amplitudes ranging from 0.7 to 1.0 foot between low and high tide.

Specific data gaps and problems seen in the data. The YSI 600LS CTD continuous monitoring instrument performed consistently well during the year. There are no data gaps nor were there any disturbances to the instrument during the year-long monitoring period.

Only one problem was noted, that one file was automatically shifted by the database program without need, during a large saltwater intrusion event. The shifted conductivity had a difference of 6.1 percent between files, compared with only 0.2 percent difference in

conductivity between files. The conductivity and salinity records in file number 08040903, ending October 8, 2004, were shifted back.

TABLE A-19

Station 8 Summary Statistics for the CTD Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Temperature °C	Conductivity (Shifted) (µS/cm)	Salinity (Shifted) (ppt)	Depth (Shifted) (feet)	Depth (NAVD 88)
Minimum	6.9	202.0	0.1	0.5	-0.3
Median	26.0	368.1	0.2	2.2	1.4
Average	24.3	1,651.8	0.9	2.2	1.4
Maximum	33.0	16,698.0	9.8	4.6	3.8
Standard Deviation	5.99	3,110.98	1.77	0.52	0.52

Station 8 – Current Velocity, Speed, and Direction – ADCP

Station 8 is located on the fender of the LA 58 Bridge on the upstream, eastside of Bayou Terrebonne, Montegut, Louisiana. Bayou Terrebonne is a channel southwest of Bayou Lafourche that turns directly south, branching off of Bayou Lafourche. The station is much closer to the Gulf of Mexico. It is also tidal fresh, with a median salinity of 0.2 ppt, but with much more pronounced tidal fluctuations, and more frequent saline intrusions that range up to 10 ppt (Table A-20). It has a single daily tidal cycle, with a much larger amplitude than those observed in Bayou Lafourche, with amplitudes ranging from approximately 0.7 to 1.0 foot between low and high tide.

TABLE A-20

Station 8 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Velocity in X	Validated Speed	Validated Direction
Minimum	-48.3	0.0	0.0
Median	16.0	19.0	97.2
Average	13.4	19.6	137.8
Maximum	59.4	59.9	357.9
Standard Deviation	18.41	11.82	76.17

Tidal fluctuation is apparent superimposed over the storm-flow events. The storm-flow events are common, with eight high-flow events between mid-February and mid-May. The noted storm events (Section A2.3.5) are also apparent in the data. During these events, the validated direction of flow shows that the bayou does not reverse flow for daily tidal fluctuation, but the high flow continues in a positive downstream direction, with increased current speed. During these times, the most consistent direction of flow is around 97 degrees as seen in, and calculated by, the median validated direction (Table A-20).

Specific data gaps and problems seen in the data. The SonTek Argonaut current profiler performed consistently well during the year. There are no data gaps nor were there any disturbances to the instrument during the year-long monitoring period.

Station 16 – Current Velocity, Speed, and Direction – ADCP

Station 16 is located at the mouth of Bayou Petite Caillou at Cocodrie, Louisiana. The DCP was set up by the Louisiana Universities Marine Consortium (LUMCON) to measure depth, conductivity and temperature. CH2M HILL added a SonTek Argonaut current profiler to the DCP to measure flow velocity and direction. The conductivity, salinity, temperature and depth values are available in the electronic deliverable on compact disk, but are not presented here.

The Bayou is very close to the Gulf of Mexico. The Bayou at this point is highly influenced by the marine system, with regular daily tidal fluctuations. Unlike the other stations, the flow consistently reverses between upstream and downstream, and is much less influenced by the storm flows that cause the other stations to have continuous positive flow downstream for days at a time. One of the few periods of continuous positive flow is during the tropical storm in October, and this only lasted 2 days. Another difference is that the absolute value of its minimum velocity, -46 cm/s, is almost the same as its maximum velocity, 40.9 cm/s, indicating the greater influence of the tidal fluctuations over the freshwater flows (Table A-21).

TABLE A-21

Station 16 Summary Statistics for the ADCP Record for the Entire 2004/2005 Monitoring Period
Water Sampling Data Report

	Velocity in X	Validated Speed	Validated Direction
Minimum	-46.2	0.0	0.0
Median	1.8	7.0	90.0
Average	1.3	8.0	157.8
Maximum	40.9	46.8	357.4
Standard Deviation	9.64	5.79	90.40

Specific data gaps and problems seen in the data. The SonTek Argonaut current profiler performed consistently well during the year. There are no data gaps nor were there any disturbances to the instrument during the year-long monitoring period.

A3.4.2 QA/QC Results for External Agency Data

The Bayou Lafourche Water Quality Monitoring Program included 12 stations where conductivity, depth, and/or velocity data were collected by external agencies, including the USGS, the USACE and the LUMCON. These stations are listed in Attachment 1 of this report, along with the environmental parameters that they collect.

Copies of data files from these external agencies were sent by the agencies to CH2M HILL to be combined with the data files produced by CH2M HILL and delivered to the Louisiana DNR on the electronic deliverable (compact disk). The files contributed by these three agencies are listed in Section A4, along with their data dictionaries that list the variables

found in each file, and the definitions and units of those variables, referred to as the environmental parameters.

Each of these agencies performed their own QA/QC program tasks to collect, process, edit the data and export them to data files before they were delivered to CH2M HILL. The QA/QC procedures used by each of these agencies are described in the individual data reports published by each agency.

Only those data that have passed the final review of their QA/QC procedure have been included in the electronic deliverable provided in Attachment 10 of this report. These data include the months of January through September, 2004. Data collected by the USGS can be requested in electronic format from the USGS Water Resources Division at the Louisiana Water Science Center. Questions can be directed to Mr. Scott Perrien or Mr. David Walters (Scott Perrien, personal communication, May 2005).

Data reported from USACE is presented as collected from USACE via personal communication with Lauren Hatten, project engineer.

Data reported from LUMCON is presented as collected from the LUMCON website (www.lumcon.edu).

After the data files from each of the external agencies were received, the data management QA/QC officer reviewed them for completeness. Continuous data, since the last datum record download from each file, were entered into the project database by the QA/QC officer and appended to the station record. As this task was performed for each agency's set of data files, the QA/QC manager verified that the data were correctly loaded into the project database and no data gaps existed that might have been caused by technical problems from export procedures used by the agency or the process of importing the data files to the project database.

After this QA/QC procedure, the files were formatted in the manner specified by LDNR and exported to the proper database type, also as specified. Agency files were approved through the secondary QA/QC data review as previously described and through final review by agency staff.

A3.5 Figures – Time-series Graphs – CH2M HILL CDT and ADCP

Time-series graphs of stations for both ADCP and CTD instrument readings are included in Attachment 8. There are four graphs for each station for both the ADCP and CTD instruments, with the exception of Station 1, ADCP, which only has three graphs due to data gap issues previously discussed.

A3.6 Shift Factor Memorandum

While conducting a QA/QC process on the water quality data collected from Bayou Lafourche, we found some problems with data that had been shifted to correct for drift in instrument readings between visits to the field sites. A copy of the shift factor technical

memorandum is included in Attachment 9. It contains information regarding options to correct data affected by drift in instrument readings, the effects on the Bayou Lafourche flow and water quality modeling effort, and results and recommendations.

A4 Description of Electronic Deliverable

This section describes the electronic data files generated during the water sampling program. These data are provided in electronic format on CD (Attachment 10). The electronic deliverable is in the requested format to facilitate importing data to the hydrologic model. Attachment 10 contains the following datasets.

- Two Microsoft Access 97 databases populated with the following raw data:
 - CH2M HILL-established DCPs (CH2M_HILL.MDB)
 - Existing DCPs (EXTERNAL_DATA.MDB)
- Excel spreadsheet files of the processed and flagged data
- Instrument download files from the CH2M HILL-established DCPs.

Table A-22 provides the contents and file structure of the electronic deliverable.

TABLE A-22
Electronic Data Deliverable Contents and Structure
Water Sampling Data Report

Contents	Type	Format
01 Electronic Data Deliverable	Folder	
02 Microsoft Access Database	Folder	
Internal Database (CH2M HILL-established stations)	Database	MS Access 1997
Standard Units	Table	MS Access 1997
CTD File Inventory	Table	MS Access 1997
ADCP File Inventory	Table	MS Access 1997
Continuous CTD Records	Table	MS Access 1997
Continuous ADCP Records	Table	MS Access 1997
Flagged CTD Records	Table	MS Access 1997
Flagged ADCP Records	Table	MS Access 1997
External Database (Existing stations)	Database	MS Access 1997
Standard Units	Table	MS Access 1997
USGS Data	Table	MS Access 1997
Lumcon Data	Table	MS Access 1997
USACE Data	Table	MS Access 1997
03 Microsoft Excel Files	Folder	--
Internal Data (CH2M HILL-established stations)	Subfolder	--
YSI 600 LS	Subfolder	--
YSI 600 LS Table Headings.xls	Table	MS Excel
Data Qualifiers.xls	Table	MS Excel
Station01.xls	Table	MS Excel
Station03.xls	Table	MS Excel

TABLE A-22
Electronic Data Deliverable Contents and Structure
Water Sampling Data Report

Contents	Type	Format
Station04.xls	Table	MS Excel
Station05.xls	Table	MS Excel
Station07.xls	Table	MS Excel
Station08.xls	Table	MS Excel
Sontek Argonaut SL	Subfolder	--
Sontek Argonaut SL Table Headings.xls	Table	MS Excel
Stat01.xls	Table	MS Excel
Stat02.xls	Table	MS Excel
Stat04.xls	Table	MS Excel
Stat05.xls	Table	MS Excel
Stat08.xls	Table	MS Excel
Stat16.xls	Table	MS Excel
External Data	Subfolder	--
Lumcon Table Headings.xls	Table	MS Excel
USGS Table Headings.xls	Table	MS Excel
USACE Table Headings.xls	Table	MS Excel
USGS.xls	Table	MS Excel
Lumcon.xls	Table	MS Excel
USACE.xls	Table	MS Excel
04 Instrument Data Files (CH2M HILL-established stations)	Folder	--
Sontek Argonaut SL	Subfolder	--
YSI 600 LS	Subfolder	--

A5 References

Department of the Interior, U.S. Geological Survey. 2005. Water Data Report, Louisiana, 2004. LA Water Science Center Rep. #LA 04-1. Baton Rouge, LA.

Mislan, A. Chief of the Hydra-Modeling Section, U.S. Army Corps of Engineers, New Orleans Office, P.O. Box 60267, New Orleans, LA 70160. Contact e-mail address: angel.mislan@mvn02.usace.army.mil.

Perrien, S.M., E.I.T. Civil Engineer, U.S. Geological Survey, Baton Rouge Office. Personal Communication, May 17, 2005. Contact e-mail address: sperrien@usgs.gov.

Attachment 1
Sampling and Analysis Plan for Water Quality

Final Technical Memorandum

Mississippi River Water Reintroduction Into Bayou Lafourche

Task 4.2: Sampling and Analysis Plan for Water Quality

Prepared for
Louisiana Department of Natural Resources

July 2004

CH2MHILL
1515 Poydras Street
Suite 2110
New Orleans, LA 70112

Contents

	Page
Acronyms and Abbreviations	v
Sampling and Analysis Plan	1
1 Purpose of Study	1
2 Objectives of Sampling and Analysis Plan	1
3 Site Selection.....	1
3.1 Existing Data Collection Platforms	2
3.2 Additional Data Collection Platforms Required.....	2
4 Field Activity Methods and Procedures	2
4.1 Permission and Access	3
4.2 Utility Clearances	4
4.3 Health and Safety	4
4.4 Instrument Packages.....	4
4.5 Installation of Data Collection Platforms.....	4
4.6 Installation of Staff Gages	6
4.7 Location and Elevation Surveys.....	6
4.8 Operation and Maintenance	7
4.9 Quality Control.....	8
5 Measurement and Data Acquisition.....	8
5.1 Measurement Quality Objectives.....	8
5.2 Instrument Specifications.....	10
5.3 Instrument Operations	11
5.4 Data Management and QA/QC.....	15
6 Data Reporting.....	18
6.1 Data and Records	18
7 Deliverables.....	20
8 References.....	20

Attachments

- 1A Health and Safety Plan
- 1B DCP and Staff Gauge Schematics
- 1C Individual Station Location Figures

Tables

1	Summary of Station Locations Included in the Sampling and Analysis Plan	3
2	Data Collection Platforms to be Installed and Surveyed	5
3	Data Collection Platforms to be Modified/Supplemented	6

Contents, Continued

	Page
4	Locations for Staff Gage Installations6
5	Existing Data Collection Platforms to be adjusted into the SCLW Primary GPS Network7
6	Calibration Criteria for Continuous Water-Quality Instruments13
7	Parameter Shift Criteria and Maximum Allowable Limits for Continuous Water-Quality Monitoring Sensors17

Figures

1-1	Hydrologic Stations and Measurement Parameters21
1-2	Established Hydrologic Data Collection Platforms Included in the Water Quality Monitoring Task.....23
1-3	Additional Continuous Hydrologic Data to be Collected During the Water Quality Monitoring Task.....25
1-4	Data Management, QA/QC Procedures, and Role Responsibilities27

Acronyms and Abbreviations

$\mu\text{S/cm}$	microSiemens per centimeter
ADCP	Acoustic Doppler Current Profiler
CTD	Conductivity, Temperature, and Depth
DCP	Data Collection Platform
GIWW	Gulf Intracoastal Waterway
GPS	Global Positioning System
HARN	High Accuracy Resolution Network
LDNR	Louisiana Department of Natural Resources
LUMCON	Louisiana Universities Marine Consortium
NAVD 88	North American Vertical Datum, 1988
NGS	National Geodetic Survey
ppt	part per thousand
QA/QC	Quality Assurance/Quality Control
SAP	Sampling and Analysis Plan
SLCW GPS	South Louisiana Coast Wide Global Positioning System
USGS	United States Geological Survey

Sampling and Analysis Plan

1 Purpose of Study

The purpose of the water quality monitoring task of the Bayou Lafourche Freshwater Diversion study is to collect data in support of hydrodynamic modeling. Parameters to be monitored will include surface water elevation, salinity, velocity, and stream discharge. These data will be used to calibrate and verify the performance of the hydrodynamic model. These tasks are part of the larger project objective, which is to evaluate the feasibility of alternatives to reintroduce water from the Mississippi River into Bayou Lafourche.

2 Objectives of Sampling and Analysis Plan

The overall objective of the Sampling and Analysis Plan (SAP) is to provide a comprehensive plan for collecting, validating, and managing data tailored to meet the defined objectives of hydrodynamic modeling task. Following are the primary objectives of the SAP:

- Development of data collection protocols that support the collection of suitable data for the modeling effort.
- Communication of the methodology, QA/QC protocols, and contingency plans to the project team.

The objectives of the SAP will be achieved by completing the following activities:

- Evaluating the appropriate locations, methods, and instruments for collection of data.
- Documenting the procedures, methods, and techniques for collecting, validating, and managing information in such a way as to ensure accurate, reliable, and accessible data.
- Supporting communication and coordination among managers, field personnel, subcontractors, modelers, and other project team members.
- Providing a basis for controlling time, budget, and level-of-effort considerations.
- Avoiding potential data gaps, inefficient use of resources, unsafe working environments, and collection techniques resulting in poor-quality data.

3 Site Selection

Based on the needs of the hydrodynamic modeling task, continuous data from 18 stations have been identified by the modeling team, FTN Associates, Inc. (FTN). Data from these stations are necessary to calibrate and verify the hydrodynamic model. FTN requires that continuous data are collected for a 9-month period in order to provide adequate data for the model. The following parameters are needed to support the modeling effort:

- Surface water elevation

- Salinity
- Velocity
- Stream discharge

Surface water elevation measurements will be needed at all 18 stations. Salinity, velocity, and stream discharge will be needed at selected stations. Figure 1-1 (all figures are at the end of this Attachment) indicates station locations and parameters to be measured at each station.

These data will be collected using a combination of existing data collection platforms (DCPs) and DCPs installed by CH2M HILL. Several of the proposed stations have DCPs currently operated and maintained by federal or state agencies. These existing DCPs will be used where appropriate. DCPs installed and maintained by CH2M HILL for the duration of the data collection period will supplement the existing stations to meet project objectives. Locations of the stations are not expected to change during the data collection period. Table 1 provides a list of the proposed stations with a description of their location, operational status, and the parameters needed. Figure 1-1 indicates station locations and parameters to be measured at each station.

3.1 Existing Data Collection Platforms

FTN selected 12 existing DCPs in the Barataria and Terrebonne basins for the water quality monitoring task. These data collection platforms are generally maintained by federal and state agencies (e.g., USGS and LDNR) and have been maintained continuously for various periods of time. Location and verification of operational and reporting status of these DCPs was conducted by CH2M HILL during preparation of the SAP through contact with the operating agencies and site visits. Selected data collected by these DCPs will be provided by CH2M HILL to FTN as described in Section 6 and delivered as described in Section 7 after the appropriate adjustments have been made. Existing DCP locations are provided in Figure 1-2.

3.2 Additional Data Collection Platforms Required

CH2M HILL will install and maintain these DCPs during the required data collection period. Figure 1-3 shows locations of new DCPs.

Some of the additional DCP locations overlap with existing DCPs. At these locations, existing DCPs do not collect all of the necessary parameters required for the modeling effort. As a result, new DCPs will need to be established for the additional instruments to collect the required data. Procedures for establishing new DCPs are described in following sections.

4 Field Activity Methods and Procedures

Field activity methods and procedures for installing new DCPs and verifying existing DCPs are described below.

4.1 Permission and Access

Permission to access property for surveying activities and to install DCPs will be the responsibility of CH2M HILL. CH2M HILL will contact landowners and secure access permission prior to doing surveys or installing/servicing instruments on any privately owned lands. Parish records will be used to initially determine land use and the land owner. Contact will be made with land owners by phone and certified letter. Documentation regarding contact and permission will be maintained in the project file. Rights of entry to privately owned property will be respected by all CH2M HILL personnel.

TABLE 1
Summary of Station Locations Included in the Sampling and Analysis Plan

Description	Station Number	Status	Operating Agency	Current Parameters	Additional Parameters Required
Bayou Lafourche above Company Canal	1	To be established	LDNR/CH2M	--	ZCV
Company Canal at HWY 1 near Lockport	2	Existing/To be established	USGS	ZC	V
Lake Fields	3	To be established	LDNR/CH2M	--	ZC
GIWW East of Bayou Lafourche at Larose	4	To be established	LDNR/CH2M	--	ZCV
Bayou Lafourche below GIWW	5	To be established	LDNR/CH2M	--	ZCV
GIWW West of Bayou Lafourche at Larose	6	Existing	USGS	ZCV	--
Grand Bayou Marsh	7	To be established	LDNR/CH2M	--	ZC
Bayou Terrebonne Southeast of Houma, LA	8	To be established	LDNR/CH2M	--	ZCV
Bayou Lafourche near Donaldsonville, LA	9	Existing	USGS	Q	--
Bayou Lafourche at Thibodaux, LA	10	Existing	USGS	Z	--
Davis Freshwater Diversion	11	Existing	USGS/LDNR	Q	--
Lake Cataouatche	12	Existing	USGS/LDNR	ZC	--
Lake Salvador	13	Existing	USGS/LDNR	ZC	--
Barataria Bay near Grand Terre Island	14	Existing	USGS/LDNR	ZC	--
Houma Nav Canal at Dulac, LA	15	Existing	USGS/LDNR	ZCV	--
Bayou Petit Caillou at Cocodrie, LA	16	Existing/To be established	LUMCON	ZC	V
GIWW	17	Existing	USGS/USACE	ZCV	--
Gage #1 at Minors Canal	18	Existing	USACE	ZC	--

Notes:

Z = Surface water elevation (depth)
 C = Salinity (Specific conductivity and temperature)
 V = Velocity
 Q = Stream discharge

USGS = United States Geological Survey
 LDNR = Louisiana Department of Natural Resources
 USACE = United States Army Corps of Engineers
 LUMCON = Louisiana Universities Marine Consortium

4.2 Utility Clearances

To assure that there is no interference with in-place utilities, CH2M HILL will obtain clearance prior to any work at a given site if excavation or subsurface disturbance is required. "LA One Call" will be contacted 48 hours prior to initiating work.

4.3 Health and Safety

The Health and Safety Plan or Field Safety Instructions will be maintained in the project file. Copies will be distributed to the project team members that will be working in the field. Signed documentation of the project team members' receipt and review of the Health and Safety Plan or Field Safety instructions will be maintained in the project file. A copy of the Health and Safety Plan is provided in Attachment 1A.

4.4 Instrument Packages

To measure the parameters relevant to the modeling effort, the following parameters will be measured by the instrumentation installed by CH2M HILL:

- Depth (surface water elevation)
- Temperature and specific conductivity (salinity)
- Velocity

In general, the following instrumentation will be used to collect the parameters of interest:

- **Multi-parameter monitoring sonde** – This type of datasonde will measure temperature, specific conductivity, and vented water level (depth). This usually consists of a 2- to 3-inch-diameter cylinder that is approximately 24 inches long. This instrument is capable of in situ, long-term data logging. Measurements will be taken at the point of deployment.
- **Acoustic Doppler current profiler (ADCP)** – The units use Doppler technology to measure the return frequency of an acoustic signal sent through the water to determine the water velocity. They also measure velocity at programmable distances from the sensor. Depending on unit type, measurements up to 100 m from the sensor may be made. Multi-cell units can measure discrete velocities at user-programmable intervals from the sensor's location. Parallel (X) and perpendicular (Y) velocities relative to the sensor's beam path are measured. These units will be horizontally oriented. The beam path would be oriented across the channel flow (from bank to bank). Bottom-mounted units oriented vertically or units located in the cross-section of the channel flow are not considered practical due to access constraints and navigational hazards (ship traffic).

4.5 Installation of Data Collection Platforms

CH2M HILL will install six DCPs at the approximate locations shown in Figure 1-3. Existing structures, including bridges, pilings, and docks, will be used when they are located near the desired location and offer a suitable site for collection of the required data. If suitable structures are not present, CH2M HILL will install DCPs in the firmest soil available, and where they are least likely to be damaged by water craft.

The desired DCP configuration will consist of the equipment illustrated in Figure 1 in Attachment 1B, or its equivalent. The support pole shall be installed by driving a post driver to a depth which provides solid support of the post. The support pole shall be vertically installed and will provide a stable location to affix a continuous data recorder and a known elevation marker. The depth to which the post is driven into the soil will depend upon local conditions. The post must be stable in the soil and have enough remaining out of the water, approximately 3 to 4 feet, to securely attach a data collection unit at a level where the electrical connections will remain above the water surface at all times. Some locations may require a more substantial DCP to maintain the integrity of the monitoring equipment. In such cases, an appropriate DCP will be designed and installed to meet the site-specific needs. All DCPs will be marked with reflective signage and high-visibility markings for safety and will be located out of the normal path of ship traffic. All DCP material will be secured in a manner to deter and prevent tampering, vandalism, or theft. This may include the use of locking aluminum gage houses, locking well caps, and other devices as needed.

All DCPs will be surveyed into the South Louisiana Coast Wide Global Positioning System (SLCW GPS) network by CH2M HILL. Elevation surveys are required to establish the correct datum for reporting surface water elevation. Thus, each support pole shall have a permanent elevation mark or "nail" on the side, which will be surveyed into the SLCW GPS network. Support poles made of metal will utilize the top of the pipe as the "mark" or will be notched in an obvious location. Survey notes and photos shall clearly document the "mark" used to establish the SLCW GPS network elevation.

Table 2 lists the names and coordinates of the data collection platforms to be installed and surveyed by CH2M HILL. Aerial photos noting the proposed locations for DCPs are provided in Attachment 1C.

TABLE 2
Data Collection Platforms to be Installed and Surveyed

Location Description	Latitude (°North)	Longitude (°West)
Lake Fields	29.64963227	-90.57647678
Grand Bayou Marsh*	29.45527700	-90.42194500
GIWW North of Bayou Lafourche	29.56917514	-90.38544872
Bayou Terrebonne Southeast of Houma, LA	29.54680783	-90.58707912
Bayou Lafourche below GIWW	29.57054091	-90.38048688
Bayou Lafourche above Company Canal	29.64958552	-90.54123351

Note:

*An abandoned USGS/LDNR DCP will be rehabilitated for this site.

Modification of Established Collection Platforms

An effort will be made to supplement two existing DCPs to collect additional parameters of interest. One DCP is currently operated by USGS (Baton Rouge Office) and one is operated by LUMCON. With the permission of the operating agency and assuming it is technically feasible, the existing DCP will be modified to include the new instruments. Otherwise, a new DCP will be established near the existing DCP to support the additional instrumentation.

Table 3 lists the names and coordinates of the existing DCPs to be modified. Pictures of each station and their current locations are provided in Attachment 1C.

TABLE 3
Data Collection Platforms to be Modified/Supplemented

Location Description	Latitude (°North)	Longitude (°West)
Bayou Petite Caillou near Cocodrie, LA	29.24578989	-90.66122060
Company Canal at HWY 1 near Lockport, LA	29.64500000	-90.54472200

4.6 Installation of Staff Gages

Staff gages will be installed adjacent to all new DCPs by CH2M HILL in a manner similar to that shown in Figure 2 in Attachment 1B. Staff gages or independent survey marks are required to verify surface water elevation readings from the data collection instruments and to determine correction factors for continuous data, as needed. They will be installed only at locations where surface water elevation measurements will be continuously recorded by CH2M HILL. Staff gages will generally consist of a 2.5-inch by 6.3-foot-long porcelain-enamel-coated metal gage graduated to hundredths of a foot and marked every foot and tenth of a foot. The staff gages will be surveyed into the SLCW GPS network. Data collected will be sufficient to allow verification of surveys. Installation and surveying will be consistent with Section J of the *Contractor's Guide to Minimum Standards* (LDNR, 2003). If site conditions preclude installation of staff gages in the manner described above, the installation will be modified to include an independent survey mark as needed but not in a way that would compromise the integrity or quality of data.

Table 4 lists the names and coordinates of staff gages to be installed and surveyed.

TABLE 4
Locations for Staff Gage Installations

Location Description	Latitude (°North)	Longitude (°West)
Lake Fields	29.64963227	-90.57647678
Grand Bayou Marsh	29.45527700	-90.42194500
GIWW East of Bayou Lafourche	29.56917514	-90.38544872
Bayou Terrebonne Southeast of Houma, LA	29.54680783	-90.58707912
Bayou Lafourche below GIWW	29.57054091	-90.38048688
Bayou Lafourche above Company Canal	29.64958552	-90.54123351

4.7 Location and Elevation Surveys

Location and elevational surveys will be required to establish the precise location of new DCPs and to establish LDNR's preferred vertical datum for reporting surface water elevation (NAVD 88). CH2M HILL will survey utilizing published NGS High Accuracy Resolution Network Monuments (HARN), NGS Bench Marks, and Secondary Static GPS benchmarks, which are part of the SLCW GPS network. CH2M HILL will follow the recommendations and guidelines established in the *Contractor's Guide to Minimum Standards* (LDNR, 2003).

Survey of New Data Collection Platforms

Each new DCP and staff gage installed by CH2M HILL will be surveyed into the SLCW GPS network. It is anticipated that this will include six DCPs and six staff gages. Permanent elevation marks will be included with every installed DCP or staff gage. Survey notes and photos will clearly define the “mark” used to establish the SLCW GPS network elevation. Data collected will be sufficient to allow verification of surveys and data collected by these instruments.

Verification of Established Data Collection Platforms

Five existing USGS data collection platforms requiring adjustment into the SLCW GPS network shall be verified by CH2M HILL. Adjustment into the SLCW GPS network is required to convert continuous surface water elevation measurements into the NAVD 88 datum presently utilized by LDNR. All other DCPs are already in the SLCW GPS network. Each platform will be surveyed into the SLCW GPS network. Survey notes and photos shall clearly define the “mark” used to establish the SLCW GPS network elevation. Data collected will be of sufficient quality to allow verification of surveys and data collected by these instruments.

CH2M HILL will establish a correction factor for all data from these stations used in the hydrodynamic modeling task. Surface water elevation data will be converted to the SLCW GPS network NAVD 88 datum.

In addition, stations 11, 12, and 13, which are operated by USGS for LDNR are in the LDNR primary network, but do not have a zero gage height at 0.0 feet NAVD88. Consequently, a correction factor is needed to adjust reported data, which will be obtained from LDNR. Station 16, which is maintained by LUMCON, is adjusted into the LDNR Primary GPS Network, but does not have a zero gage height at 0.0 feet NAVD 88. The correction factor to adjust stage elevation into the NAVD 88 datum will be obtained from LUMCON. Table 5 lists the names and coordinates of data collection platforms to be surveyed.

TABLE 5
Existing Data Collection Platforms to be adjusted into the SCLW Primary GPS Network

Location Description	Latitude (°North)	Longitude (°West)
Houma Nav Canal at Dulac, LA	29.38500000	-90.72972200
Company Canal at Hwy 1 near Lockport, LA	29.64500000	-90.54472200
GIWW West of Bayou Lafourche at Larose	29.56895922	-90.38523415
Bayou Lafourche at Thibodaux, LA	29.79888900	-90.81805600
Bayou Lafourche near Donaldsonville, LA	30.09666700	-91.00000000

4.8 Operation and Maintenance

Service and Download Frequency

For sufficient data collection and proper equipment maintenance, data servicing and downloading will be performed at an interval of approximately 21 days. At no time should the interval exceed 28 days due to instrument limitations, such as memory or battery life, to offset the potential for any data loss caused by malfunction, loss, damage. After 3 months of significant data are collected and DCP maintenance is established, the service and download

interval may be extended to 28 days upon recommendation of the CH2M HILL task manager and approval of the Project Manager. At no time will the scheduled interval exceed 35 days.

Contingency Planning

If site conditions dictate, the operational status of the DCPs will be checked and the hydrodynamic data collection instruments will be downloaded and maintenance performed before the 2-week interval has passed. The CH2M HILL task manager will be responsible for initiating contingency site visits. Natural conditions such as hurricanes, flooding, or severe drought may warrant a contingency site visit.

4.9 Quality Control

Performance Audits

The data management QA/QC officer will conduct no less than two field performance audits during the field sampling period. The audits will involve assessing the sample collecting and processing procedures relative to the procedures described in this plan and relative to standard collection procedures. Data recording procedures will be reviewed for completeness. Performance audit results will be documented and included in the data validation report QA/QC checklist for that field service visit.

The results of the field performance audit may identify the need for corrective actions. The field QA/QC manager will immediately implement the necessary corrective actions and will conduct a follow-up audit to confirm that the correct procedures continue to be followed. Any corrective actions will be documented in a memo prepared by the data management QA/QC officer. This memo will be reviewed, approved, and maintained by the task manager.

5 Measurement and Data Acquisition

5.1 Measurement Quality Objectives

Practical constraints, i.e., budget, time, human performance, and instrument performance, will place limits on the amount, type, and quality of the data that can be collected. As a result, the project objectives must be balanced with the constraints of the collection effort. This section describes the measurement quality objectives that support the standards of data quality to meet the project objectives and those that are considered achievable given the constraints described above.

Measurement quality objectives will be established for the following parameters:

- Duration of data collection
- Frequency of measurement
- Temperature
- Specific conductivity
- Salinity
- Depth (surface water elevation)
- Velocity

Duration of Data Collection

Data collection for all stations will be for the same, continuous 9-month period (270 days), beginning once the necessary DCPs have been installed and are operational. Once data collection has been initiated and station operation verified, the CH2M HILL task manager will identify the nearest practical date to begin the data collection period. Suspending or extending the data collection period will not be done unless changes in the duration of collection are identified by CH2M HILL's task manager and are approved by CH2M HILL's Project Manager.

Frequency of Data Collection

Data collection will be continuous throughout the nine-month data collection period. Measurements will be taken at regular, pre-determined intervals. Frequency of measurement for temperature, specific conductivity, depth, and velocity will be taken at a minimum of once an hour and will not exceed a frequency of four measurements within an hour (i.e., 15 minutes). Velocity measurements will be averaged over a specific time interval (i.e. average measurement over 3 minutes during each 15-minute sampling interval).

Temperature

Temperature will be measured with an accuracy of +/- 0.15 degree Celsius (°C) at a resolution of 0.01°C.

Specific Conductivity

Specific conductivity will be measured with an accuracy of +/- 0.5 percent or 2 microSiemens per centimeter ($\mu\text{S}/\text{cm}$) (whichever is greater) with a resolution of four significant figures.

Salinity

Based on the temperature, specific conductivity, and pressure measurements, salinity will be calculated with an accuracy of 1.0 percent, or +/- 0.1 part per thousand (ppt), (whichever is greater) at a resolution of 0.01 ppt.

Depth

Depth (i.e., pressure) will be measured with an accuracy of +/- 0.01 foot at a resolution of 0.001 foot. Each measurement will be an averaged reading taken over a continuous 60-second interval (minimum). Depth measurements will be used to calculate surface water elevation using contemporaneous measurements from the DCP and elevational survey.

Velocity

Velocity will be measured with an accuracy of +/- 1 percent of measured velocity or +/- 0.5 cm/s, (whichever is greater) at a resolution of 0.1 cm/s. Each measurement will be an averaged measurement taken over a 60-second continuous sampling period (minimum). The integrating interval will be determined during the field deployment based on the diagnostic evaluation of signal strength and specific site conditions.

5.2 Instrument Specifications

To achieve the measurement quality objectives, data collection instruments will meet the following specifications.

For conductivity, temperature, and depth (CTD) data collection sondes (YSI 6000 series or equivalent):

1. The instrument shall be capable of working in fresh, polluted, or marine water.
2. The instrument shall be capable of operating in water depths from 0 to 30 feet.
3. The instrument shall have the capability of being powered by an external 12-volt DC power supply through an interface cable.
4. The instrument, with the exception of the depth sensor vent tube's terminal end (which will be maintained above the water level), shall be completely submersible in water.
5. The instrument shall contain at least 384 K of flash memory for data storage and be capable of storing more than 150,000 individual readings.
6. The instrument shall be capable of internal battery power. Battery life should exceed 100 days at a 60 minute logging interval.
7. The communication connector shall be a removable underwater connector
8. The cage, which protects the sensors from damage, should be threaded so that removal of the cage to access the sensors can be done without the use of tools.
9. The instrument shall have a connectable field replacement probe for the conductivity and temperature sensors. These sensors shall be capable of being removed without opening the sonde or exposing the internal electronics to the environment.
10. The instrument shall be capable of having a vented characterized level sensor capable of measuring in the range of 0 to 30 feet of water with an accuracy of +/-0.01 foot from 0 to 10 feet and +/-0.06 foot from 10 to 30 feet and a resolution of 0.001 foot. The report output shall be displayed in feet. Instrument software shall provide optional data filtering to minimize wave effects. The instrument shall have an automatic density-compensated (vented) level sensor.
11. The instrument shall be capable of measuring temperature using a thermistor in the range of -5 to +45°C with an accuracy of +/-0.15°C at a resolution of 0.01°C. The output shall be capable of being displayed in Celsius, Fahrenheit, or Kelvin.
12. The instrument shall be capable of measuring conductivity in the range of 0 to 100 mS/cm with an accuracy of +/-0.5 percent or 2 µS/cm (whichever is greater) with a resolution to four significant figures. The output shall be capable of being displayed in mS/cm or µS/cm. The conductivity sensor shall be capable of measuring over the entire range (0-100 mS/cm) without changing the cell constant.
13. The instrument shall have available as an output a salinity calculation based on the conductivity and temperature measurements in the range of 0-70 ppt with an accuracy of 1.0 percent or +/-0.1 ppt (whichever is greater) at a resolution of 0.01 ppt. The algorithms used for the calculation should be those found in the *Standard Methods for Examination of Water and Wastewater*.

14. The instrument shall be supplied with one DOS- or Windows-based software program providing communication and data processing. Data shall be presented in both report and graphical form, and data statistics will be automatically generated and displayed for minimum, maximum, mean, and standard deviation. The software program shall be capable of exporting data in both comma and quote delimited and ASCII formats.
15. All sealed ports shall have secondary backup seals, thus protecting the internal electronics from the environment.
16. The instrument shall include both RS-232 and SDI-12 communication protocols for outputting data.

For acoustic Doppler current profilers, ADCP's (Sontek Argonaut SL, or equivalent):

1. The instrument shall be capable of operating in water depths from 1 to 30 feet.
2. The instrument shall have the capability of being powered by an external 12 VDC power supply through an interface cable.
3. The instrument shall have a two-beam transducer design.
4. The instrument shall have a user-programmable sampling volume from 1.5 meters (5 feet) to 120 meters (400 feet) horizontally away from the sensor.
5. The instrument shall have a RS-232/SDI-12 communication protocol.
6. The instrument shall have 4 Mb internal memory.
7. The instrument shall have DOS- or Windows-based software program providing communication and signal processing.
8. The instrument shall have a multi-cell current profiling feature for up to six user-programmable distances.
9. The instrument shall have an internal logging compass and two-axis tilt sensor.

5.3 Instrument Operations

Maintenance

Maintenance generally is governed by the fouling rate of the sensors, and this rate varies by sensor type, environment, and season. The performance of temperature and specific conductance sensors tends to be less affected by fouling but still requires routine maintenance to maintain normal function. In addition to fouling problems, physical disruptions (such as those caused by recording equipment malfunction, sedimentation, electrical disruption, debris, or vandalism) also may require additional site visits. Based on the sensor and anticipated environmental conditions, bi-weekly maintenance should meet the measurement quality objectives.

Maintenance functions at a water quality monitoring station include:

- Inspection of the site for signs of physical disruption
- Inspection of sensor(s) for fouling, corrosion, or damage
- Battery (or power) check
- Time check

- Routine sensor cleaning and servicing
- Calibration (if needed)
- Downloading of data

Specific maintenance requirements will depend on site-specific configuration and equipment. The manufacturer's instructions must be followed for each type of equipment. Standard operating procedure for calibration, maintenance, and download of the data collection instruments (monitoring equipment) will be developed and tested prior to the initiation of the data collection period. CH2M HILL will not be responsible for the maintenance of the existing instruments operated by other groups or agencies.

Sensor Inspection

The purpose of the sensor inspection is to provide an ending point for the interval of water quality record since the last service visit, a beginning point for the next interval of water-quality record, and verification that the sensor is working properly. This is accomplished by recording the initial sensor readings, servicing the sensors, recording the cleaned sensor readings, performing a calibration check of sensors by using appropriate standards, and if the reading of the monitoring sensor are outside the range of acceptable differences, re-calibrating the sensor. A final environmental sensor reading is required after the calibration check or after recalibration.

The difference between the initial sensor reading and the cleaned sensor reading is the sensor error as a result of fouling; the difference between the calibration-check reading and calibrated-sensor reading, if necessary, is a result of instrument drift. All information related to the sensor inspection will be recorded on a field form or in a field notebook. The sensor readings in the field notes become the basis for corrections (shifts) during the record-processing stage. Complete and thorough documentation of the sensor inspection is important to maintaining data integrity.

Monitor Calibration Criteria

A calibration check will be performed on cleaned monitoring sensors. If the monitor sensors are outside the range of acceptable differences, the sensor must be recalibrated. If the calibration-check sensor readings for the monitor are within the calibration criteria (Table 6), the monitoring sensors are considered checked and no further adjustments are required.

The calibrated sensor reading is the beginning observation of the new water quality record interval. If the calibrated monitoring sensor fails to agree with the calibrated field meter within the calibration criteria, the faulty sensor must be repaired or replaced after verifying that the readings of the field meter are not in error. The alternative is to replace the monitoring sonde or sensor with a calibrated backup unit and repair the malfunctioning monitor in the laboratory or return it to the manufacturer for repair. All sensor readings will be recorded in the field notes, and all calibration information will be recorded in the monitor instrument log. The calibrated monitoring sensor will be returned to the water and allowed to equilibrate to the stream temperature. The manufacturer's recommendations regarding typical amount of time required for equilibration will be followed.

TABLE 6
Calibration Criteria for Continuous Water-Quality Instruments

Measured Physical Property	Calibration Criteria for Measurements
Temperature	$\pm 0.2^{\circ}\text{C}$ between cleaned monitoring instrument and the calibration instrument
Velocity	N/A; field calibration not required (see text)
Specific Conductance	Percent difference exceeds 5.0 between cleaned monitoring instrument and the calibration instrument
Depth	Cleaned depth out of water is not 0.00 ft

Note:

N/A = Not applicable

Velocity data from ADCP's is used directly as output from the system without any post processing. The velocity response will not change or drift with time, and the system typically does not require calibration. However, diagnostic parameters, signal strength and standard deviation will be checked for quality and accuracy of the data. In addition, the heading, pitch, and roll will be evaluated for differences between one download to the next. Specifically, signal strength of the ADCP will be evaluated in the field by conducting a diagnostic survey after each download. Signal strength is the measure of the strength of the acoustic return signal from the water; it decreases with distance from the transducer due to the geometric spreading and sound absorption. In the case of a Sontek/YSI, Inc. ADCP, signal strength data is typically reported in internal logarithmic units called counts. One counts equals 0.43 dB and for good operating conditions the signal strength should be 10 counts above the reported noise. If the signal strength is found to be lower than this threshold while conducting diagnostics, the area will be evaluated for possible signal obstructions. If no obstructions are found, the instrument will be pulled from the water and cleaned to remove any possible fouling that would cause dampening to the signal strength. If the signal-to-noise ratio cannot be brought within the allowable limits (Section 5.4), the instrument will be redeployed at a nearby location or returned to the manufacturer for evaluation as needed.

Field Cleaning of Sensors

The manufacturer's recommended cleaning procedures will be followed for multi-parameter sensor systems.

Field Calibration

A water quality monitoring sensor or sonde will be calibrated in the laboratory before installation at a field location. Field calibration is performed if the cleaned sensor readings obtained during the calibration check differ by more than the calibration criteria (Table 6). Calibration is performed by using standards of known quality. All calibration equipment must be kept clean, stored in protective cases during transportation, and protected from extreme temperatures. Backup monitoring sondes or sensors will be used to replace water-quality monitors that fail calibration after troubleshooting steps have been applied.

Troubleshooting

Troubleshooting in the field can prevent the need for extra trips and greatly reduce lost records and the amount of time spent in processing the records in the office later. A successful service trip results in a properly calibrated and operating monitor. A list of common problems that are likely to be encountered in the field when servicing monitors will be developed to assist in the troubleshooting process.

When a parameter cannot be calibrated with known standard solutions, the field team leader will determine if the problem resides with the monitoring sensor or with the monitor itself and will make necessary corrections to ensure that the monitor is operational. The field team leader will carry backup sensors and sondes, if possible, so that troubleshooting can be accomplished at the time of the service visit.

Record Keeping

Field notes and instrument logs are the basis for documentation of water quality monitoring records. A log sheet/checklist will be developed to facilitate the collection of this information. Minimum requirements in the field notes for field servicing of instruments include the following:

- Station number and name
- Name(s) of data collector(s)
- Date and times of each set of measurements
- Field meter and monitor serial numbers
- Purpose of the site visit
- Weather
- Biological activity
- Horizontal and vertical locations of sensors in the cross section (if applicable)
- Recorded monitor values and corresponding field values (initial, after cleaning, and final instream readings)
- Pertinent gage-height data
- Remarks that describe channel conditions, condition of the sensors, and so forth
- Battery voltage of monitor at arrival and departure
- Notation whether sensors were changed or replaced (other remarks or observations that may aid in further processing of the record will be included)

Forms including these items encourage consistency and help to avoid the costly omission of critical information. A field form that constitutes a comprehensive checklist for data collection and that will be used in the data collection effort will be filled out during each field service event. Each data collection instrument will have an instrument log book, and all pertinent information regarding the monitor will be recorded in the instrument log book.

One of the most important pieces of recorded information is the instrument calibration in the laboratory and field. Calibration information will be recorded initially on field forms or in field notebooks, but the information will then be copied into the instrument log book. The instrument log book should contain a complete record of all maintenance in the field, the laboratory, or by the manufacturer. Permanent instrument logs contain critical calibration and performance information that document instrument performance throughout the useful service life of the instrument.

Critical calibration log information to be maintained in the record includes:

- Calibration dates, times, and temperatures
- Calibration standard values and lot numbers
- Initial and final monitor calibration data
- Field meter calibration values

5.4 Data Management and QA/QC

Document and record management is critical to project performance. The following procedures ensure that data (including raw and processed data) reporting is prepared in a timely fashion. The data will be reviewed, approved, disseminated, and maintained, as required. Figure 1-4 provides a flow chart summarizing the data management and QA/QC guidelines discussed below.

Downloading of Data Collection Instruments

During each field servicing event, continuously logged data from the instruments will be downloaded and transferred to a handheld datalogger, laptop computer, or handheld PC, as appropriate. Download, file naming conventions, and file transfer procedures will be included in the field service event standard operating procedures. Written field notes will be taken noting the date, time, location, instrument, and file name for each data collection instrument download event. Any problems or issues with data downloading in the field will be noted as well.

Upon completion of each field servicing and data download event, the field team leader will transfer raw data files to CH2M HILL's New Orleans server network at the appropriate directory determined by CH2M HILL's task manager. A CD backup of the directory will be recorded and provided to the CH2M HILL task manager.

Field Servicing Event Records and Reports

Subsequent to each field servicing event, the field team leader will make one copy of all field notes and continuous recorder calibration sheets. Pertinent photographs or other visual records will be scanned into an electronic format (if needed) and one copy produced. A field servicing event report will be generated that describes any logistical problems encountered in the field and any potential impacts to the data.

Data Entry and Verification

Following each field servicing and data download event, the field team leader will load the raw data files into the appropriate spreadsheet or database for processing and QA/QC, following a set of standard operating procedures for data management and QA/QC that

will be developed and tested prior to data collection. The required information from the field servicing event notes and continuous recorder calibration sheets will be loaded into the spreadsheet/database as well. The field team leader will perform and verify electronic shifts of data and will construct graphs of shifted specific conductance, depth, salinity, and velocity. Shifted, verified data will be imported to the project database as appropriate. Specific QA/QC considerations are described below.

At least once a month, generally after a field service event, data collected by other agencies that are included in the network of stations for the monitoring effort will be downloaded from the reporting agency web site or will be obtained electronically from the site operator. The electronic data will be imported into a spreadsheet or database program and saved. No shifts of the data will be performed. Initial evaluation of the data will be performed by time-series graphing of specific conductance, depth, salinity, and velocity, as appropriate. All data will be entered into the project database.

Subsequent to the validation process, any edits, deletions, or other changes to the data (other than shifts) will be flagged and documented in the master database.

Data Validation

Data validation will be conducted in two phases; each phase will be performed by a different person. Phase I will be performed by the individual responsible for field collection of data (field team leader); Phase II will be executed by a designated data management QA/QC officer. General responsibilities and procedures are described below.

Phase I – Initial Data Validation.

Data Reported by CH2M HILL. Phase I will be performed by the field team leader during the initial data entry and verification. Once continuous data and appropriate information from the calibration sheets and field logs are loaded into the appropriate spreadsheet or database, the following QA/QC procedures for the current datum record will be performed:

- *Application and verification of shifts and corrections* – Electronic shifts will be applied to parameters exceeding the criteria in Table 7 and verified for the current datum record during the initial data validation. Electronic shifts will be linear interpolations of the recorded data since the previous datum record. Shifts for the current datum record will be compared to the quality control limits in Table 7. These quality control limits, or “maximum allowable limits” are generally 10 times the calibration criteria (Table 6). If the difference between the monitoring sensor reading and the field calibration check instrument sensor reading differs by more than the maximum allowable limit during the cleaned sensor calibration check, the data records will be flagged and the data will not be considered usable. Parameters exceeding the maximum allowable limits in Table 7 will be flagged in the current datum record.

ADCP velocity data will be checked to ensure that the signal strength remained 10 counts (43 dB) above the reported noise level. Passing debris, boats, and barges could cause drops in signal strength. This data will be flagged. The heading, pitch and roll of each instrument should remain constant from download to download. A heading, pitch and roll measurement is taken with every velocity measurement. These parameters will be reviewed for any shifts during data collections. Shifts in these parameters should only occur if the instrument mounting orientation is altered, which would result from a

collision with the DCP. Data in which shifts in the heading pitch and roll are found will be flagged.

- *Graphical evaluation of the current datum record* – Graphs of temperature, shifted conductance, shifted depth, shifted salinity, and velocity will be evaluated and any missing readings (data gaps), out-of-range, or suspect values will be identified and flagged.

TABLE 7
Parameter Shift Criteria and Maximum Allowable Limits for Continuous Water-Quality Monitoring Sensors

Measured Physical Property	Parameter Shift Criteria	Maximum Allowable Limits for Sensor Values
Temperature	N/A	2.0°C between cleaned monitoring instrument and the calibration instrument
Specific conductivity	± 5% difference between dirty continuous recorder measurement and calibrated instrument	±50% between cleaned continuous recorder instrument and the calibrated instrument
Velocity	N/A	10 Counts (43dB) above reported noise levels.
Depth	±5% difference between dirty depth reading and cleaned depth reading OR dirty depth out of water reading and cleaned depth sensor reading	0.1 ft between calculated surface water elevation from cleaned sensor depth reading and direct reading on staff gage

Note:

N/A = Not applicable

Once the current datum record has been validated, it will be imported into the project database and appended to the station record. The following QA/QC procedures will be performed for the station record:

- Graphical evaluation of the current datum record – Graphs of temperature, shifted specific conductance, shifted depth, shifted salinity, and velocity will be checked for normal transition between the last datum record (previous month's data) and the present datum record.
- Preparation of the Phase I data validation report package – Once the initial data validation has been performed, the field team leader will provide the data management QA/QC officer an initial data validation report package for each station that will include: (a) QA/QC data checklist, (b) continuous recorder calibration sheets, (c) electronic data files (current datum record and updated project database), and (d) field trip report.

Data Reported by Other Agencies. Generally, validation of continuous data reported by other agencies will not be possible. Graphs of temperature, shifted conductance, shifted depth, and shifted salinity, and velocity will be evaluated and any missing readings (data gaps), out-of-range, or suspect values will be flagged. Records will be identified and flagged as needed. Continuous data since the last datum record download will be entered into the project database and appended to the station record. Data validation reports issued by reporting agencies will be obtained when possible and reviewed to subjectively evaluate the

quality of the station record. All data reported by other agencies will be considered preliminary and no data validation will be performed by CH2M HILL.

Phase II – Data Validation Review. The data management QA/QC officer will review the initial data validation report package(s) provided by the field team leader. The following QA/QC procedures will be performed by the QA/QC officer:

- *Validation of shifts and corrections* – all electronic shifts of data will be validated to insure that shifts are appropriate and conducted properly.
- *Validation of flagged data* – graphs of parameters will be reviewed and any missing, out-of-range, or suspect records that should be flagged in the database will be confirmed. This will include a review of the current datum record and the station record. Any questionable records or flagged records will be discussed with the field team leader and corrected, as appropriate.
- *Data validation checklist* – a QA/QC checklist will be completed for the data validation review and will be filled out by the data management QA/QC officer. Any questions not answered definitively will be discussed with the data collector. As issues are resolved, they will be documented in the checklist. Unresolved issues will be documented on the checklist and corrections to data during the validation process will be described on the checklist as well. Once the validation process and the checklist are completed, the data management QA/QC officer will sign the checklist, keep a copy, and provide the original along with the initial data validation report package to the task manager.

The task manager will be responsible for maintaining the reviewed data validation reports, consisting of the signed checklist and initial data validation report.

6 Data Reporting

6.1 Data and Records

Data and record tracking is an important aspect of information control and utilization. Data and records must be compiled and organized in a format that identifies its contents and location in order to make the data and records easily located. The following sections describe the management of data and records produced during this task.

Survey Locations

A GPS Survey Report shall be produced as outlined in the *Contractor's Guide to Minimum Standards* (LDNR, 2003). The task manager will maintain this survey report in the project file. In addition, a completed spreadsheet designed to confirm survey elevations will be included. Verification of land owner permission for property access will be appended to the survey report.

Station Record

For each new station established, a complete description will be prepared and will be revised only upon changes in location or operation. Station descriptions will include at a minimum:

1. Labeled/indexed photographs (hardcopy or digital) of DCPs and staff gages showing general location, close-up of elevation mark, and water depth at location after installation.
2. A table or illustration of the installation describing dimensions of the DCP or staff gage.

Any changes or modifications to the station will be appended to the station record. The task manager will maintain this record.

Collected Data

Collected data will be maintained in an electronic format in the project database. Raw and validated data will be kept in a file structure as directed by the task manager. Backup of raw and validated data will be performed as raw or validated data are added to the project records or after any modification/updates to the project database. Data backups will be placed on a CD and dated; these will be performed at a minimum once a month. Backups will be maintained by the task manager.

Supporting Documentation

The following additional documentation supporting the water quality task will be maintained by the task manager:

- Reviewed and approved data validation reports
- Instrument logbooks
- Corrective action memos

Internal Deliverables

Internal deliverables are any data or reports that will be distributed to CH2M HILL personnel or subcontractors (e.g. FTN). The primary recipient of internal deliverables will be FTN. These deliverables will be used to support the modeling tasks for the project. Primary internal deliverables for this task will include:

- The SAP for the data collection task; and
- Monthly data reports in electronic format.

The draft SAP will be delivered to FTN for their review and comments during CH2M HILL's internal review period. The purpose of this deliverable is to provide FTN an opportunity to provide input to ensure that data of sufficient quality and quantity is collected and consistent with FTN's work plan.

Following data collection and review periods, data will be provided to FTN. This will be an electronic deliverable consisting of:

- Complete and current copies of the cumulative database, including validated data from instruments operated by CH2M HILL; and
- Data reported by other agencies included in the SAP.

Copies of the reviewed and approved data validation reports will be made available upon request.

Frequency of Reporting

Data will be provided to FTN on a monthly basis.

Format of Deliverables

The data will be provided in Microsoft Access 97.

7 Deliverables

The following deliverables will be provided to LDNR:

- Draft and final sampling and analysis plan technical memoranda;
- Documentation of site access approvals; and
- Final data report including electronic copies (compact disc) of the collected data.

8 References

LDNR. 2003. *Contractor's Guide to Minimum Standards*. Coastal Restoration Division

Gordon, AB and M Katzenback. 1983. *Guidelines for use of water-quality monitors*. U.S. Geological Survey Open-File Report 83-681.

Water Environment Federation. 1998. *Standard Methods for the Examination of Water and Wastewater*. 20th Edition.

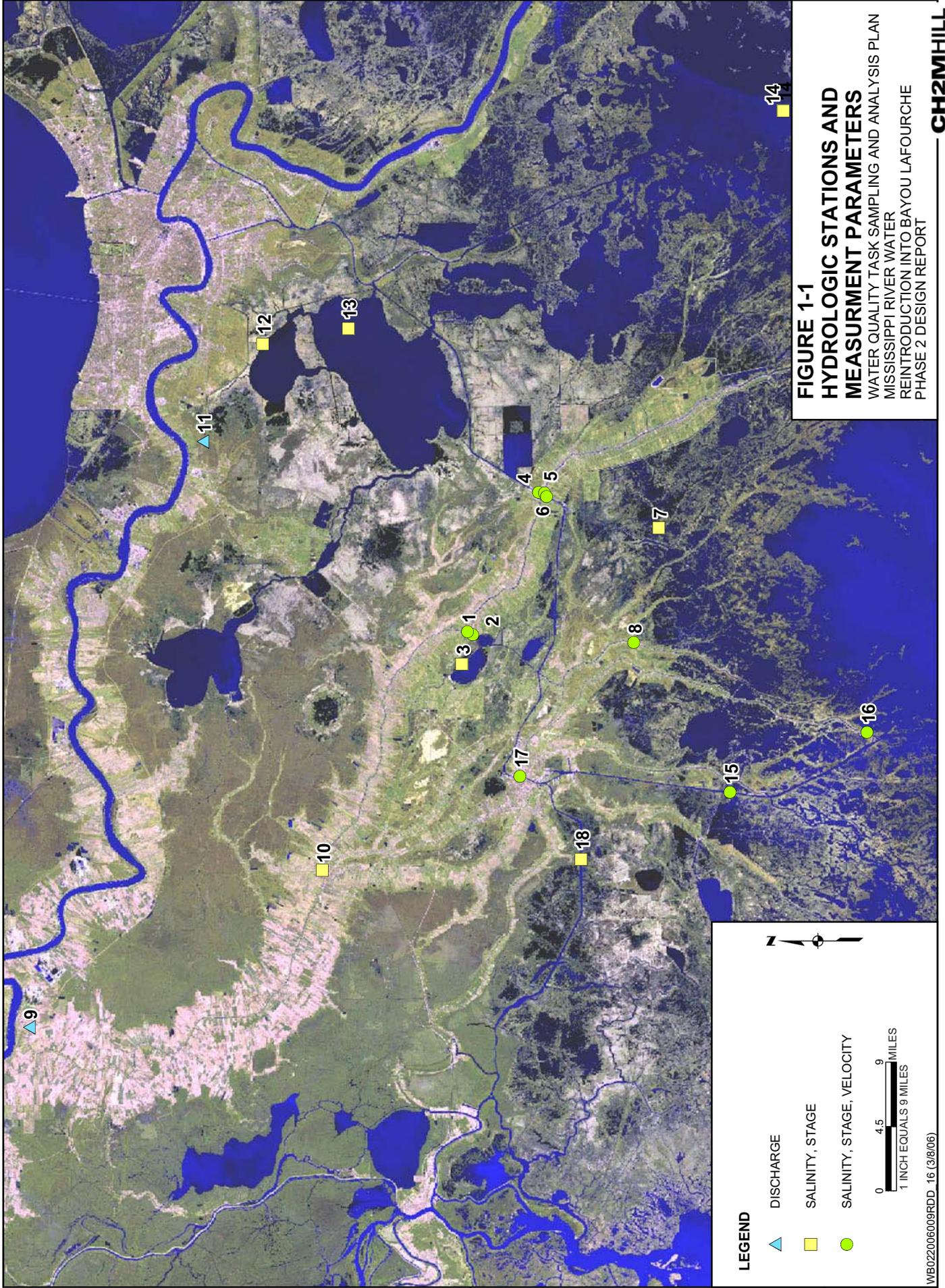
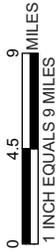


FIGURE 1-1
HYDROLOGIC STATIONS AND
MEASUREMENT PARAMETERS

WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

LEGEND

- ▲ DISCHARGE
- SALINITY, STAGE
- SALINITY, STAGE, VELOCITY

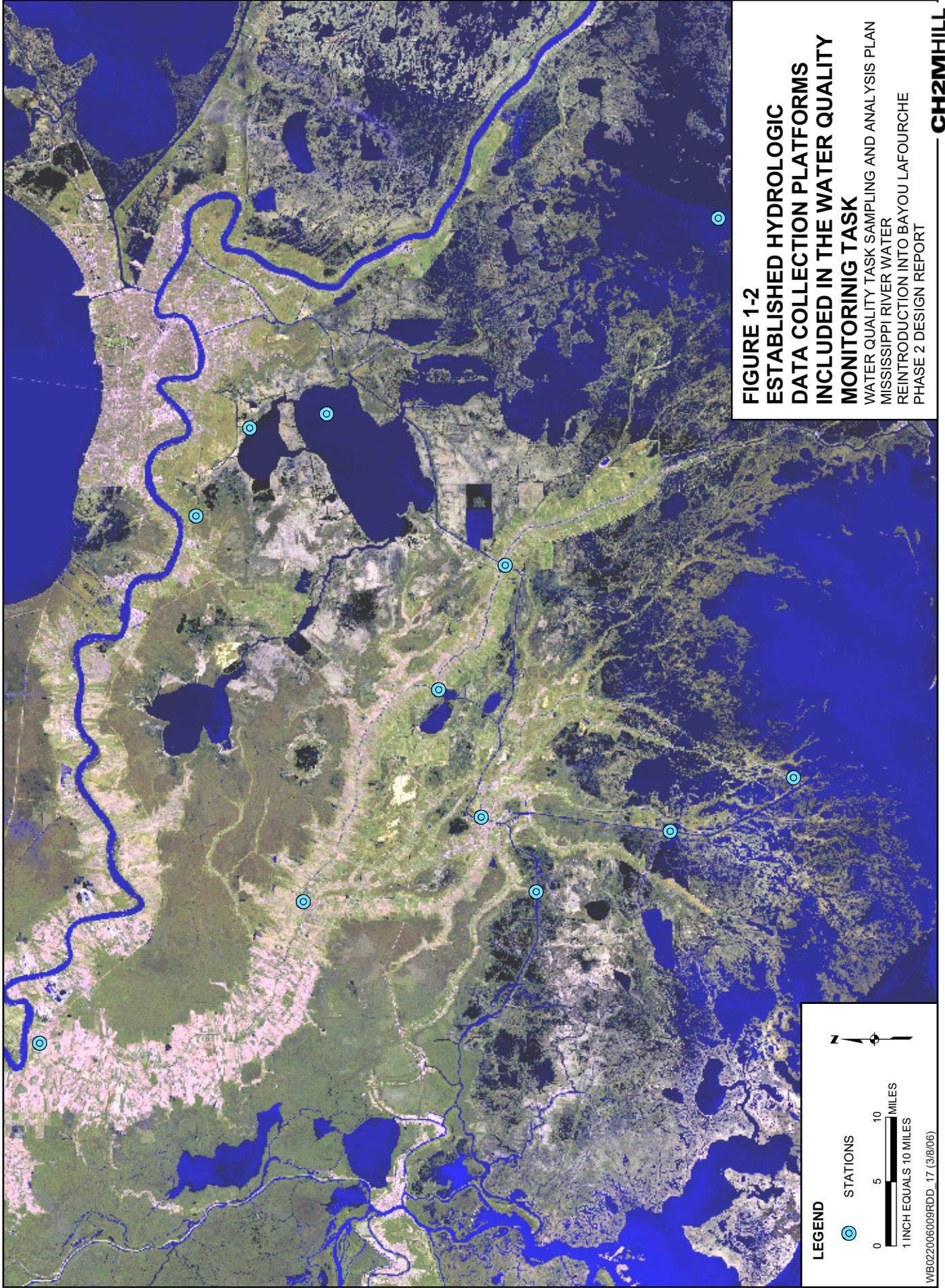
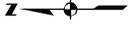


FIGURE 1-2
ESTABLISHED HYDROLOGIC
DATA COLLECTION PLATFORMS
INCLUDED IN THE WATER QUALITY
MONITORING TASK
 WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

LEGEND

-  STATIONS

0 5 10
 MILES
 1 INCH EQUALS 10 MILES



WB02200609RDD_17 (3/8/06)

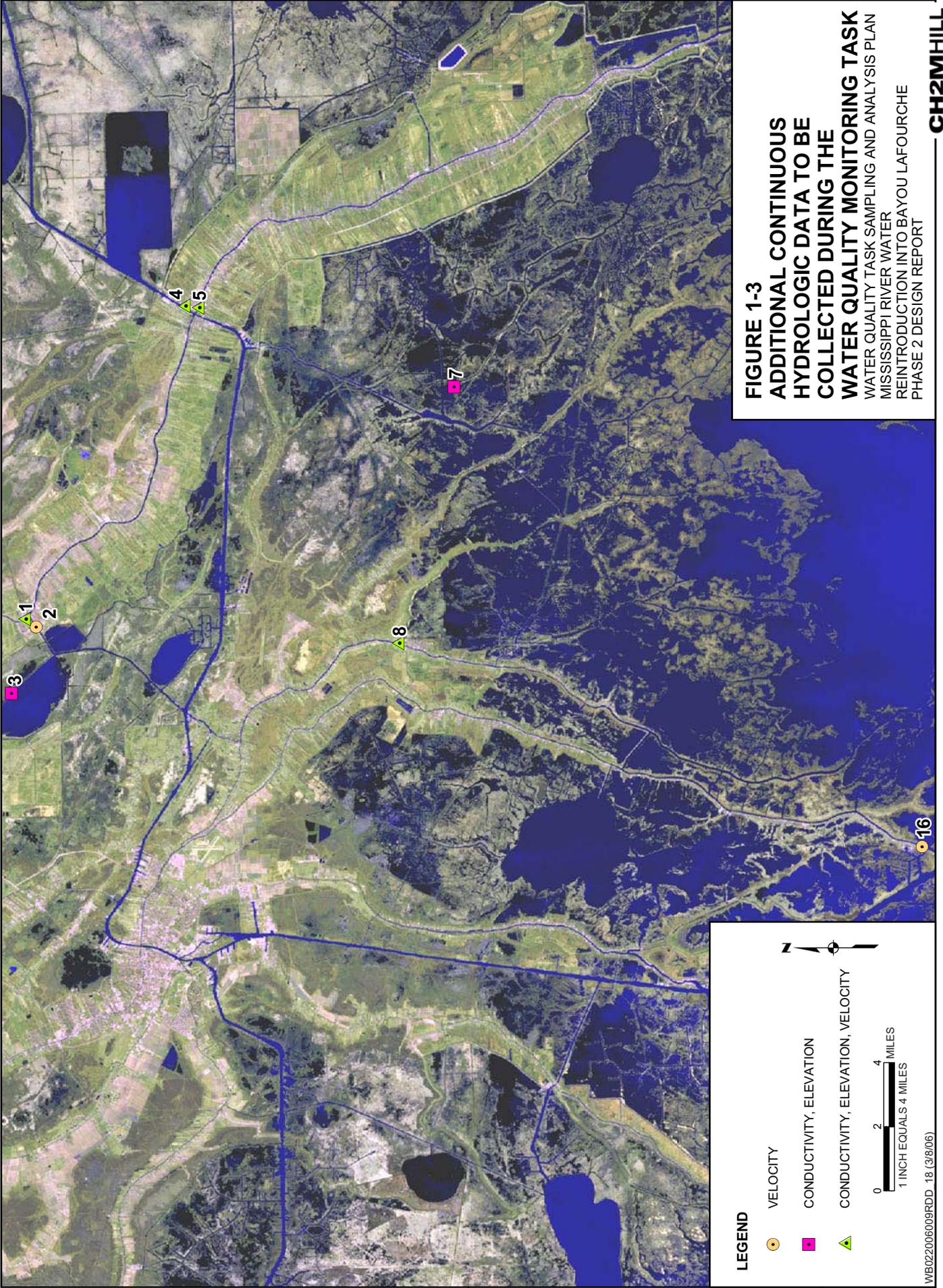


FIGURE 1-3
ADDITIONAL CONTINUOUS
HYDROLOGIC DATA TO BE
COLLECTED DURING THE
WATER QUALITY MONITORING TASK
 WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

LEGEND

- VELOCITY
- CONDUCTIVITY, ELEVATION
- ▲ CONDUCTIVITY, ELEVATION, VELOCITY

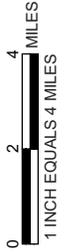



FIGURE 4

Data management, QA/QC procedures, and roles/responsibilities
 Bayou Lafourche freshwater diversion water-quality monitoring task

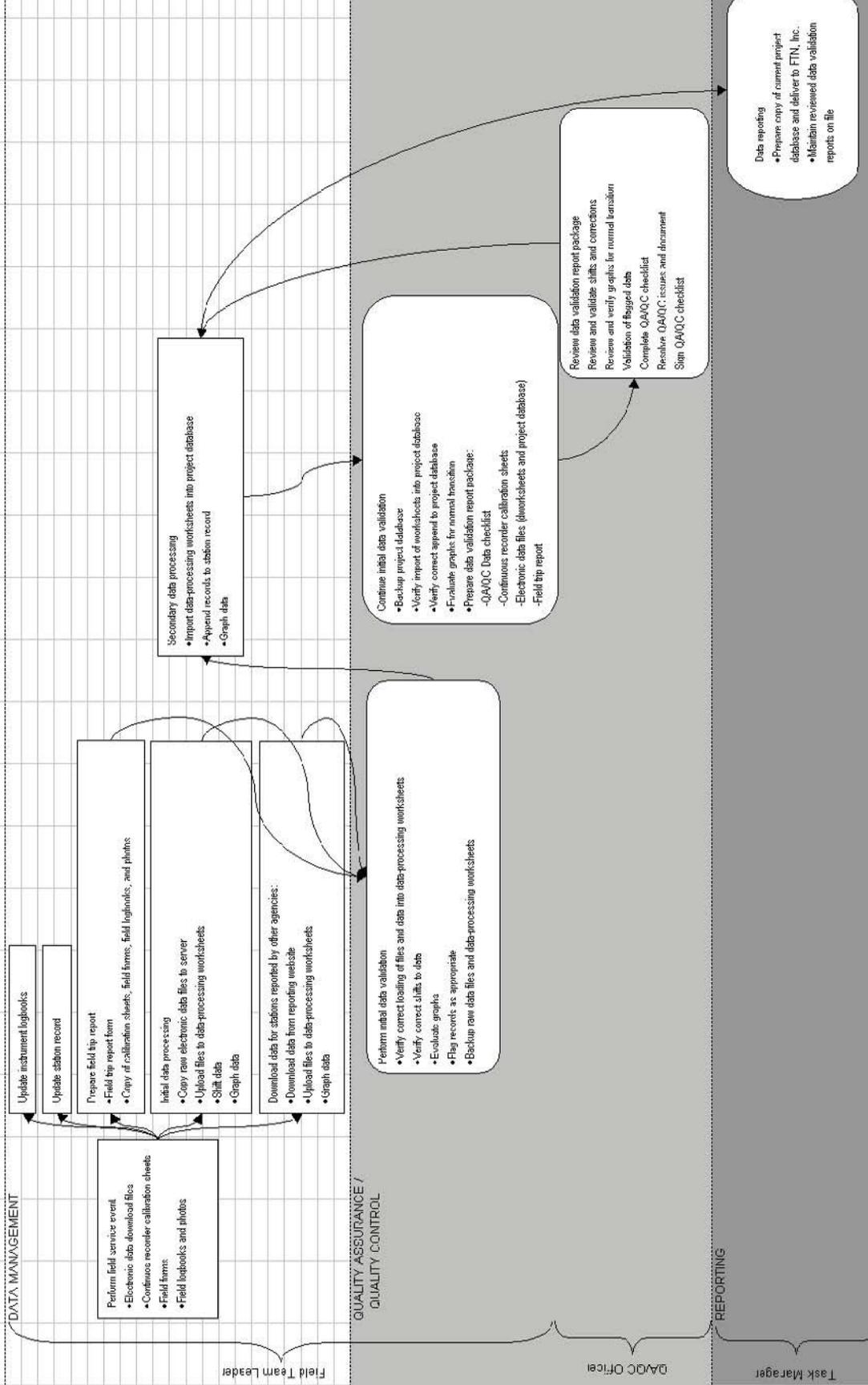


FIGURE 1-4
DATA MANAGEMENT, QA/QC PROCEDURES,
AND ROLE RESPONSIBILITIES
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

Attachment 1A
Health and Safety Plan

CH2M HILL Health and Safety Plan

(Reference CH2M HILL SOP HS-19, Site-Specific Written Safety Plans)

This Health and Safety Plan will be kept on the site during field activities and will be reviewed as necessary. The plan will be amended or revised as project activities or conditions change or when supplemental information becomes available. The plan adopts, by reference, the Standards of Practice (SOP) in the CH2M HILL *Corporate Health and Safety Program, Program and Training Manual*, as appropriate. In addition, this plan adopts procedures in the project Work Plan. The Site Safety Coordinator (SSC) is to be familiar with these SOPs and the contents of this plan. CH2M HILL's personnel and subcontractors must sign Attachment 1.

1 Project Information and Description

PROJECT NO: 177889.BL.04.WS

CLIENT: CH2M HILL Automated Normal Template 3.0LDNR

PROJECT/SITE NAME: Bayou Lafourche Water Quality and Flow Data Collection

SITE ADDRESS: Bayou Lafourche and surrounding or connecting waterways

CH2M HILL PROJECT MANAGER: Chris Arts

CH2M HILL OFFICE: New Orleans

DATE HEALTH AND SAFETY PLAN PREPARED: August 2003

DATE(S) OF SITE WORK: December 2003

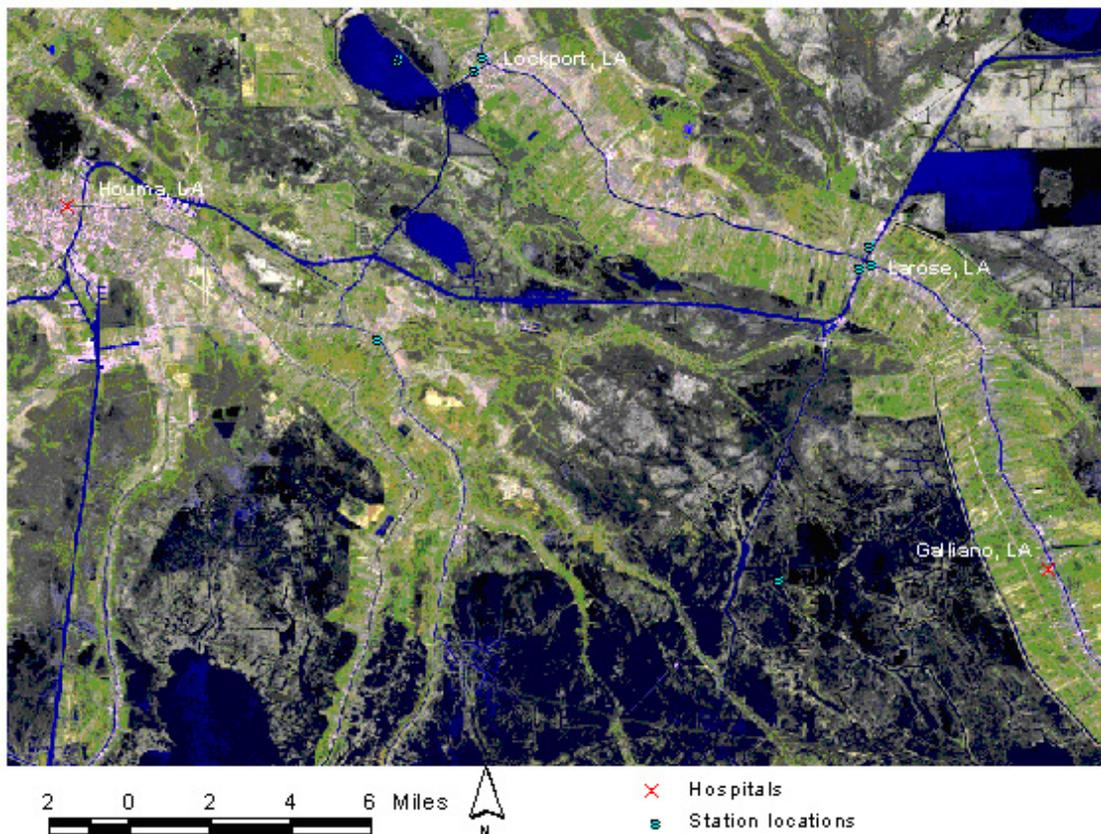
SITE ACCESS: By shallow draft watercraft launched from various public and private launches

SITE SIZE: The Bayou Lafourche water system covers an area of approximately 350 square miles. There will be approximately 8 meter stations throughout the Bayou Lafourche Basin.

SITE TOPOGRAPHY: The site includes bayous, navigable channels, canals, wetlands and swamp.

PREVAILING WEATHER: Fall season – moderate chance of rain and severe weather. Average high temperature is 77°F, average low temperature is 55°F. Winter season – low to moderate chance of rain and severe weather. Average high temperature is 50°F, average low temperature is 40°F. Spring season – moderate chance of rain and severe weather. Average high temperature is 70°F, average low temperature is 50°F.

SITE DESCRIPTION AND HISTORY: The site is an area of sediment deposited by the Mississippi River. It is intended that sediments will be removed and additional water flow will be introduced.



SITE MAP

Note locations of Support, Decontamination, and Exclusion Zones site telephone; first aid station; evacuation routes; and assembly areas.

2 Tasks to be Performed Under this Plan

2.1 Description of Tasks

(Reference Field Project Start-up Form)

Refer to project documents (i.e., Work Plan) for detailed task information. A health and safety risk analysis (Section 1.2) has been performed for each task and is incorporated in this plan through task-specific hazard controls and requirements for monitoring and protection. Tasks other than those listed below require an approved amendment or revision to this plan before tasks begin. Refer to Section 8.2 for procedures related to “clean” tasks that do not involve hazardous waste operations and emergency response (HAZWOPER).

2.1.1 HAZWOPER-Regulated Tasks

- Surface water quality monitoring
- Surface water flow monitoring

Task Hazard Analysis*(Refer to Section 2 for hazard controls)*

Potential Hazards	Tasks	
	Surface Water Monitoring Using a Boat	Surface Water Monitoring from the Shore or Water
Flying debris/objects	X	X
Noise > 85dBA	X	
Electrical	X	
Suspended loads	X	
Buried utilities, drums, tanks		
Slip, trip, fall	X	X
Back injury	X	X
Confined space entry		
Trenches/excavations		
Visible lightning	X	X
Vehicle traffic		
Elevated work areas/falls		X
Fires		X
Entanglement		
Drilling		
Heavy equipment		
Working near water		X
Working from boat	X	
IDW Drum Sampling		

3 Hazard Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of either the site or the particular hazard. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the SSC for clarification.

In addition to the controls specified in this section, Project-Activity Self-Assessment Checklists are contained in Attachment 5. These checklists are to be used to assess the adequacy of CH2M HILL and subcontractor site-specific safety requirements. The objective of the self-assessment process is to identify gaps in project safety performance, and prompt for corrective actions in addressing these gaps. Self-assessment checklists should be completed early in the project, when tasks or conditions change, or when otherwise specified by the HSM. The self-assessment checklists, including documented corrective

actions, should be made part of the permanent project records, and be promptly submitted to the HSM.

Project-specific frequency for completing self-assessments: Daily

3.1 Project-Specific Physical (Safety) Hazards

3.1.1 General Hazards

General Hazards and Housekeeping

(Reference CH2M HILL SOP HS-20, *General Practices*)

- Site work will be performed during daylight hours whenever possible. Work conducted during hours of darkness will require enough illumination intensity to read a newspaper without difficulty.
- Hearing protection must be worn in areas where you need to shout to hear someone within 3 feet.
- Good housekeeping must be maintained at all times in all project work areas.
- Common paths of travel should be established and kept free from the accumulation of materials.
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions.
- Provide slip-resistant surfaces, ropes, and/or other devices to be used.
- Stairs or ladders are generally required when there is a break in elevation of 19 inches or more.
- Specific areas should be designated for the proper storage of materials.
- Tools, equipment, materials, and supplies shall be stored in an orderly manner.
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area.
- Containers should be provided for collecting trash and other debris and shall be removed at regular intervals.
- All spills shall be quickly cleaned up. Oil and grease shall be cleaned from walking and working surfaces.

Hazard Communication

(Reference CH2M HILL SOP HS-05, *Hazard Communication*)

The SSC is to perform the following:

- Complete an inventory of chemicals brought on site by CH2M HILL using Attachment 2.

- Confirm that an inventory of chemicals brought on site by CH2M HILL subcontractors is available.
- Request or confirm locations of Material Safety Data Sheets (MSDS) from the client, contractors, and subcontractors for chemicals to which CH2M HILL employees potentially are exposed.
- Before or as the chemicals arrive on site, obtain an MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Give employees required chemical-specific HAZCOM training using Attachment 3.

Shipping and Transportation of Chemical Products

(Reference CH2M HILL's Procedures for Shipping and Transporting Dangerous Goods)

Chemicals brought to the site might be defined as hazardous materials by the U.S. Department of Transportation (DOT). All staff who ship the materials or transport them by road must receive CH2M HILL training in shipping dangerous goods. All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. Contact the HSM or the Equipment Coordinator for additional information.

Manual Lifting

(Reference CH2M HILL SOP HS-29, *Manual Lifting*)

- Proper lifting techniques must be used when lifting any object.
 - Plan storage and staging to minimize lifting or carrying distances.
 - Split heavy loads into smaller loads.
 - Use mechanical lifting aids whenever possible.
 - Have someone assist with the lift – especially for heavy or awkward loads.
 - Make sure the path of travel is clear prior to the lift.

Fire Prevention

(Reference CH2M HILL SOP HS-22, *Fire Prevention*)

- Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet. When 5 gallons or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet. Extinguishers must:
 - be maintained in a fully charged and operable condition,
 - be visually inspected each month, and
 - undergo a maintenance check each year.
- The area in front of extinguishers must be kept clear.
- Post "Exit" signs over exiting doors, and post "Fire Extinguisher" signs over extinguisher locations.

- Combustible materials stored outside should be at least 10 feet from any building.
- Solvent waste and oily rags must be kept in a fire resistant, covered container until removed from the site.
- Flammable/combustible liquids must be kept in approved containers, and must be stored in an approved storage cabinet.

Electrical

(Reference CH2M HILL SOP HS-23, *Electrical*)

- All temporary wiring, including extension cords, must have ground fault circuit interrupters (GFCI) installed.
- Extension cords must be:
 - equipped with third-wire grounding.
 - covered, elevated, or protected from damage when passing through work areas.
 - protected from pinching if routed through doorways.
- Electrical power tools and equipment must be effectively grounded or double-insulated UL approved.
- Electrical power tools, equipment, and cords are to be inspected for damage before use. If damaged, they should be tagged and removed from service.
- Operate and maintain electrically powered equipment according to manufacturers' instructions.
- Protect all electrical equipment, tools, switches, and outlets from elements.
- Only qualified personnel are to work on energized electrical circuits and equipment. Only authorized personnel are permitted to enter high-voltage areas.
- Properly label switches, fuses, and breakers.

Ladders

(Reference CH2M HILL SOP HS-25, *Stairways and Ladders*)

- Ladders must be inspected by a competent person for visible defects prior to each day's use. Defective ladders must be tagged and removed from service.
- Portable ladders must extend at least 3 feet above landing surface
- User must face the ladder when climbing; keep belt buckle between side rails
- User must use both hands to climb; use rope to raise and lower equipment and materials
- Straight and extension ladders must be tied off to prevent displacement
- Ladders that may be displaced by work activities or traffic must be secured or barricaded
- Fixed ladders \geq 20 feet in height must be provided with fall protection devices.

- Stepladders are to be used in the fully opened and locked position
- Users are not to stand on the top two steps of a stepladder; nor are users to sit on top or straddle a stepladder
- Straight and extension ladders must be positioned at such an angle that the ladder base to the wall is one-fourth of the working length of the ladder

Heat and Cold Stress

(Reference CH2M HILL SOP HS-09, *Heat and Cold Stress*)

Preventing and Treating Heat Stress

- Drink 16 ounces of water before beginning work. Disposal cups and water maintained at 50°F to 60°F should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Take regular breaks in a cool, shaded area. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. The devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Monitor buddy for signs of heat stress. Persons who experience signs of heat rash or heat cramps should consult the SSC to avoid progression of heat-related illness.
- Those who experience heat syncope (sudden fainting), heat exhaustion (hot, pale, clammy/moist skin), or heat stroke (red, hot, dry skin; loss of consciousness) must be cooled down immediately and provided cool water or sports drink. Persons who experience heat syncope or heat exhaustion should also seek medical attention as soon as possible. Persons who experience heat stroke must get immediate medical attention.

Monitoring Heat Stress. These procedures should be considered when the ambient air temperature exceeds 70°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress.

The heart rate (HR) should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 100 beats/minute, or 20 beats/minute above resting pulse. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the

same. If the pulse rate still exceeds 100 beats/minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 100 beats/minute, or 20 beats/minute above resting pulse.

Preventing and Treating Cold Stress

- Be aware of the symptoms of cold-related disorders, and *wear proper clothing for the anticipated fieldwork*.
- Consider monitoring the work conditions and adjusting the work schedule using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council (NSC) (CH2M HILL SOP HS-09).
- *Wind-Chill Index* is used to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it is used only as a guideline to warn workers when they are in a situation that can cause cold-related illnesses.
- *NSC Guidelines for Work and Warm-Up Schedules* can be used with the wind-chill index to estimate work and warm-up schedules for fieldwork. The guidelines are not absolute; *workers should be monitored for symptoms of cold-related illnesses*. If symptoms are not observed, the work duration can be increased.
- Persons who experience signs of incipient frost bite (frost nip) or incipient hypothermia (generally cold, shivering) should consult the SSC to avoid progression of cold-related illness.
- Persons who experience signs of frost bite (discolored, waxy, resilient skin) or hypothermia (low body temperature characterized by uncontrollable shivering, weakness, apathy, etc.) must be warmed and provided warm fluids (not hot, and no caffeinated drinks), and must get immediate medical attention.

Compressed Gas Cylinders

(Reference CH2M HILL SOP HS-63, *Welding and Cutting*)

- Valve caps must be in place when cylinders are transported, moved, or stored.
- Cylinder valves must be closed when cylinders are not being used and when cylinders are being moved.
- Cylinders must be secured in an upright position at all times.
- Cylinders must be shielded from welding and cutting operations and positioned to avoid being struck or knocked over; contacting electrical circuits; or exposed to extreme heat sources.
- Cylinders must be secured on a cradle, basket, or pallet when hoisted; they may not be hoisted by choker slings.

Procedures for Locating Buried Utilities

Local Utility Mark-Out Service

Name: LA One Call

Phone: (800) 272-3020

- Where available, obtain utility diagrams for the facility.
- Review locations of sanitary and storm sewers, electrical conduits, water supply lines, natural gas lines, and fuel tanks and lines.
- Review proposed locations of intrusive work with facility personnel knowledgeable of locations of utilities. Check locations against information from utility mark-out service.
- Where necessary (e.g., uncertainty about utility locations), excavation or drilling of the upper depth interval should be performed manually
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon).
- When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the SSC should confirm that arrangement.

Working Near Water

When working near water, and there is a risk of drowning:

- U.S. Coast Guard-approved personal flotation devices (PDFs), or life jacket, provided for each employee will be worn.
- PFDs will be inspected before and after each use. Defective equipment will not be used.
- Sampling and other equipment will be used according to the manufacturers' instructions.
- A minimum of one life-saving skiff will be provided for emergency rescue.
- A minimum of one ring buoy with 90 feet of 3/8-inch solid-braid polypropylene (or equal) rope will be provided for emergency rescue.

Working on Water

- Safe means of boarding or leaving a boat or a platform will be provided to prevent slipping and falling.
- Boat/barge must be equipped with adequate railing.
- Employees should be instructed on safe use.
- Work requiring the use of a boat will not take place at night or during inclement weather.
- The boat/barge must be operated according to U.S. Coast Guard regulations (speed, lightning, right-of-way, etc.).
- The engine should be shut off before refueling; do not smoke while refueling.

IDW Drum Sampling

CH2M Hill personnel will not be sampling drums of IDW.

Confined Space Entry

(Reference CH2M HILL SOP HS-17, *Confined Space Entry*)

No confined space entry will be permitted. Confined space entry requires additional health and safety procedures, training, and a permit. If conditions change such that confined-space entry is necessary, contact the HSM to develop the required entry permit.

When planned activities will not include confined-space entry, permit-required confined spaces accessible to CH2M HILL personnel are to be identified before the task begins. The SSC is to confirm that permit spaces are properly posted or that employees are informed of their locations and hazards.

3.1.2 Biological Hazards and Controls

(Reference CH2M HILL SOP HS-46, *Biological Hazards*)

Snakes

Snakes typically are found in underbrush and tall grassy areas. If you encounter a snake, stay calm and look around; there may be other snakes. Turn around and walk away on the same path you used to approach the area. If a person is bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Seek medical attention immediately. **DO NOT** apply ice, cut the wound, or apply a tourniquet. Try to identify the type of snake: note color, size, patterns, and markings.

Poison Ivy and Poison Sumac

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Become familiar with the identity of these plants. Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

Ticks

Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch in size. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into boots; spray **only outside** of clothing with permethrin or permanone and spray skin with only DEET; and check yourself frequently for ticks.

If bitten by a tick, grasp it at the point of attachment and carefully remove it. After removing the tick, wash your hands and disinfect and press the bite areas. Save the removed tick. Report the bite to human resources. Look for symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme: a rash might appear that looks like a bullseye with a small welt in the center. RMSF: a rash of red spots under the skin 3 to 10 days after the tick bite. In both cases, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, seek medical attention.

Bees and Other Stinging Insects

Bee and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people who are allergic. Watch for and avoid nests. Keep exposed skin to a minimum. Carry a kit if you have had allergic reactions in the past, and inform the SSC and/or buddy. If a stinger is present, remove it carefully with tweezers. Wash and disinfect the wound, cover it, and apply ice. Watch for allergic reaction; seek medical attention if a reaction develops.

Bloodborne Pathogens

(Reference CH2M HILL SOP HS-36, *Bloodborne Pathogens*)

Exposure to bloodborne pathogens may occur when rendering first aid or CPR, or when coming into contact with landfill waste or waste streams containing potentially infectious material. Exposure controls and personal protective equipment (PPE) are required as specified in CH2M HILL SOP HS-36, Bloodborne Pathogens. Hepatitis B vaccination must be offered before the person participates in a task where exposure is a possibility.

Mosquito Bites

Due to the recent detection of the West Nile Virus in the Southeastern United States it is recommended that **preventative measures** be taken to reduce the probability of being bitten by mosquitos whenever possible. Mosquitos are believed to be the primary source for exposure to the West Nile Virus as well as several other types of encephalitis. The following guidelines should be followed to reduce the risk of these concerns for working in areas where mosquitos are prevalent.

- Stay indoors at dawn, dusk, and in the early evening.
- Wear long-sleeved shirts and long pants whenever you are outdoors.
- Spray clothing with repellents containing permethrin or DEET since mosquitos may bite through thin clothing.
- Apply insect repellent sparingly to exposed skin. An effective repellent will contain 35 percent DEET (N,N-diethyl-meta-toluamide). DEET in high concentrations (greater than 35 percent) provides no additional protection.
- Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands.
- Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product.

Note: Vitamin B and "ultrasonic" devices are NOT effective in preventing mosquito bites.

Symptoms of Exposure to the West Nile Virus. Most infections are mild, and symptoms include fever, headache, and body aches, occasionally with skin rash and swollen lymph glands. More severe infection may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and, rarely, death.

The West Nile Virus incubation period is from 3-15 days.

If you have any questions or to report any suspicious symptoms, contact the project Health and Safety Manager.

Fire Ant Bites

Fire ants are common in the southern U.S. These insects typically build mounds on the land surface that are usually easy to identify. Avoid disturbing these mounds. A bite from a fire ant can be painful but rarely is life threatening. However, it is possible that the bite could cause an allergic reaction. If bitten, check for symptoms of an allergic reaction such as weakness, nausea, vomiting, dizziness, or shortness of breath. If symptoms appear, seek medical attention

Alligators

Survey the area to look for alligators prior to initiating sampling efforts. If an alligator is observed in the pond near the sampling location, do not approach the sampling site until the alligator has left the area. Avoid areas near heavy vegetation because it may conceal a large alligator. During sampling, one member of the sampling team should watch the sludge pond for signs of an alligator, while the other team member collects the samples. Leave the area around the pond bank immediately following sample collection. If an alligator is encountered, **DO NOT APPROACH**. Stay at least 25 yards away Don't feed alligators! Many attacks involve alligators who have been fed, and lost their natural fear of man.

Feral Pigs

Feral pigs are wild and dangerous animals. Large boars have tusks and can weigh up to 500 pounds. Sows with litters can be aggressive and attack people. Though the possibility is remote, feral swine could spread pseudorabies and brucellosis.

Feral pigs should be avoided and not harassed if encountered during field work.

3.1.3 Radiological Hazards and Controls

Refer to CH2M HILL's Corporate Health and Safety Program, Program and Training Manual, and Corporate Health and Safety Program, Radiation Protection Program Manual, for standards of practice in contaminated areas.

Hazards	Controls
None Known	None Required

Contaminants of Concern

(Refer to Project Files for more detailed contaminant information)

Contaminant	Location and Maximum ^a Concentration (ppm)	Exposure Limit ^b	IDLH ^c	Symptoms and Effects of Exposure	PIP ^d (eV)
No identified COPCs					
Potential Routes of Exposure					
Dermal: Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 4.	Inhalation: Vapors and contaminated particulates. This route of exposure is minimized through proper respiratory protection and monitoring, as specified in Sections 4 and 5, respectively.	Other: Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before drinking or smoking).			

^aSpecify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), S (Surface Soil), SL (Sludge), SW (Surface Water).

^bAppropriate value of PEL, REL, or TLV listed.

^cIDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.

^dPIP = photoionization potential; NA = Not applicable; UK = Unknown.

4 Project Organization and Personnel

4.1 CH2M HILL Employee Medical Surveillance and Training

(Reference CH2M HILL SOPs HS-01, *Medical Surveillance*, and HS-02, *Health and Safety Training*)

The employees listed below are enrolled in the CH2M HILL Comprehensive Health and Safety Program and meet state and federal hazardous waste operations requirements for 40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training. Employees designated "SSC" have completed a 12-hour site safety coordinator course, and have documented requisite field experience. An SSC with a level designation (D, C, B) equal to or greater than the level of protection being used must be present during all tasks performed in exclusion or decontamination zones. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and CPR. At least one FA-CPR designated employee must be present during all tasks performed in exclusion or decontamination zones. The employees listed below are currently active in a medical surveillance program that meets state and federal regulatory requirements for hazardous waste operations. Certain tasks (e.g., confined-space entry) and contaminants (e.g., lead) may require additional training and medical monitoring.

Pregnant employees are to be informed of and are to follow the procedures in CH2M HILL's SOP HS-04, *Reproduction Protection*, including obtaining a physician's statement of the employee's ability to perform hazardous activities before being assigned fieldwork.

Employee Name	Office	Responsibility	SSC/FA-CPR
Jason Kase	NWO	Project Scientist	FA-CPR
Nicole Monroe	NWO	Field Technician	SSC; FA-CPR
Andrew Kirby	NWO	Field Engineer	
Ryan Bitely	NVR	Geologist	SSC; FA-CPR

4.2 Field Team Chain of Command and Communication Procedures

4.2.1 Louisiana Department of Natural Resources

Contact Name: John Hodnett or Bob Roberts

Phone: (225) 342-7305 or (225) 342-9423

4.2.2 CH2M HILL

Project Manager: Chris Arts

Health and Safety Manager: Michael Goldman

Field Team Leader: Jason Kase

Site Safety Coordinator: Nicole Monroe

The SSC is responsible for contacting the Field Team Leader and Project Manager. In general, the Project Manager will contact the client. The Health and Safety Manager should be contacted as appropriate.

4.2.3 CH2M HILL Subcontractors

(Reference CH2M HILL SOP HS-55, Subcontractor, Contractor, and Owner)

Subcontractor: T. Baker Smith & Sons, Inc.
 Subcontractor Contact Name: Jimmy Ledet
 Telephone: 985-446-7970

The subcontractors listed above are covered by this HSP and must be provided a copy of this plan. However, this plan does not address hazards associated with the tasks and equipment that the subcontractor has expertise in (e.g., drilling, excavation work, electrical). Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit these procedures to CH2M HILL for review before the start of field work. Subcontractors must comply with the established health and safety plan(s). The CH2M HILL SSC should verify that subcontractor employee training, medical clearance, and fit test records are current and must monitor and enforce compliance with the established plan(s). CH2M HILL's oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s).

CH2M HILL should continuously endeavor to observe subcontractors' safety performance. This endeavor should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. In addition to this level of observation, the SSC is responsible for confirming CH2M HILL subcontractor performance against both the subcontractor's safety plan and applicable self-assessment checklists. Self-assessment checklists contained in Attachment 5 are to be used by the SSC to review subcontractor performance.

Health and safety related communications with CH2M HILL subcontractors should be conducted as follows:

- Brief subcontractors on the provisions of this plan, and require them to sign the Employee Signoff Sheet included in Attachment 1.
- Request subcontractor(s) to brief the project team on the hazards and precautions related to their work.
- When apparent non-compliance/unsafe conditions or practices are observed, notify the subcontractor safety representative and require corrective action – the subcontractor is responsible for determining and implementing necessary controls and corrective actions.
- When repeat non-compliance/unsafe conditions are observed, notify the subcontractor safety representative and stop affected work until adequate corrective measures are implemented.
- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, and stop affected work until adequate corrective measures are implemented. Notify the Project Manager and HSM as appropriate.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.

4.2.4 Contractors

(Reference CH2M HILL SOP HS-55, *Subcontractor, Contractor, and Owner*)

Contractor:

Contractor Contact Name:

Telephone:

This plan does not cover contractors that are contracted directly to the client or the owner. CH2M HILL is not responsible for the health and safety or means and methods of the contractor's work, and we must never assume such responsibility through our actions (e.g., advising on H&S issues). In addition to this plan, CH2M HILL staff should review contractor safety plans so that we remain aware of appropriate precautions that apply to us. Except in unusual situations when conducted by the HSM, CH2M HILL must never comment on or approve contractor safety procedures. Self-assessment checklists contained in Attachment 5 are to be used by the SSC to review the contractor's performance ONLY as it pertains to evaluating our exposure and safety.

Health and safety related communications with contractors should be conducted as follows:

- Request the contractor to brief CH2M HILL employees and subcontractors on the precautions related to the contractor's work.
- When an apparent contractor non-compliance/unsafe condition or practice poses a risk to CH2M HILL employees or subcontractors:
 - Notify the contractor safety representative
 - Request that the contractor determine and implement corrective actions
 - If needed, stop affected CH2M HILL work until contractor corrects the condition or practice. Notify the client, Project Manager, and HSM as appropriate.
- If apparent contractor non-compliance/unsafe conditions or practices are observed, inform the contractor safety representative. Our obligation is limited strictly to informing the contractor of our observation – the contractor is solely responsible for determining and implementing necessary controls and corrective actions.
- If an apparent imminent danger is observed, immediately warn the contractor employee(s) in danger and notify the contractor safety representative. Our obligation is limited strictly to immediately warning the affected individual(s) and informing the contractor of our observation – the contractor is solely responsible for determining and implementing necessary controls and corrective actions.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.

5 Personal Protective Equipment (PPE)

(Reference CH2M HILL SOP HS-07, *Personal Protective Equipment*, HS-08, *Respiratory Protection*)

PPE Specifications ^a				
Task	Level	Body	Head	Respirator ^b
General site entry Surveying Observation of material loading for offsite disposal Oversight of remediation and construction	D	Work clothes; steel-toe, leather work boots; work glove.	Hardhat ^c Safety glasses Ear protection ^d	None required
Surface water sampling Aquifer testing Sediment sampling Surface soil sampling Hand augering Geoprobe boring	Modified D	PFDs Work clothes or cotton coveralls Boots: Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers Gloves: Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat ^c Safety glasses Ear protection ^d	None required
Groundwater sampling Soil boring Investigation-derived waste (drum) sampling and disposal	Modified D	Coveralls: Uncoated Tyvek® Boots: Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers Gloves: Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat ^c Splash shield ^c Safety glasses Ear protection ^d	None required
Test pit excavation Tasks requiring upgrade	C	Coveralls: Polycoated Tyvek® Boots: Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers Gloves: Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat ^c Splash shield ^c Ear protection ^d Spectacle inserts	APR, full face, MSA Ultratwin or equivalent; with GME-H cartridges or equivalent ^e .
Tasks requiring upgrade	B	Coveralls: Polycoated Tyvek® Boots: Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers Gloves: Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat ^c Splash shield ^c Ear protection ^d Spectacle inserts	Positive-pressure demand self-contained breathing apparatus (SCBA); MSA Ultralite, or equivalent.

PPE Specifications^a	
Reasons for Upgrading or Downgrading Level of Protection	
Upgrade^f	Downgrade
<ul style="list-style-type: none"> • Request from individual performing tasks. • Change in work tasks that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels (Section 5) exceeded. 	<ul style="list-style-type: none"> • New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decreases the hazard. • Change in work task that will reduce contact with hazardous materials.

^aModifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.

^bNo facial hair that would interfere with respirator fit is permitted.

^cHardhat and splash-shield areas are to be determined by the SSC.

^dEar protection should be worn when conversations cannot be held at distances of 3 feet or less without shouting.

^eCartridge change-out schedule is at least every 8 hours (or one work day), except if relative humidity is > 85%, or if organic vapor measurements are > midpoint of Level C range (refer to Section 5) – then at least every 4 hours. If encountered conditions are different than those anticipated in this HSP, contact the HSM.

^fPerforming a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the HSM, and an SSC qualified at that level is present.

6 Air Monitoring/Sampling

(Reference CH2M HILL SOP HS-06, *Air Monitoring*)

6.1 Air Monitoring Specifications

Air monitoring will not be required.

6.2 Calibration Specifications

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

Calibration of air monitors will not be required.

6.3 Air Sampling

Air Sampling will not be required.

7 Decontamination

(Reference CH2M HILL SOP HS-13, *Decontamination*)

The SSC must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SSC. The SSC must ensure that procedures are established for disposing of materials generated on the site.

7.1 Decontamination Specifications

Personnel	Sample Equipment	Heavy Equipment
Boot wash/rinse	Wash/rinse equipment	Power wash
Glove wash/rinse	Solvent-rinse equipment	Steam clean
Outer-glove removal	Contain solvent waste for offsite disposal	Dispose of equipment rinse water to facility or sanitary sewer, or contain for offsite disposal
Body-suit removal		
Inner-glove removal		
Respirator removal		
Hand wash/rinse		
Face wash/rinse		
Shower ASAP		
Dispose of PPE in municipal trash, or contain for disposal		
Dispose of personnel rinse water to facility or sanitary sewer, or contain for offsite disposal		

7.2 Diagram of Personnel-Decontamination Line

No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SSC should establish areas for eating, drinking, and smoking. Contact lenses are not permitted in exclusion or decontamination zones.

Figure 1 illustrates a conceptual establishment of work zones, including the decontamination line. Work zones are to be modified by the SSC to accommodate task-specific requirements.

8 Spill-Containment Procedures

Sorbent material will be maintained in the support zone. Incidental spills will be contained with sorbent and disposed of properly.

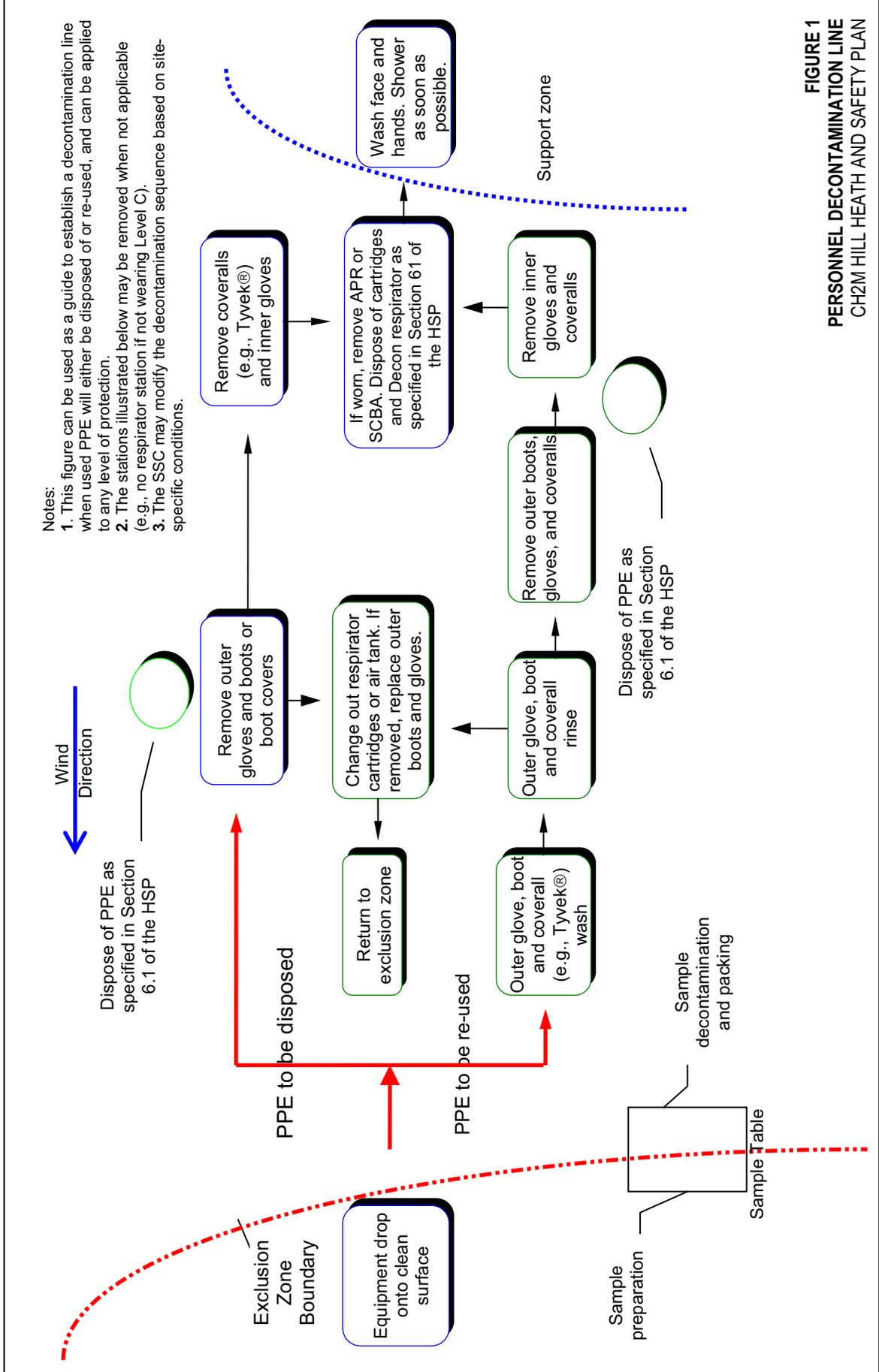


FIGURE 1
PERSONNEL DECONTAMINATION LINE
 CH2M HILL HEALTH AND SAFETY PLAN

9 Site-Control Plan

9.1 Site-Control Procedures

(Reference CH2M HILL SOP HS-11, *Site Control*)

- The SSC will conduct a site safety briefing (see below) before starting field activities or as tasks and site conditions change.
- Topics for briefing on site safety: general discussion of Health and Safety Plan, site-specific hazards, locations of work zones, PPE requirements, equipment, special procedures, emergencies.
- The SSC records attendance at safety briefings in a logbook and documents the topics discussed.
- Post the OSHA job-site poster in a central and conspicuous location in accordance with CH2M HILL SOP HS-71, *OSHA Postings*.
- Establish support, decontamination, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Establish onsite communication consisting of the following:
 - Line-of-sight and hand signals
 - Air horn
 - Two-way radio or cellular telephone if available
- Establish offsite communication.
- Establish and maintain the “buddy system.”
- Initial air monitoring is conducted by the SSC in appropriate level of protection.
- The SCC is to conduct periodic inspections of work practices to determine the effectiveness of this plan – refer to Sections 2 and 3. Deficiencies are to be noted, reported to the HSM, and corrected.

9.2 HAZWOPER Compliance Plan

(Reference CH2M HILL SOP HS-19, *Site-Specific Written Safety Plans*)

Certain parts of the site work are covered by state or federal HAZWOPER standards and therefore require training and medical monitoring. Anticipated HAZWOPER tasks (Section 1.1.1) might occur consecutively or concurrently with respect to non-HAZWOPER tasks. This section outlines procedures to be followed when approved activities specified in Section 1.1.2 do not require 24- or 40-hour training. Non-HAZWOPER-trained personnel also must be trained in accordance with all other state and federal OSHA requirements.

- In many cases, air sampling, in addition to real-time monitoring, must confirm that there is no exposure to gases or vapors before non-HAZWOPER-trained personnel are allowed

on the site, or while non-HAZWOPER-trained staff are working in proximity to HAZWOPER activities. Other data (e.g., soil) also must document that there is no potential for exposure. The HSM must approve the interpretation of these data. Refer to subsections 2.5 and 5.3 for contaminant data and air sampling requirements, respectively.

- When non-HAZWOPER-trained personnel are at risk of exposure, the SSC must post the exclusion zone and inform non-HAZWOPER-trained personnel of the:
 - nature of the existing contamination and its locations
 - limitations of their access
 - emergency action plan for the site
- Periodic air monitoring with direct-reading instruments conducted during regulated tasks also should be used to ensure that non-HAZWOPER-trained personnel (e.g., in an adjacent area) are not exposed to airborne contaminants.
- When exposure is possible, non-HAZWOPER-trained personnel must be removed from the site until it can be demonstrated that there is no longer a potential for exposure to health and safety hazards.
- Remediation treatment system start-ups: Once a treatment system begins to pump and treat contaminated media, the site is, for the purposes of applying the HAZWOPER standard, considered a treatment, storage, and disposal facility (TSDF). Therefore, once the system begins operation, only HAZWOPER-trained personnel (minimum of 24 hours of training) will be permitted to enter the site. All non-HAZWOPER-trained personnel must not enter the TSDF area of the site.

10 Emergency Response Plan

(Reference CH2M HILL, SOP HS-12, *Emergency Response*)

10.1 Pre-Emergency Planning

The SSC performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with CH2M HILL onsite parties, the facility, and local emergency-service providers as appropriate.

- Review the facility emergency and contingency plans where applicable.
- Determine what onsite communication equipment is available (e.g., two-way radio, air horn).
- Determine what offsite communication equipment is needed (e.g., nearest telephone, cell phone).
- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital; communicate the information to onsite personnel.
- Field Trailers: Post “Exit” signs above exit doors, and post “Fire Extinguisher” signs above locations of extinguishers. Keep areas near exits and extinguishers clear.

- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures.
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases.
- Rehearse the emergency response plan before site activities begin, including driving route to hospital.
- Brief new workers on the emergency response plan.

The SSC will evaluate emergency response actions and initiate appropriate follow-up actions.

10.2 Emergency Equipment and Supplies

The SSC should mark the locations of emergency equipment on the site map and post the map.

Emergency Equipment and Supplies	Location
20 LB (or two 10-lb) fire extinguisher (A, B, and C classes)	Support Zone/Heavy Equipment
First aid kit	Support Zone/Field Vehicle
Eye Wash	Support & Decon Zone/Field Vehicle
Potable water	Support & Decon Zone/Field Vehicle
Bloodborne-pathogen kit	Support Zone/Field Vehicle
Additional equipment (specify):	

10.3 Incident Response

In fires, explosions, or chemical releases, actions to be taken include the following:

- Shut down CH2M HILL operations and evacuate the immediate work area.
- Notify appropriate response personnel.
- Account for personnel at the designated assembly area(s).
- Assess the need for site evacuation, and evacuate the site as warranted.

Instead of implementing a work-area evacuation, note that small fires or spills posing minimal safety or health hazards may be controlled.

10.4 Emergency Medical Treatment

The procedures listed below may also be applied to non-emergency incidents. Injuries and illnesses (including overexposure to contaminants) must be reported to Human Resources. If there is doubt about whether medical treatment is necessary, or if the injured person is reluctant to accept medical treatment, contact the CH2M HILL medical consultant. During non-emergencies, follow these procedures as appropriate.

- Notify appropriate emergency response authorities listed in Section 9.8 (e.g., 911).
- The SCC will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury.
- Initiate first aid and CPR where feasible.
- Get medical attention immediately.
- Perform decontamination where feasible; lifesaving and first aid or medical treatment take priority.
- Make certain that the injured person is accompanied to the emergency room.
- When contacting the medical consultant, state that the situation is a CH2M HILL matter, and give your name and telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.
- Report incident as outlined in Section 9.7.

10.5 Evacuation

- Evacuation routes and assembly areas (and alternative routes and assembly areas) are specified on the site map.
- Evacuation route(s) and assembly area(s) will be designated by the SSC before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The SSC and a “buddy” will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The SSC will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s).
- The SSC will write up the incident as soon as possible after it occurs and submit a report to the Corporate Director of Health and Safety.

10.6 Evacuation Signals

Signal	Meaning
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

10.7 Incident Notification and Reporting

- Upon any project incident (fire, spill, injury, near miss, death, etc.), immediately notify the PM and HSM. Call emergency beeper number if HSM is unavailable.
- For CH2M HILL work-related injuries or illnesses, contact and help Human Resources administrator complete an Incident Report Form (IRF). IRF must be completed within 24 hours of incident.
- For CH2M HILL subcontractor incidents, complete the Subcontractor Accident/Illness Report Form and submit to the HSM.
- Notify and submit reports to client as required in contract.

10.8 Emergency Contacts

24-hour CH2M HILL Emergency Beeper – 888/444-1226

Medical Emergency – 911

Facility Medical Response #:
Local Ambulance #:

CH2M HILL Medical Consultant

Dr. Peter Greaney
GMG WorkCare, Orange, CA
(800) 455-6155
(After hours calls will be returned within 20 minutes)

Fire/Spill Emergency – 911

Facility Fire Response #:
Local Fire Dept #:

Local Occupational Physician

Security & Police – 911

Facility Security #:
Local Police #:

Corporate Director Health and Safety

Name: Mollie Netherland/SEA
Phone: (206) 453-5005
24-hour emergency beeper: (888) 444-1226

**Utilities Emergency – LA One
Call 800-272-3020**

Water: LA One Call (800) 272-3020
Gas: LA One Call (800) 272-3020
Electric: LA One Call (800) 272-3020

Health and Safety Manager (HSM)

Name: Michael Goldman
Phone: (770) 604-9182

Site Safety Coordinator (SSC)

Name: Nicole Monroe
Phone: (504) 473-1399

Regional Human Resources Department

Name: Jerry Weeks
Phone: (352) 335-5877 ext 2389

Project Manager

Name: Chris Arts
Phone: (504) 593-9421 ext 38

Corporate Human Resources Department

Name: John Monark/COR
Phone: (303) 771-0900

Federal Express Dangerous Goods Shipping

Phone: (800) 238-5355

**CH2M HILL Emergency Number for Shipping
Dangerous Goods**

Phone: (800) 255-3924

Worker's Compensation and Auto Claims

Sterling Administration Services
Phone: (800) 420-8926 After hours: (800) 497-4566
Report fatalities AND report vehicular accidents involving pedestrians, motorcycles, or more than two cars.

Federal Agency / Contact Name:

Phone:

State Agency / Contact Name:

Phone:

Local Agency / Contact Name:

Phone:

Contact the Project Manager. Generally, the Project Manager will contact relevant government agencies.

Facility Alarms:

Evacuation Assembly Area(s):

Facility/Site Evacuation Route(s):

Hospital Name/Address: Terrebonne General Hospital
Lady of the Sea General Hospital

Hospital Phone #: (985) 873-4141
(985) 632-6401

Directions to Hospital

Lady of the Sea General Hospital
200 W 134th Pl
Cut Off, LA 70345

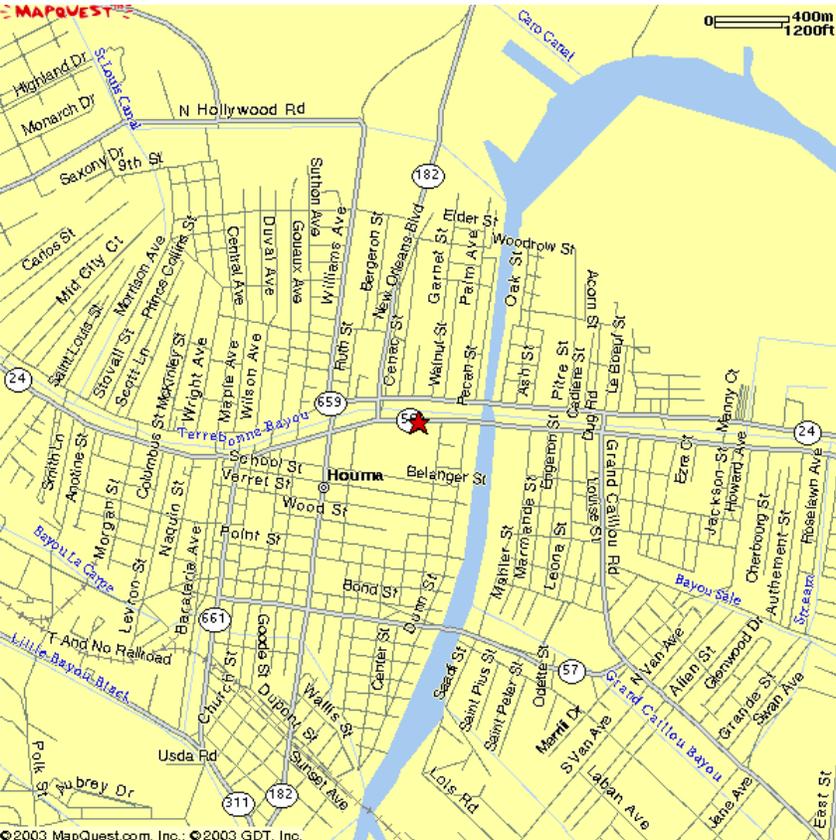
Terrebonne General Hospital
8166 Main St
Houma, LA 70360

11 Hospital Maps and Directions



Lady of the Sea General Hospital
 200 W 134th Pl
 Cut Off, LA 70345
 (985) 632-6401

On Hwy 1 (West side of Bayou Lafourche) in Cut Off, north of Galliano.



Terrebonne General Hospital
 8166 Main St
 Houma, LA 70360
 (985) 873-4141

On Hwy 56, on the west side of Bayou Terrebonne in Houma.

12 Approval

This site-specific Health and Safety Plan has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if those conditions change.

12.1 Original Plan

Written By: Nicole Monroe Date: August 8, 2003

Approved By: _____ Date: _____

12.2 Revisions

Revisions Made By: _____ Date: _____

Revisions to Plan: _____

Revisions Approved By: _____ Date: _____

13 Attachments

- Attachment 1:** Employee Signoff Form – Health and Safety Plan
- Attachment 2:** Project-Specific Chemical Product Hazard Communication Form
- Attachment 3:** Chemical-Specific Training Form
- Attachment 4:** Project H&S Forms/Permits
- Attachment 5:** Project Activity Self-Assessment Checklists
- Attachment 6:** Applicable Material Safety Data Sheets

CH2MHILL

Project-Specific Chemical Product Hazard Communication Form

This form must be completed prior to performing activities that expose personnel to hazardous chemicals products. Upon completion of this form, the SSC shall verify that training is provided on the hazards associated with these chemicals and the control measures to be used to prevent exposure to CH2M HILL and subcontractor personnel. Labeling and MSDS systems will also be explained.

Project Name: Bayou Lafourche Water Quality Data Collection **Project Number:**

MSDSs will be maintained at the following location(s): Project Folder

Hazardous Chemical Products Inventory

Chemical	Quantity	Location	MSDS Available	Container labels	
				Identity	Hazard
pH buffers	< 500 ml	Support Zone			
MSA Sanitizer	< 1 liter	Support/Decon Zones			
Alconox/Liquinox	< 1 liter	Support/Decon Zones			
Calibration Fluid	<500 ml	Support Zone			

Refer to SOP HS-05 *Hazard Communication* for more detailed information.

CH2MHILL

CHEMICAL-SPECIFIC TRAINING FORM

Location: _____	Project #: _____
HCC: _____	Trainer: _____

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The HCC shall use the product MSDS to provide the following information concerning each of the products listed above.

- Physical and health hazards
- Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)
- Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants shall have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.

Copies of MSDSs, chemical inventories, and CH2M HILL's written hazard communication program shall be made available for employee review in the facility/project hazard communication file.

Attachment 1B
DCP and Staff Gauge Schematics

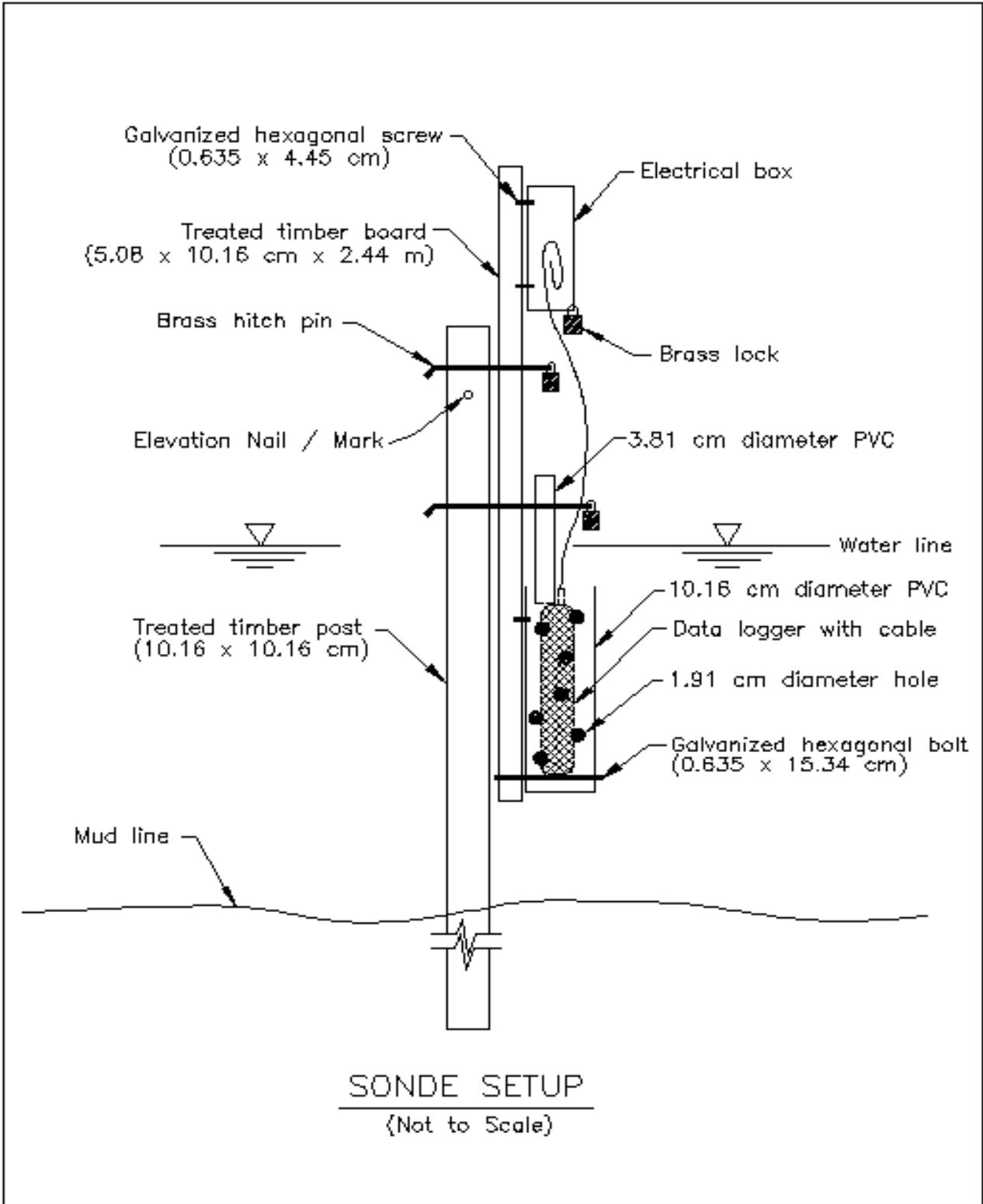


FIGURE 1
SONDE SETUP
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

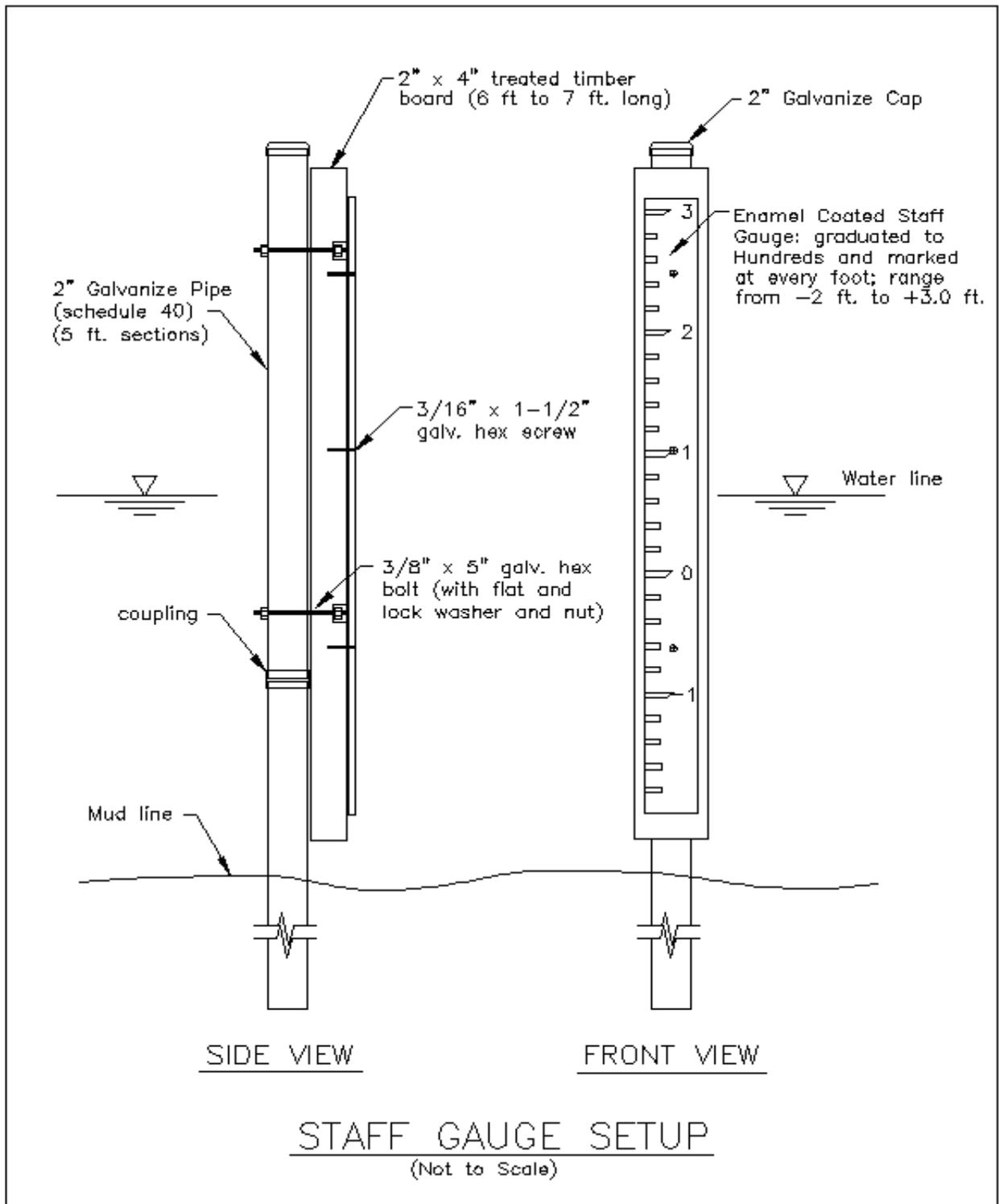


FIGURE 2
STAFF GAUGE SETUP
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

Attachment 1C
Individual Station Location Figures

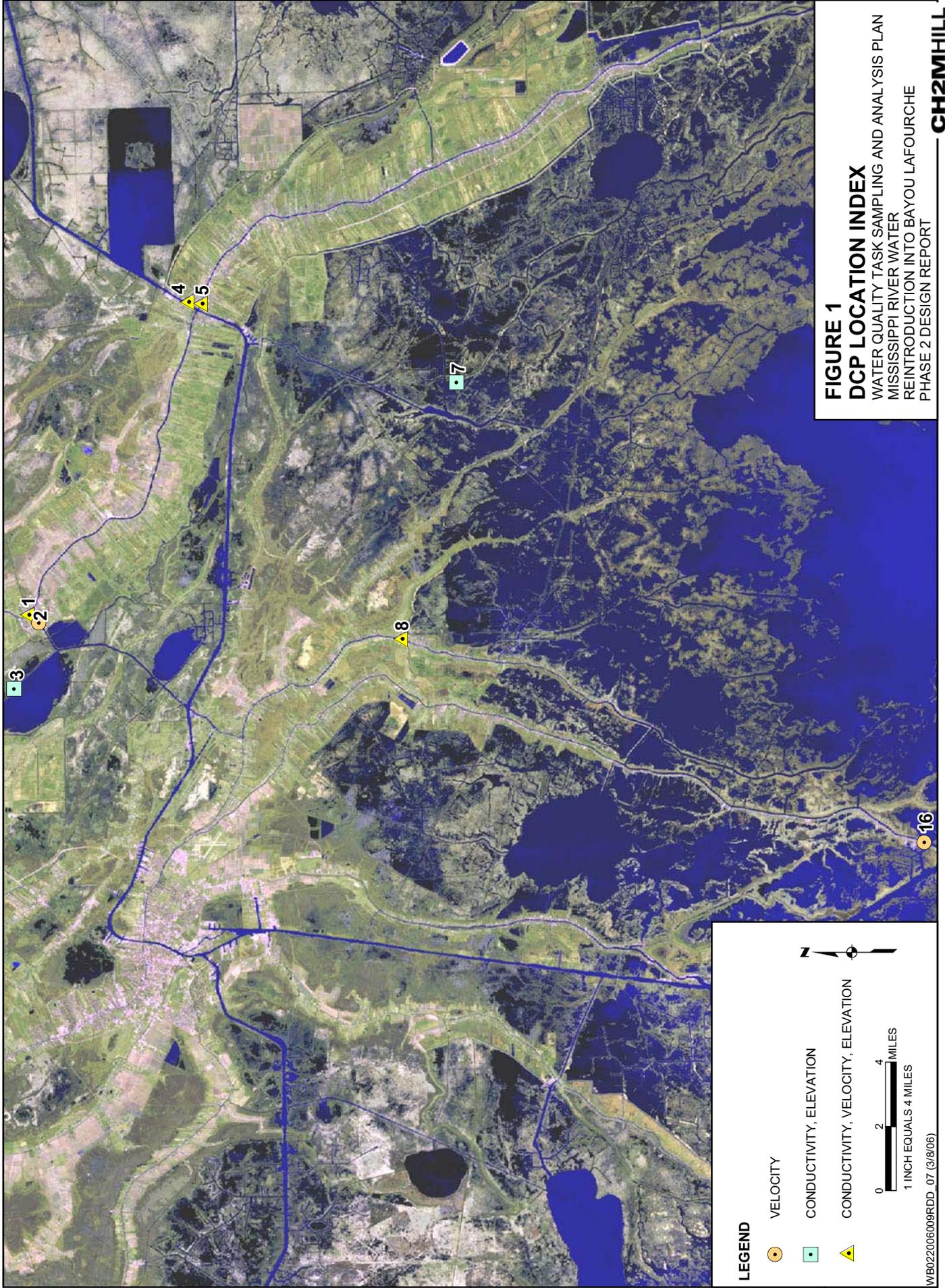


FIGURE 1
DCP LOCATION INDEX
 WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



▲ STATION 1

● STATION 2

LEGEND

● VELOCITY

▲ CONDUCTIVITY, VELOCITY, ELEVATION

STATION 1 - BAYOU LAFOURCHE UPSTREAM OF COMPANY CANAL

STATION 2 - COMPANY CANAL AT HWY 1 BRIDGE

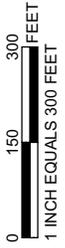
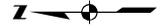


FIGURE 2

STATION 1 AND STATION 2

WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT



FIGURE 3
STATION 3
 WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

LEGEND

- CONDUCTIVITY, ELEVATION

STATION 3 - LAKE FIELDS

0 150 300
FEET

1 INCH EQUALS 300 FEET

WB02200609RDD_09 (3/8/06)



FIGURE 4
STATION 4 AND STATION 5
 WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

LEGEND

-  CONDUCTIVITY, VELOCITY, ELEVATION
- STATION 4 - GIWW EAST OF BAYOU LAFOURCHE
- STATION 5 - BAYOU LAFOURCHE DOWNSTREAM OF GIWW

0 200 400 FEET
 1 INCH EQUALS 400 FEET





LEGEND

- CONDUCTIVITY, ELEVATION

STATION 7 - GRAND BAYOU MARSH IN POINT AU
CHEINE WMA

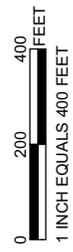


FIGURE 5
STATION 7
WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
MISSISSIPPI RIVER WATER
REINTRODUCTION INTO BAYOU LAFOURCHE
PHASE 2 DESIGN REPORT



LEGEND

 CONDUCTIVITY, VELOCITY, ELEVATION

STATION 8 - BAYOU TERREBONNE AT MONTEGUT, LA

0 200 400
FEET
1 INCH EQUALS 400 FEET



FIGURE 6

STATION 8

WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
MISSISSIPPI RIVER WATER
REINTRODUCTION INTO BAYOU LAFOURCHE
PHASE 2 DESIGN REPORT



FIGURE 7
STATION 16
 WATER QUALITY TASK SAMPLING AND ANALYSIS PLAN
 MISSISSIPPI RIVER WATER
 REINTRODUCTION INTO BAYOU LAFOURCHE
 PHASE 2 DESIGN REPORT

LEGEND

- VELOCITY

STATION 16 - BAYOU PETITE CAILLOU AT
 COCODRIE, LA

0 200 400 FEET
 1 INCH EQUALS 400 FEET

N

WB022006009RDD_13 (3/8/06)

Attachment 2
Field Deployment of Continuous Water
Quality Instruments

Task 4.2 Field Deployment of Continuous Water Quality Instruments

PREPARED FOR: Chris Arts
PREPARED BY: Jason Kase
DATE: February 22, 2004

Objective

The purpose of the water quality monitoring task of the Bayou Lafourche Freshwater Diversion study is to collect data in support of hydrodynamic modeling. Parameters to be monitored will include surface water elevation, salinity, velocity and discharge. Six multi-parameter monitoring sondes (CTD) were installed for the monitoring of temperature, surface water elevation, and specific conductivity from which salinity is derived. Six acoustic Doppler current profilers (ADCP) were installed for the monitoring of velocity. Data will be acquired from these devices for a period of nine months and will then be used to calibrate and verify the performance of the hydrodynamic model. These tasks are part of the larger project objective which is to evaluate the feasibility of alternatives to reintroduce water from the Mississippi River back into Bayou Lafourche.

Work Performed

General Description

The CH2M HILL field team mobilized to Houma, LA on February 10, 2004. Site installation was initiated on February 11, 2004. A total of Six ADCPs and six CTDs were installed. Four ADCPs and four CTDs were installed in conjunction with each other while the remaining two ADCPs and two CTDs were installed separately or in conjunction with existing equipment maintained by LUMCON or USGS. Installation was concluded on February 19, 2004, with demobilization the same day.

Station 1

Establishment of Station 1 consisted of the installation of a CTD, an ADCP, and a staff gauge platform. Construction of the Station 1 data collection platform (DCP) was initiated on February 19, 2004 and completed on the same day. This station is located on east side of Bayou Lafourche above Company Canal in Lockport, LA. The DCP was established on the seawall of Thoma-sea boatyard via timber piling. The DCP was constructed by attaching a fabricated 4"X6" timber vertically to a bulkhead piling. Then the ADCP deployment pole (a 1.9" OD galvanized pipe) was attached to the fabricated 4"X6" via two swivel clamps. The CTD stilling well (a 2" PVC pipe attached to a treated 2"x4" timber) was then mounted to the side of the fabricated 4"X6" timber. See Photograph 1 in Attachment 2A for the completed DCP.

A SonTek Argonaut SL 500kHz Acoustic Doppler Current Profiler (ADCP, Serial No. C585) was installed on the DCP on February 19, 2004. Continuous ADCP data collection was initiated at 14:25 on February 19, 2004. The ADCP was installed at depth of approximately 3 ft. below the water surface and the beam path of the instrument oriented perpendicular to the observed flow. The instrument was deployed in the “down” position; positive velocities indicate flow in the southeast direction. The heading, pitch, and roll were considered within acceptable limits. Using the diagnostic instrument software, the effective instrument measurement parameters were determined. Based on the results, the cell begin and cell end were set at 2 m and 12¹ m, respectively. A diagnostic profile graph for the instrument is provided in the Attachment 2B. The multicell option was enabled and included 5 measurement cells, each with a window of 2 m and a blanking distance of 2 m. The averaging interval was set at 300s with a sample collected every 900s. The instrument cable and power source (Powersonic 12V, 28Ah gel cell) were placed inside the weatherproof housing. All measurement parameters for the deployment are summarized in Table 1.

A YSI 600LS datasonde (CTD, Serial No. 03M0432AE) was installed on the DCP on February 19, 2004. Continuous data collection was initiated at 14:13 on February 19, 2004. The CTD was installed at a depth of approximately 2.65 ft. below the water surface. Prior to deployment of the CTD the instrument was calibrated using a conductivity standard of 1,000 $\mu\text{S}/\text{cm}$. In addition, site readings were taken with a field calibration instrument (YSI 600XLM, S/N 00L0192AA) and the deployment instrument immediately prior to deployment. Results are summarized in Table 2. The instrument was configured to collect discrete measurements of specific conductivity, temperature, and depth every 900 s.

Specific measurements were taken prior to deployment to determine the mark to sensor distance of the instrument and subsequent surface water elevation measurements. These measurements are provided in Table 2. The “mark” is a line notched into the PVC and painted with fluorescent orange survey paint. Sufficient documentation (descriptive, diagrammatic, and visual) was collected to allow subsequent elevational measurements of the survey mark of the CTD deployment were collected.

A staff gauge platform along with survey mark on piling was installed adjacent to the CTD unit to allow field checks of the CTD deployment depth measurements. The staff gauge platform was mounted via lag screws and nails to an adjacent piling.

Station 2

Surface water elevation and salinity will be provided by existing USGS equipment. Therefore, Station 2 establishment consisted of the installation of an ADCP only. Construction of Station 2 DCP was initiated on February 12, 2004 and completed on the same day. This station is located in Lockport, LA on the Highway 1 Bridge crossing Company Canal. The DCP was established on the fender of the Highway 1 Bridge on the upstream, north side of Company Canal. The DCP was constructed by tightly enclosing a single timber of the bridge fender with four pieces of 1.9” OD galvanized pipe with treaded rod and four right angle scaffolding clamps. The horizontal pieces of the enclosures extending away from the fender on the in-stream side such that the ADCP deployment pole could be attached.

¹ Cell end needs to be checked at the next site visit.

A SonTek Argonaut SL 500kHz Acoustic Doppler Current Profiler (ADCP, Serial No. C586) was installed on the DCP on February 12, 2004. Continuous ADCP data collection was initiated at 13:20 on February 12, 2004. The ADCP was installed at depth of approximately 1.5 ft. below the water surface and the beam path of the instrument oriented perpendicular to the observed flow. The instrument was deployed in the “down” position; positive velocities indicate flow in the northeast direction. The heading, pitch, and roll were considered within acceptable limits. Using the diagnostic instrument software, the effective instrument measurement parameters were determined. Based on the results, the cell begin and cell end were set at 2 m and 40 m, respectively. A diagnostic profile graph for the instrument is provided in the Attachment 2B. The multicell option was enabled and included 5 measurement cells, each with a window of 7.7 m and a blanking distance of 2 m. The averaging interval was set at 300s with a sample collected every 900s. The instrument cable and power source (Powersonic 12V, 28Ah gel cell battery) were placed inside the weatherproof housing. All measurement parameters for the deployment are summarized in Table 1.

Station 3

Station 3 establishment consisted of the installation a CTD and staff gauge platform only. Construction of Station 3 DCP was initiated on February 16, 2004 and completed on the same day. This station is located on the center of the northeast bank of Lake Fields. The DCP was established by driving a 21' galvanized pipe nine ft below the mud line approximately nine feet out from an existing seawall approximately 6.5 ft deep. A 2"X6" timber was then mounted onto the galvanized pipe and the CTD stilling well, was then attached to the 2"X6" timber. See Photograph 2 in Attachment 2A for the completed DCP.

A YSI 600LS datasonde (CTD, Serial No. 03M0432AB) was installed on the DCP on February 16, 2004. Continuous data collection was initiated at 17:40 on February 16, 2004. The CTD was installed at a depth of approximately 1.25 ft. below the water surface. Prior to deployment of the CTD the instrument was calibrated using a conductivity standard of 1,000 $\mu\text{S}/\text{cm}$. In addition, site readings were taken with a field calibration instrument (YSI 600XLM, S/N 00L0192AA) and the deployment instrument immediately prior to deployment. Results are summarized in Table 2. The instrument was configured to collect discrete measurements of specific conductivity, temperature, and depth every 900 s.

Specific measurements were taken prior to deployment to determine the mark to sensor distance of the instrument and subsequent surface water elevation measurements. These measurements are provided in Table 2. The “mark” is the top of the PVC well lock plate and is not painted. Sufficient documentation (descriptive, diagrammatic, and visual) was collected to allow subsequent elevational measurements of the survey mark of the CTD deployment were collected.

A survey mark was installed adjacent to the CTD unit to allow field checks of the CTD deployment depth measurements. The survey mark, a 60d nail painted with orange survey paint, was installed on a bulkhead piling at the nearest point to shore from the instrument.

Station 4

Station 4 establishment consisted of the installation of a CTD, an ADCP, and a staff gauge platform. Construction of Station 4 ADCP was initiated on February 15, 2004 and completed on the same day. This station is located in Larose, LA under Hwy 308 Bridge on the south

side of the GIWW. The ADCP was established on the south retaining wall of the GIWW directly under the bridge. The ADCP mounting is constructed of four pieces of 1.9" OD galvanized pipe secured to the concrete top of the retaining wall with shielded lag bolts and four right angle scaffolding clamps. The horizontal pieces of the enclosures extending away from the wall into the GIWW such that the ADCP deployment pole could be attached. See Photograph 3 in Attachment 2A for completed DCP.

A SonTek Argonaut SL 500kHz Acoustic Doppler Current Profiler (ADCP, Serial No. C590) was installed on the DCP on February 15, 2004. Continuous ADCP data collection was initiated at 13:45 on February 15, 2004. The ADCP was installed at depth of approximately 4.5 ft below the water surface and the beam path of the instrument oriented perpendicular to the observed flow. The instrument was deployed in the "up" position; positive velocities indicate flow in the northeast direction. The heading, pitch, and roll were considered within acceptable limits. Using the diagnostic instrument software, the effective instrument measurement parameters were determined. Based on the results, the cell begin and cell end were set at 2 m and 70 m, respectively. A diagnostic profile graph for the instrument is provided in the Attachment 2B. The multicell option was enabled and included 5 measurement cells, each with a window of 13.6 m and a blanking distance of 2 m. The averaging interval was set at 300s with a sample collected every 900s. The instrument cable and power source (Powersonic 12V, 28Ah gel cell battery) were placed inside the weatherproof housing. All measurement parameters for the deployment are summarized in Table 1.

A YSI 600LS datasonde (CTD, Serial No. 03M0432AC) was installed on the DCP on February 15, 2004. Continuous data collection was initiated at 14:20 on February 15, 2004. The CTD was installed at a depth of approximately 1.7' below the water surface. Prior to deployment of the CTD the instrument was calibrated using a conductivity standard of 1,000 $\mu\text{S}/\text{cm}$. In addition, site readings were taken with a field calibration instrument (YSI 600XLM, S/N 00L0192AA) and the deployment instrument immediately prior to deployment. Results are summarized in Table 2. The instrument was configured to collect discrete measurements of specific conductivity, temperature, and depth every 900 s.

Specific measurements were taken prior to deployment to determine the mark to sensor distance of the instrument and subsequent surface water elevation measurements. These measurements are provided in Table 2. The "mark" was is a line notched into the aluminum well and painted with fluorescent orange survey paint. Sufficient documentation (descriptive, diagrammatic, and visual) was collected to allow subsequent elevational measurements of the survey mark of the CTD deployment.

A survey mark was installed adjacent to the CTD unit to allow field checks of the CTD deployment depth measurements. The survey mark is a piece of 1.9" OD galvanized pipe attached to the top of the retaining wall with shielded lag bolts. The survey point is painted with fluorescent orange paint.

Station 5

Station 5 establishment consisted of the installation of a CTD, an ADCP, and a staff gauge platform. Construction of Station 5 DCP was initiated on February 12, 2004 and completed on the same day. The station is located in Larose, LA on the northeast side of Bayou Lafourche. The DCP was established on the northeast, downstream fender of the floodgate

on Bayou Lafourche. The DCP was constructed by tightly enclosing a single timber of the floodgate fender with four pieces of 1.9" OD galvanized pipe with treaded rod and four right angle scaffolding clamps. The horizontal pieces of the enclosures extending away from the fender on the in-stream side such that the ADCP deployment pole could be attached. The CTD stilling well was lag screwed to the fender adjacent to the ADCP. See Photograph 5 in Attachment 2A for completed DCP.

A SonTek Argonaut SL 500kHz Acoustic Doppler Current Profiler (ADCP, Serial No. C582) was installed on the DCP on February 12, 2004. Continuous ADCP data collection was initiated at 15:15 on February 15, 2004. The ADCP was installed at depth of approximately 2.5 ft. below the water surface and the beam path of the instrument oriented perpendicular to the observed flow. The instrument was deployed in the "down" position; positive velocities indicate flow in the southeast direction. The heading, pitch, and roll were considered within acceptable limits. Using the diagnostic instrument software, the effective instrument measurement parameters were determined. Based on the results, the cell begin and cell end were set at 2 m and 18 m, respectively. A diagnostic profile graph for the instrument is provided in the Attachment 2B. The multicell option was enabled and included 5 measurement cells, each with a window of 3.2 m and a blanking distance of 2 m. The averaging interval was set at 300s with a sample collected every 900s. The instrument cable and power source (Powersonic 12V, 28Ah gel cell battery) were placed inside the weatherproof housing. All measurement parameters for the deployment are summarized in Table 1.

A YSI 600LS datasonde (CTD, Serial No. 03M0432AD) was installed on the DCP on February 12, 2004. Continuous data collection was initiated at 18:00 on February 12, 2004. The CTD was installed at a depth of approximately 3.5 ft. below the water surface. Prior to deployment of the CTD the instrument was calibrated using a conductivity standard of 1,000 $\mu\text{S}/\text{cm}$. In addition, site readings were taken with a field calibration instrument (YSI 600XLM, S/N 00L0192AA) and the deployment instrument immediately prior to deployment. Results are summarized in Table 2. The instrument was configured to collect discrete measurements of specific conductivity, temperature, and depth every 900 s.

Specific measurements were taken prior to deployment to determine the mark to sensor distance of the instrument and subsequent surface water elevation measurements. These measurements are provided in Table 2. The "mark" is a 60d nail installed in the 2" x 4" timber that the CTD well is mounted on, the nail is painted with fluorescent orange survey paint. Sufficient documentation (descriptive, diagrammatic, and visual) was collected to allow subsequent elevational measurements of the survey mark of the CTD deployment.

A staff gauge platform was installed adjacent to the CTD unit to allow field checks of the CTD deployment depth measurements. The staff gauge platform was installed by lag screwing a counter sunk, treated 2X4 to the bridge fender adjacent to the CTD.

Station 7

Station 7 completion consisted of the installation a CTD and a staff gauge platform only. Installation of Station 7 CTD was initiated on February 16, 2004 and completed on the same day. The station is located in Grand Bayou Marsh approximately 3 miles northeast of Pointe Au Chein, LA. The CTD was established on the existing platform pilings owned by and with the permission of the USGS. The CTD installation is a 2" PVC well bolted to two

horizontal 2x4 cross-timbers (between 2 pilings) on the side of the platform. See Photograph 1 in Attachment 2A for completed DCP. See Photograph 5 in Attachment 2A for completed DCP.

A YSI 600LS datasonde (CTD, Serial No. 03M0432AA) was installed on the DCP on February 16, 2004. Continuous data collection was initiated at 16:20 on February 16, 2004. The CTD was installed at a depth of approximately 0.5 ft below the water surface. Prior to deployment of the CTD the instrument was calibrated using a conductivity standard of 1,000 $\mu\text{S}/\text{cm}$. In addition, site readings were taken with a field calibration (YSI 600XLM, S/N 00L0192AA) and the deployment instrument immediately prior to deployment. Results are summarized in Table 2. The instrument was configured to collect discrete measurements of specific conductivity, temperature, and depth every 900 s.

Specific measurements were taken prior to deployment to determine the mark to sensor distance of the instrument and subsequent surface water elevation measurements. These measurements are provided in Table 2. The "mark" is a 60d nail installed in the 2" x4" timber the well is mounted to. Sufficient documentation (descriptive, diagrammatic, and visual) was collected to allow subsequent elevational measurements of the survey mark of the CTD deployment.

A survey mark was installed adjacent to the CTD unit to allow field checks of the CTD deployment depth measurements. The survey mark is a 60d nail installed in the platform piling, the nail is painted with fluorescent orange survey paint.

Station 8

Station 8 establishment consisted of the installation of a CTD, an ADCP, and a staff gauge. Construction of Station 8 DCP was initiated on February 11, 2004 and completed on February 13, 2004. The station is located in Montegut, LA, on Bayou Terrebonne. The ADCP was established on the fender of the LA 58 Bridge on the upstream, east side of Bayou Terrebonne. The DCP was constructed by tightly enclosing a single timber of the bridge fender with four pieces of 1.9" OD galvanized pipe with treaded rod and four right angle scaffolding clamps. The horizontal pieces of the enclosures extending away from the fender on the in-stream side such that the ADCP deployment pole could be attached. An additional piece of galvanized pipe and right angle scaffolding clamp was bolted to a piling for additional stability. See Photograph 6 and Photograph 7 in Attachment 2A for completed DCP.

A SonTek Argonaut SL 500kHz Acoustic Doppler Current Profiler (ADCP, Serial No. C587) was installed on the DCP on February 13, 2004. Continuous ADCP data collection was initiated at 11:55 on February 13, 2004. The ADCP was installed at depth of approximately 1.5 ft below the water surface and the beam path of the instrument oriented perpendicular to the observed flow. The instrument was deployed in the "down" position; positive velocities indicate flow in the southeast direction. The heading, pitch, and roll were considered within acceptable limits. Using the diagnostic instrument software, the effective instrument measurement parameters were determined. Based on the results, the cell begin and cell end were set at 2 m and 14 m, respectively. A diagnostic profile graph for the instrument is provided in the Attachment 2B. The multicell option was enabled and included 5 measurement cells, each with a window of 2.4 m and a blanking distance of 2 m. The averaging interval was set at 300s with a sample collected every 900s. The instrument

cable and power source (Powersonic 12V, 28Ah gel cell battery) were placed inside the weatherproof housing. All measurement parameters for the deployment are summarized in Table 1.

A YSI 600LS datasonde (CTD, Serial No. 03M0432AB) was installed on the DCP on February 11, 2004. Continuous data collection was initiated at 12:07 on February 13, 2004. The CTD was installed at a depth of approximately 1.3 ft below the water surface. Prior to deployment of the CTD the instrument was calibrated using a conductivity standard of 1,000 $\mu\text{S}/\text{cm}$. In addition, site readings were taken with a field calibration instrument (YSI 600XLM, S/N 00L0192AA) and the deployment instrument immediately prior to deployment. Results are summarized in Table 2. The instrument was configured to collect discrete measurements of specific conductivity, temperature, and depth every 900 s.

Specific measurements were taken prior to deployment to determine the mark to sensor distance of the instrument and subsequent surface water elevation measurements. These measurements are provided in Table 2. The "mark" is a 60d nail installed in the 2" x 4" timber that the CTD well is mounted on, the nail is painted with fluorescent orange survey paint. Sufficient documentation (descriptive, diagrammatic, and visual) was collected to allow subsequent elevational measurements of the survey mark of the CTD deployment.

A staff gauge platform was installed adjacent to the CTD unit to allow field checks of the CTD deployment depth measurements. The staff gauge platform was mounted by lag screwing a counter sunk, treated 2" X 4" on an adjacent piling.

Station 16

Surface water elevation and salinity will be provided by existing LUMCON equipment in the Cocodrie area. Therefore, Station 16 completion consisted of the installation of an ADCP only. Construction of Station 16 DCP was initiated on February 17, 2004 and completed on the same day. The station is located on the west side of the Bayou Petite Caillou in Cocodrie, LA. The DCP was established by attaching two level pieces of 1.9" OD galvanized pipe approximately 1 ft apart between two piling at the end of a dock via lag screws. This ADCP deployment pole was then attached to those cross pieces via right angle scaffolding clamps. See Photograph 8 in Attachment 2A for completed DCP.

A SonTek Argonaut SL 500kHz Acoustic Doppler Current Profiler (ADCP, Serial No. C581) was installed on the DCP on February 17, 2004. Continuous ADCP data collection was initiated at 15:50 on February 17, 2004. The ADCP was installed at depth of approximately 1.5 ft. below the water surface and the beam path of the instrument oriented perpendicular to the observed flow. The instrument was deployed in the "up" position; positive velocities indicate flow in the south direction. The heading, pitch, and roll were considered within acceptable limits. Using the diagnostic instrument software, the effective instrument measurement parameters were determined. Based on the results, the cell begin and cell end were set at 2 m and 20 m, respectively. A diagnostic profile graph for the instrument is provided in the Attachment 2B. The multicell option was enabled and included 5 measurement cells, each with a window of 3.6 m and a blanking distance of 2 m. The averaging interval was set at 300s with a sample collected every 900s. The instrument cable and power source (Powersonic 12V, 28Ah gel cell battery) were placed inside the weatherproof housing. All measurement parameters for the deployment are summarized in Table 1.

TABLE 1
ADCP Field Notes

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 7	Station 8	Station 16
Location	Lockport Thoma-sea	Lockport Hwy 1	Lake Fields	Larose under Hwy 308	Larose on BLF	Pointe Au Chain	Montegut	Cocodrie
Serial #	C585	C586	N/A	C590	C582	N/A	C587	C581
Installation Date	02/19/2004	02/12/2004	N/A	02/15/2004	02/13/2004	N/A	02/13/2004	02/17/2004
Deployment Date	02/19/2004	02/12/2004	N/A	02/15/2004	02/15/2004	N/A	02/13/2004	02/17/2004
Heading	96	259.8	N/A	273.2	*	N/A	96.9	110.2
Pitch	0	0.2	N/A	0	*	N/A	0.5	0.2
Roll	-1.2	0.1	N/A	0.5	*	N/A	0	0.8
Orientation (plug)	down	down	N/A	up	down	N/A	down	up
Cell Begin (m)	2	2	N/A	2	2	N/A	2	2
Cell End (m)	12	40	N/A	70	18	N/A	14	20
Averaging Interval (s)	300	300	N/A	300	300	N/A	300	300
Sampling Interval (s)	900	900	N/A	900	900	N/A	900	900
Water Depth (ft)	6	6	N/A	9	5	N/A	3	3

*Denote lost or unrecorded data that will be recorded at the next site visit.

Note:

NA = Not applicable

TABLE 2
CTD Field Notes

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 7	Station 8	Station 16
Location	Lockport Thoma-sea	Lockport Hwy 1	Lake Fields	Larose under Hwy 308	Larose on BLF	Pointe Au Chein	Montegut	Cocodrie
Serial #	03M0432AE	N/A	03M0378AA	03M0432AC	03M0432AD	03M0432AB	03M0432AA	N/A
Installation Date	02/19/2004	N/A	02/16/2004	02/15/2004	02/12/2004	02/16/2004	02/11/2004	N/A
Measurement Date	02/19/2004	N/A	02/16/2004	02/15/2004	02/12/2004	02/16/2004	02/13/2004	N/A
Cal. specific conductivity (mS)	0.258	N/A	0.232	0.316	*	8.034	0.348	N/A
Dplyd specific conductivity (mS)	0.258	N/A	0.224	0.314	0.3	7.808	0.347	N/A
Percent difference	0.00	N/A	3.45	0.63	**	2.81	0.29	N/A
Calibrated Temp (C)	12.99	N/A	14.46	11.35	*	12.83	12.64	N/A
Deployed Temp (C)	13.65	N/A	14.75	11.96	13.5	14.02	13.24	N/A
Percent difference	-5.08	N/A	-2.01	-5.37	**	-9.28	-4.75	N/A
Calibrated Salinity (ppt)	0.12	N/A	0.11	*	*	4.48	*	N/A
Deployed Salinity (ppt)	0.12	N/A	0.11	0.15	0.14	4.35	0.17	N/A
Percent difference	0.00	N/A	0.00	**	**	2.90	**	N/A
Sample interval (min.)	15	N/A	15	15	15	15	15	N/A
Mark-to-sensor distance (ft.)	5.417	N/A	6.395	6.177	6.125	5.166	6.846	N/A

*Lost or unrecorded data that will be recorded at the next site visit.

**Calculations that can not be completed due to lost or unrecorded data.

Note:

NA = Not applicable



**PHOTOGRAPH 1
COMPLETE INSTALLATION OF CDP WITH ADCP AND CTD DEPLOYED ALONG
WITH INSTALLED STAFF GAUGE FOR STATION 1**



**PHOTOGRAPH 2
COMPLETION OF STATION 3 WITH DCP AND DEPLOYED CTD TO THE RIGHT AND
STAFF GAUGE TO THE LEFT ON BULKHEAD PILING**



**PHOTOGRAPH 3
COMPLETION OF STATION 4 WITH ADCP AND CTD DEPLOYED**



**PHOTOGRAPH 4
COMPLETION OF STATION 5 WITH ADCP AND CTD DEPLOYED AND STAFF GAUGE INSTALLED**



PHOTOGRAPH 5
COMPLETION OF CDP FOR STATION 7 WITH CTD DEPLOYED
Note: Staff gauge is the survey mark on the piling to the left.



**PHOTOGRAPH 6
COMPLETION OF CDP FOR THE ADCP FOR STATION 8 WITH
ADCP DEPLOYED**



**PHOTOGRAPH 7
COMPLETION OF CDP FOR THE CTD FOR STATION 8 WITH CTD
DEPLOYED AND STAFF GAUGE MOUNTING INSTALLED**



**PHOTOGRAPH 8
COMPLETION OF DCP FOR STATION 16 WITH ADCP DEPLOYED**

Attachment 2B
ADCP Diagnostic Diagrams

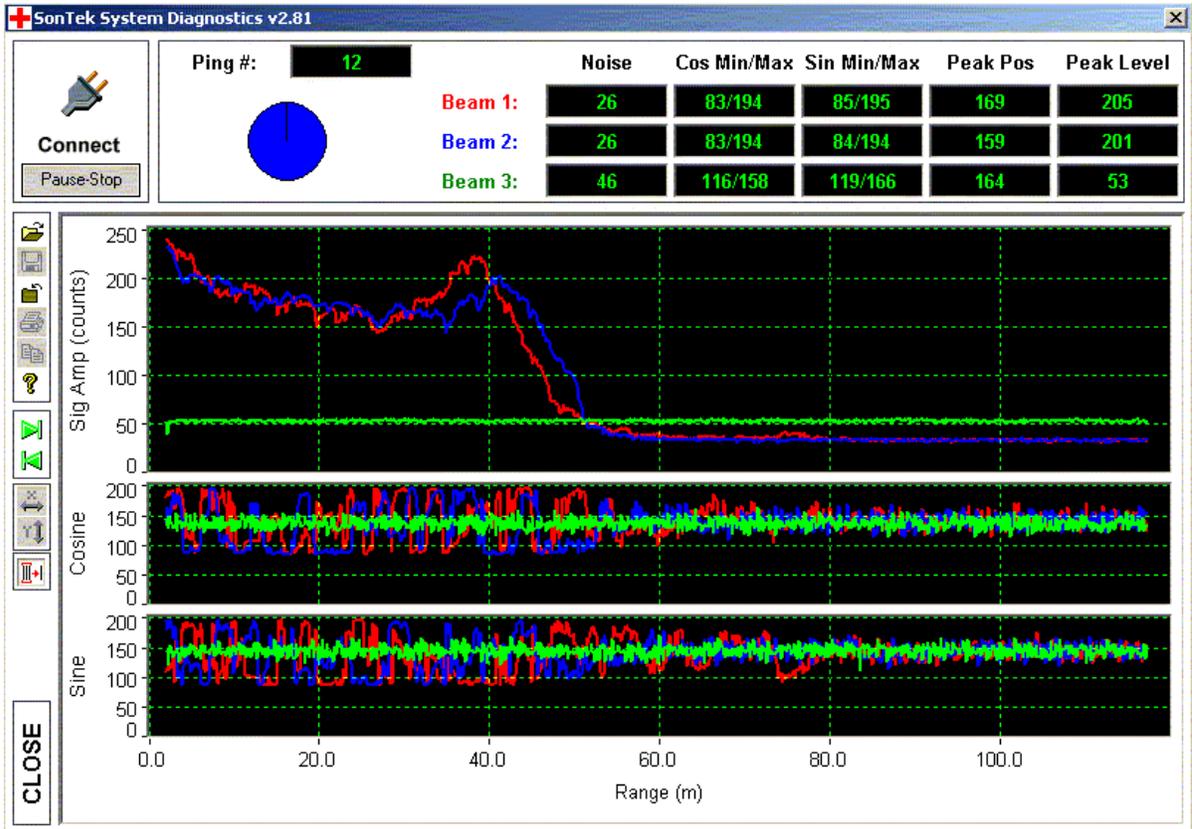


DIAGRAM 1
DIAGNOSTIC DIAGRAM FROM VIEWARGONAUT AVERAGED OVER 12 PINGS FOR STATION 1

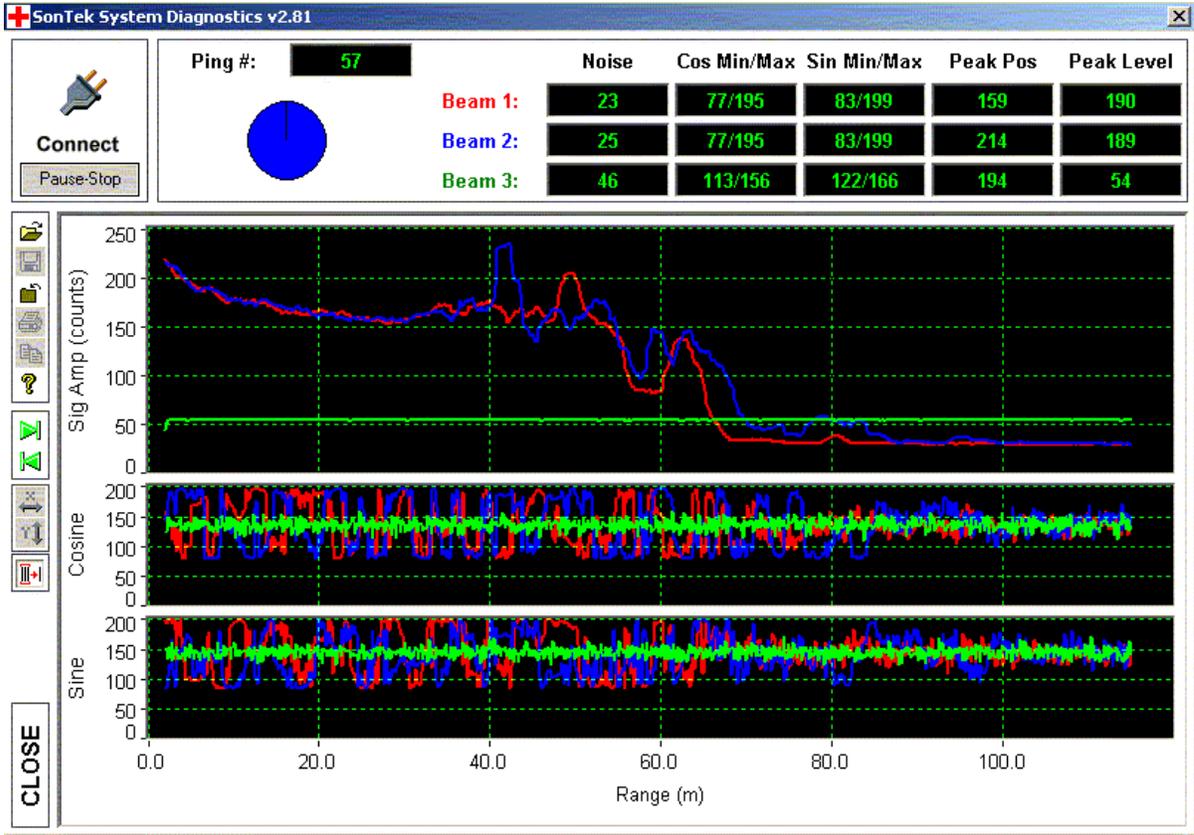


DIAGRAM 2
DIAGNOSTIC DIAGRAM FROM VIEWARGONAUT AVERAGED OVER 57 PINGS FOR STATION 2

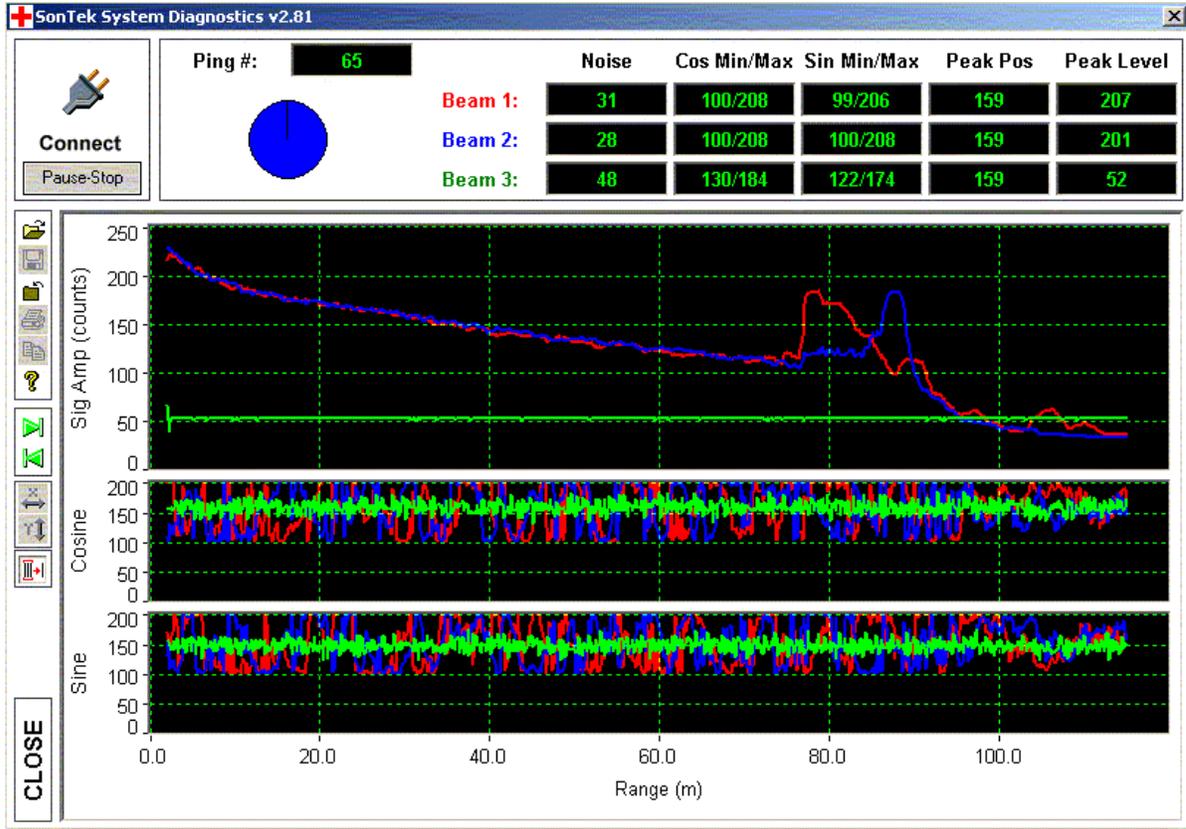


DIAGRAM 3
DIAGNOSTIC DIAGRAM FROM VIEWARGONAUT AVERAGED OVER 65 PINGS FOR STATION 4

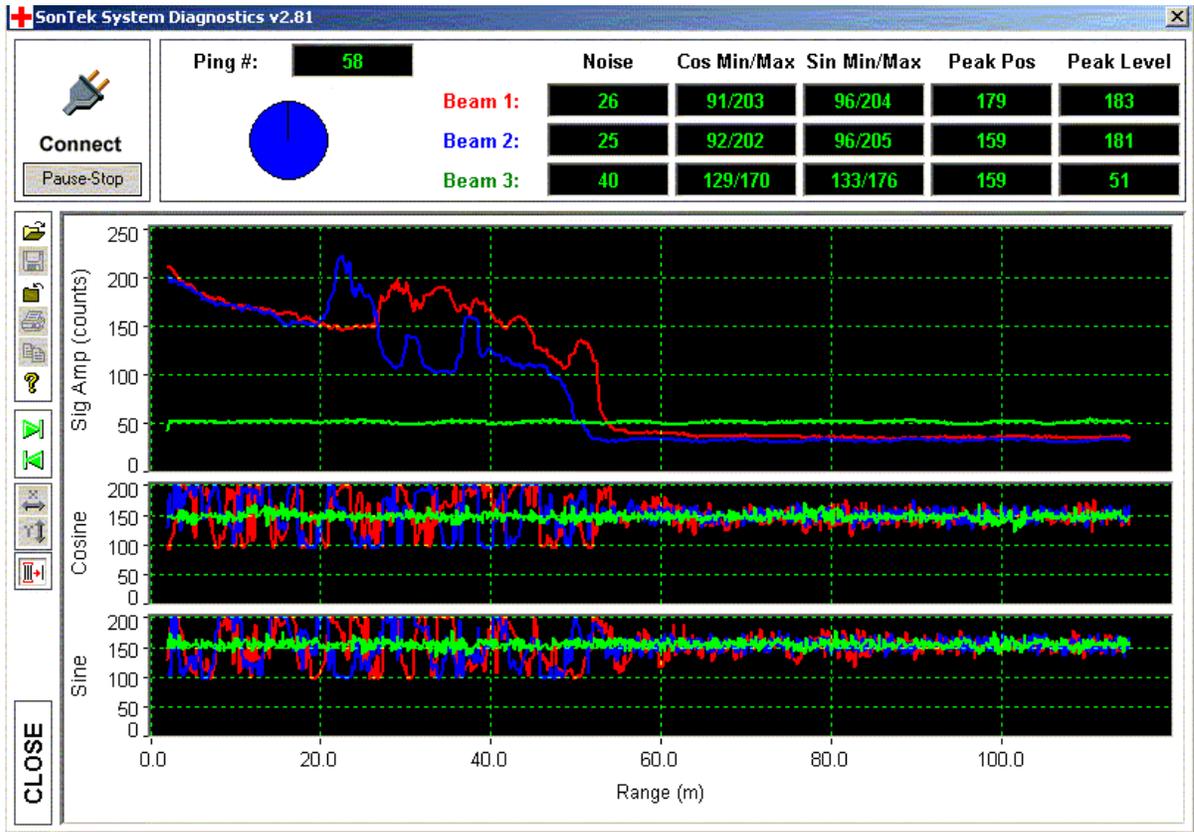


DIAGRAM 4
DIAGNOSTIC DIAGRAM FROM VIEWARGONAUT AVERAGED OVER 58 PINGS FOR STATION 5

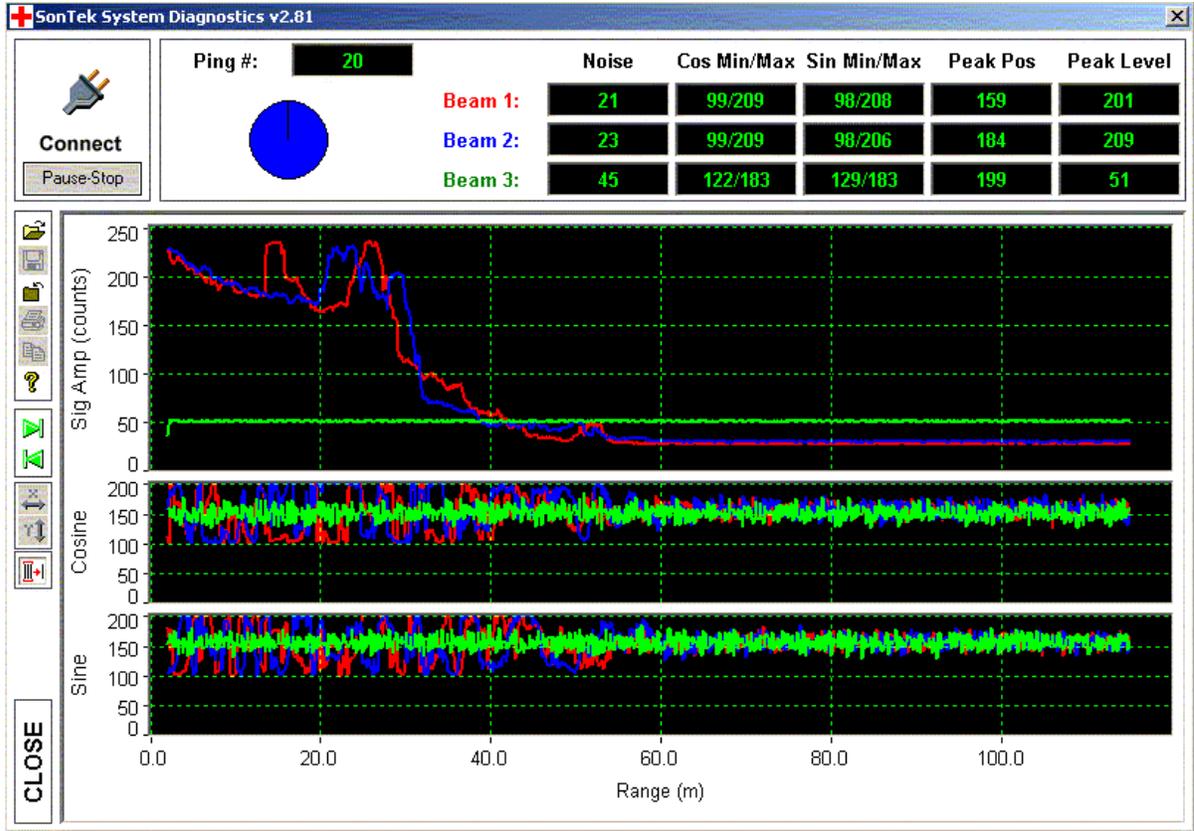


DIAGRAM 5
DIAGNOSTIC DIAGRAM FROM VIEWARGONAUT AVERAGED OVER 20 PINGS FOR STATION 8

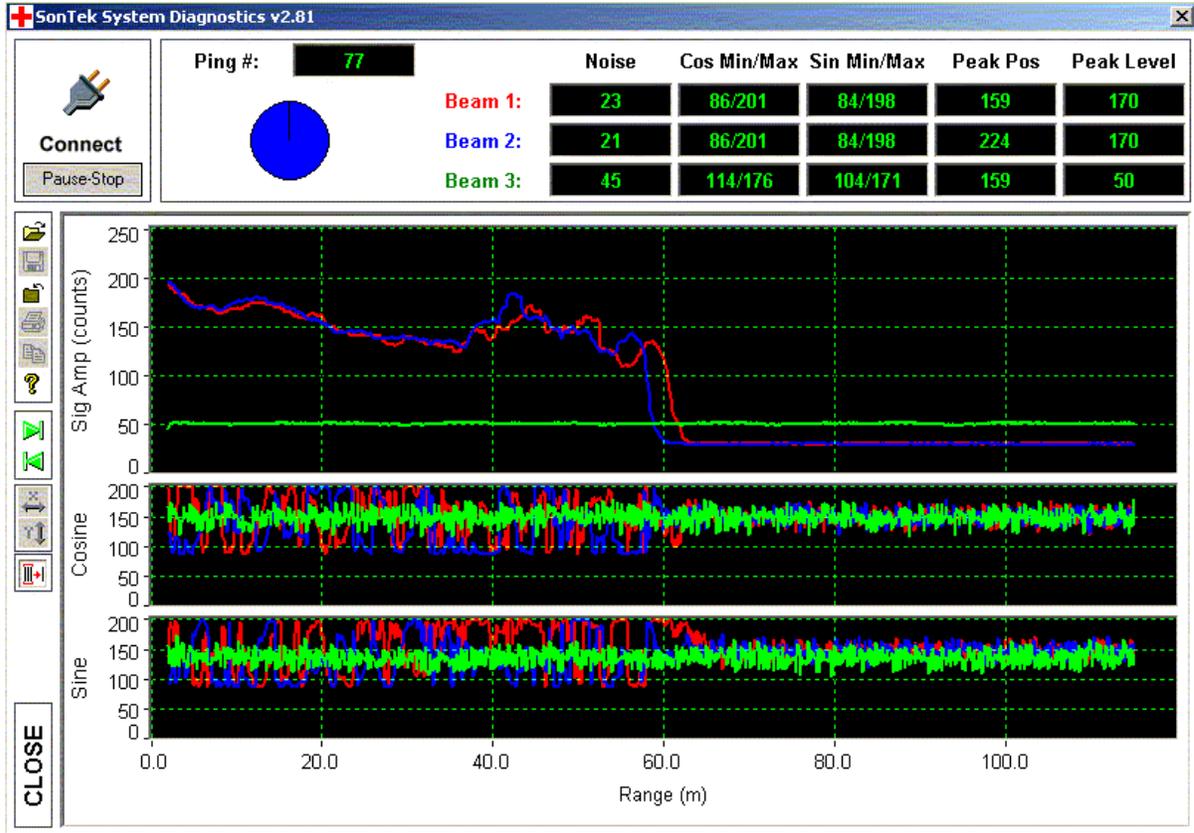


DIAGRAM 6
DIAGNOSTIC DIAGRAM FROM VIEWARGONAUT AVERAGED 77 PINGS FOR STATION 16

Attachment 2C
Field Event Forms, Station Logs and Field Notes

Bayou Lafourche Water Quality Study

Station Log

Date (MM-DD-YY)	Arrival Time (CST HH:MM)	Station
2/12/04	0900 1400	5
Technicians	Company/Agency	Location
J. Kase	CH2M HILL	Larose
N. Monroe	"	
R. Bitchly	"	
M. Johnston	"	

Keren Labbe / SonTek
Jonathan West / LDNR

Observations/Surrounding Conditions

Calm waters, low water, depth ~~at~~ ^{at} ADCP location, cold, windy.
5'

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Gauge: ~~Not~~ To be installed (mounting)
17m

CTD: Initial Readings: Temp: 13.5°C, SpCond 0.3 m/S, Sal. 0.14
Installed Depth: 3.354', V=5.7 File: 05040212
Time: 5:17:21

ADCP: To be installed

Battery/cable enclosure: To be installed

Maintenance Performed/Modifications

Staff Gauge: Not installed yet.

CTD: YSI 600LS SN: 03M0432 AD Calibrated: 0700
Fluid Lot: 4004 exp: 6-5-04 Initial: 1.149mS Temp: 22.83°C
Calibrated: .999mS. Installed w/cable 03m19

ADCP: Not installed yet

Battery/cable enclosure: Installed, steel, locked.

Photos (#, time, description)

Yes

Departure Time (CST HH:MM)

~~1330~~ 1810

**Bayou Lafourche
Water Quality Study**

Station Log

Date (MM-DD-YY)	Arrival Time (CST HH:MM)
2/12/04	0945

Station #
Lockport STD2

Technicians	Company/Agency
J. Kase	CH2M HILL
R. Bitchy	"
M. Johnston	"
N. Monroe	"

Location
Lockport

Observations/Surrounding Conditions

Temp. Dropped to 45°F. A lot of bridge traffic, water depth is about 6' at ADCP location.

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Gauge: ~~New Installation - mounting board only~~ No Gauge

CTD: No CTD

ADCP: New Installation + start-up Diag. file: STD2-021204

Battery/cable enclosure: New Installation -BAT24 mounted on back of bridge fender, horiza.

Maintenance Performed/Modifications

Staff Gauge: No gauge

CTD: No CTD

ADCP: Deployed plug input is up, flow assumed right
s/n: 6586

Battery/cable enclosure: Installed

Photos (#, time, description)

yes

Departure Time (CST HH:MM)

13:45

**Bayou Lafourche
Water Quality Study**

Station Log

Date (MM-DD-YY) **Arrival Time (CST HH:MM)**
 2/13/04 1020

Station
 8

Technicians	Company/Agency
R. Bitely	CH
N. Monroe	CH
K. Labbe	SonTek

Location
 Klondyke

Observations/Surrounding Conditions

Low tide, breezy, ≈50°F, cloudy, began raining

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Guage: mounting installed
 CTD: mounting installed
 ADCP: mounting installed new deployment
 Battery/cable enclosure: Not installed yet

Maintenance Performed/Modifications

Staff Guage: None
 CTD: Deployed YSI S/N: ~~6587~~^{72m} 03m0432AA
 ADCP: Deployed SonTek S/N: 6587 Flaw assumed left, ADCP plug input down
 Battery/cable enclosure: Installed

Photos (#, time, description)

yes

Departure Time (CST HH:MM)

1350

**Bayou Lafourche
Water Quality Study**

Station Log

Date (MM-DD-YY) Arrival Time (CST HH:MM)

2/15/2004 8:50 10:15

Station

04

Technicians

Company/Agency

J. Kase	CH2M HILL
R. Bately	"
L. Hattier	"
N. Morop	"

Location

under 308 Bridge on GIWW
in La Rose, LA

Observations/Surrounding Conditions

Plenty of barge traffic, good flow

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Guage: New mounting installation

CTD: New reinstallation and deployment

ADCP: New installation and deployment, Flaw is assumed ~~not~~ right
ADCP mounted with cable ~~input~~ up

Battery/cable enclosure: New installation

Maintenance Performed/Modifications

Staff Guage:

CTD: YSI 60065 S/N: 0320432 AC installed.
Calib. Unit Initial Reading s:
Temp: 11.35°C Cond 316µS (µs) Deployed unit readings: Bat.Volt: 6.9
Temp: 11.96 Sp. Cond: 314µS

ADCP: Argoaut 6590 deployed. Pitch: 0.0 Roll: 0.5 Heading: 273.2
BATOS

Battery/cable enclosure:

Photos (#, time, description)

yes

Departure Time (CST HH:MM)

Bayou Lafourche Water Quality Study

Station Log

Date (MM-DD-YY)	Arrival Time (CST HH:MM)	Station
2/13/04		5
Technicians	Company/Agency	Location
N. Monroe	CH2M HILL	La Rose
K. Lebbre	SonTek	R. Bitley CH2M HILL
J. Kase	CH2M HILL	L. Hether "
M. Johnston	"	

Observations/Surrounding Conditions

Rainy, cold, wind ~10mph

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Gauge: Mounting ~~new~~ installation

CTD: Already deployed, good condition

ADCP: New installation ~~operation~~

Battery/cable enclosure: Already installed, good condition

Maintenance Performed/Modifications

Staff Gauge: None

CTD: None

ADCP: New installation, ran diagnostics and real time but had a software error and could not deploy. ADCP S/N: C582

Battery/cable enclosure: Put ADCP Battery, BATO3, in enclosure & cables, closed and locked.

Photos (#, time, description)

yes

Departure Time (CST HH:MM)

~~7:45~~
7:35

**Bayou Lafourche
Water Quality Study**

Station Log

Date (MM-DD-YY)	Arrival Time (CST HH:MM)
2/15/04	1450
Technicians	Company/Agency
N. Monroe	CH2MHILL
R. Bitely	"
L. Hattis	"
J. Kase	"

Station	5
Location	LaRose on BLF

Observations/Surrounding Conditions

a small boat passed
calm waters

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Guage: mounting OK

CTD: OK

ADCP: ~~OK~~ mounted, not recording

Battery/cable enclosure: OK

Maintenance Performed/Modifications

Staff Guage: not installed yet

CTD: None

ADCP: Deployed. Cell begin: 2am Cell end: 18⁰⁰mm
File: ST05001 Bat. Volt: 12 #S: 6582

Battery/cable enclosure: None

Photos (#, time, description)

yes

Departure Time (CST HH:MM)

1520

Bayou Lafourche Water Quality Study

Station Log

Date (MM-DD-YY)	Arrival Time (CST HH:MM)	Station
2/16/04	0955	STM 7
Technicians	Company/Agency	Location
R. Bitely		Point Au. Chene
J. Kase		
L. Hattie		
N. Monroe		

Observations/Surrounding Conditions

Very shallow low tide.

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Guage: I

CTD: 66 inches from top of stop bolt to survey mark
4 inches from bottom to depth pad

ADCP: n/a

Battery/cable enclosure:

Maintenance Performed/Modifications

Staff Guage: Only a nail on the piling, painted, marked

CTD: Calib. Inst. Initial T: 12.88°C
Int. Sp. Cond: 2034 µS
Sal.: 4.48 ppt

ADCP: n/a

Battery/cable enclosure: Installed w/ lag bolts, locked

Deployed Instr. Initial T: 14.02°C
Sp. Cond: 7.808 mS
Salinity: 4.35
Pressure: 0.040
Depth: 0.182
Time: 12:02 PM
Battery: 6.1
File: 08040216

Photos (#, time, description)

yes

Departure Time (CST HH:MM)

1220

**Bayou Lafourche
Water Quality Study**

Station Log

Date (MM-DD-YY)	Arrival Time (CST HH:MM)	Station
2/14/04	3:50 PM	3
Technicians	Company/Agency	Location
R. B. Kelly	CH2M HILL	Lake Fields
J. Kase	"	
N. Morral	"	
L. Hattier	"	

Observations/Surrounding Conditions

Partly Cloudy. Initially warm but cooled. Calm waters. LOW tide.
Ms. Lee & husband and neighbor George were hospitable and nice. They have 2 very small dogs.

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Gauge: *Installing mounting*

CTD: *Installing and deploying*
4 inches from bottom of instrument to depth pad.
80³/₄ inches from top of steep bolt to top of lock plate

ADCP: *N/A*

Battery/cable enclosure: *Fiber glass, installing*

Maintenance Performed/Modifications

Staff Gauge: *Nail inserted in sea wall & painted "marked"*

Calibrating Instr.

CTD: Temp: 14.416	Spec. Cond.: 232 μ S	Depth: -
Salinity: 0.11 ppt	Pressure: -	
Battery: -	File: -	
ADCP: n/a		

Station Instrum.

Temp: 14.75	SpCond: 224 μ S
Salinity: 0.11 ppt	Pressure: 0.536
Battery: 5.9 volts	File: 03040216
Depth: 1.240	

Battery/cable enclosure: *Fiberglass box
Installed on Red with CID & locked*

Photos (#, time, description)

yes

Departure Time (CST HH:MM)

5:50 PM

Bayou Lafourche Water Quality Study

Station Log

Date (MM-DD-YY)

Arrival Time (CST HH:MM)

Station

2/17/04 1100

16

Technicians

Company/Agency

Location

R. Bixby CH2M HILL

Cocodrie

J. Kase "

M. Johnston "

N. Monroe "

Observations/Surrounding Conditions

Low tide, very low water, 3 ft at ADCP location. Installing ADCP on dock of Patrick Lefan. Weak currents.

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Guage: ~~To be installed~~ N/A
 CTD: N/A
 ADCP: To be installed.
 Battery/cable enclosure: To be installed.

Maintenance Performed/Modifications

Staff Guage: N/A
 CTD: N/A
 S/N: C581 Cell begin: 2m Cell End: 20m Cells: 3.5m (5)
 ADCP: center of ADCP 18" below water level and 18" above bottom
 Roll: 0.8 Pitch: 0.2 Heading: 110.2 File: ST16001 Deployed: 1530
 Battery: BAT06
 Battery/cable enclosure: Fiberglass enclosure installed above flood stage.
 It is tilted, so take caution of the battery falling out when opening.

Photos (#, time, description)

yes

Departure Time (CST HH:MM)

1600

Bayou Lafourche Water Quality Study

Station Log

Date (MM-DD-YY)	Arrival Time (CST HH:MM)	Station
2/18/04	1020	1 (one)
Technicians	Company/Agency	Location
R. B. Tely	CH2M HILL	Matthew
J. Kase	"	
M. Johnston	"	
N. Monroe	"	

Observations/Surrounding Conditions

Low water, calm water, heavy traffic on either side of Bayou Lafourche. New Bridge (Bayou Bridge Rd.)

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Gauge: mounting installation to be done.

CTD: Calibration of Deployment Sunde: 03/16/02 AE
 Mounting and deployment to be done. Time: 11:50 Temp: 16.84 sp Cond: 1.250
 Sal: .62 Pressure: .021 psig Depth: 0.048 ft

ADCP: 11:35 Temp: 16.50 sp Cond: 0.999
 Mounting and deployment. 1.5" Galv. Pipe, threaded rod (6) 90° scaffold clamps. Sal: .49 Press: .021 psig Depth: 0.048 ft

Battery/cable enclosure: mounting and deployment

Maintenance Performed/Modifications

Staff Gauge:

CTD:

ADCP: Pitch: 0.0 Roll: 0.4 Heading: 99.3 File: ST01001 Volts: 12
 S/N: C585 Depth: 30" Below water water Depth = 5' Time: 1500
 Cell begin: Cell End:

Battery/cable enclosure:

} Did not Deploy - No permission

Photos (#, time, description)

yes

Departure Time (CST HH:MM)

**Bayou Lafourche
Water Quality Study**

Station Log

Date (MM-DD-YY) Arrival Time (CST HH:MM)
 2/19/04 0920

Station
 2

Technicians	Company/Agency
R. Bitely	CH2M HILL
J. Kase	"
M. Johnston	"
N. Mangel	"

Location
 Lockport

Observations/Surrounding Conditions

calm waters, 6' deep at installation point, about 100-125 yards upstream from Company Canal.

Equipment at this Station and Condition (debris, mounting, level, plumb, infestations)

Staff Gauge: mounting to be installed

CTD: To be installed and deployed

ADCP: To be installed and deployed

Battery/cable enclosure: To be installed.

Maintenance Performed/Modifications

Staff Gauge: 2x4 mount is lag bolted/nailed to an adjacent piling w/ survey nail.

CTD: PVC well is bolted to a 2x4 that is bolted/nailed to the 2x6s. There is a stop bolt, screen and survey nail. The well is plumb. There is a well cap w/ a pad lock.

ADCP: 2x6s mounted vertically from a bulkhead piling. 1/2 swivel clamps bolted to the 2x6, ADCP on galv. pipe hung from clamps. ADCP is plumb.

Battery/cable enclosure: Bolted to back of 2x6s, locked.

Photos (#, time, description)

yes

Departure Time (CST HH:MM)

Bayou Lafourche
Water Quality Study

Field Event Form

Date (MM-DD-YY) Mobilization Time (CST HH:MM)

2/12/2004 0850

Stations Visited

Louport + Station 2
Station 5

Personnel Company/Agency

FTL: Nicki Monroe	CH2M HILL
Jason Kase	CH2M HILL
Ryan Bitely	CH2M HILL
Michael Johnston	CH2M HILL
Kevin Labbe	SanTek
Jonathan West	LDNR

Weather (temp, wind, rain?, clear?)

~ 50°F, wind: 10 mph out of NW, cloudy, chance of rain

Field Instrument Calibration

Technician	Company/Agency	Location	
NM	CH2M HILL	Hotel	
Make and Model	Serial #	Calibration Fluid Lot #	Calibration Fluid Expiration Date
YSI 600 XLM	0000192	4004	6-5-04

Initial Readings

SpCond (uS)	Temp (C)	Time (CST HH:MM)
1061	20.29	0650

Calibration Readings

SpCond (uS)	Temp (C)	Time (CST HH:MM)
1000.45	20.61	0655

H&S

SSC: R. Bitely	Notes/Events: Tailgate meeting
	Boat Safety
	Slips trips Hypothermia

Station 5 Summary

Installed CTD and Deployed and locked
Installed Battery/cable enclosure + locked

**Bayou Lafourche
Water Quality Study**

Field Event Form Con't

Date (MM-DD-YY)

12/12/04

Station 2 Summary

Installed ADCP hardware, ADCP and deployed
Installed Battery/Cable enclosure and locked.

Station ___ Summary

Photos not at a Station (#, time, description)

De-Mobilization Time (CST HH:MM)

**Bayou Lafourche
Water Quality Study**

Field Event Form

Date (MM-DD-YY) Mobilization Time (CST HH:MM)
 2/13/2004 0700

Stations Visited

8
5

Personnel Company/Agency

FTL: Nikki Monroe	CH2M HILL
Jason Kase	CH2M HILL
Ryan Bitely	CH2M HILL
Michael Johnston	CH2M HILL
L. Hattier	CH2M Hill

Weather (temp, wind, rain?, clear?)

1630 Windy 16 MPH from NE, cloudy, ~50°F, slight chance of rain
 1200 raining, stopped ~1300, misting off on
 1700 rain

Field Instrument Calibration

Technician	Company/Agency	Location	
NM	CH	Hotel	
Make and Model	Serial #	Calibration Fluid Lot #	Calibration Fluid Expiration Date
YSI 600XLM	00L0192	4004	6/5/04
Initial Readings			
SpCond (uS)	Temp (C)	Time (CST HH:MM)	
1021 uS	21.30	0705	
Calibration Readings			
SpCond (uS)	Temp (C)	Time (CST HH:MM)	
1000 uS	22.50	0707	
H&S			
SSC: R. Bitely	Notes/Events: Tailgate Meeting		

Station 8 Summary

Installed ADCP and Deployed	Installed locks on CTD
Installed Battery/cable enclosure	and Battery/cable enclosure
Installed CTD and Deployed	Installed cable clamps
*ADCP Hardware was installed on 2/11/04	

**Bayou Lafourche
Water Quality Study**

Field Event Form Con't

Date (MM-DD-YY)

2/13/04

Station 5 Summary

Installed ADCP hardware could not deploy - software problem. ADCP is installed, not recording. ADCP S/N: C582
Installed staff gauge mounting

Station ___ Summary

Photos not at a Station (#, time, description)

De-Mobilization Time (CST HH:MM)

Bayou Lafourche Water Quality Study

Field Event Form

Date (MM-DD-YY)	Mobilization Time (CST HH:MM)	Stations Visited
2/14/04	0830	N/A
Personnel	Company/Agency	
FTL: N. Monroe	CH2M HILL	
J. Kase	"	
R. Bitley	"	
L. Hattier	"	

Weather (temp, wind, rain?, clear?)

10:30 ≈ 50°F, wind < 15 mph NNE, rain, chance of thunder storms

Field Instrument Calibration			
Technician	Company/Agency	Location	
NM & LH	CH2M HILL	Staging Area	
Make and Model	Serial #	Calibration Fluid Lot #	Calibration Fluid Expiration Date
YSI 600 XLM	00L0192AA	4004	6-5-04
Initial Readings			
SpCond (uS)	Temp (C)	Time (CST HH:MM)	
989 uS/cm	10.79°C	10:07 AM	
Calibration Readings			
SpCond (uS)	Temp (C)	Time (CST HH:MM)	
1000	10.81	10:07 AM	
H&S			
SSC: R. Bitley	Notes/Events: Tailgate meeting		
	Attended: N. Monroe, J. Kase, R. Hattier		
	covered; Boat Safety, slips-trips, electrical hazards		
	power tools, wear PPE, overhead hazards		

Station Summary

Prep. only due to weather

Bayou Lafourche Water Quality Study

Field Event Form

Date (MM-DD-YY) Mobilization Time (CST HH:MM)
 2/15/04 0700

Stations Visited
 04
 05

Personnel	Company/Agency
FTL: N. Monroe	CH2M HILL
J. Kase	"
R. Bitely	"
L. Haffner	"

Weather (temp, wind, rain?, clear?)

Cold, partly cloudy, low 40°F, high 50°F, wind 15-25 mph NNE

Field Instrument Calibration

Technician	Company/Agency	Location
L. Haffner	CH2M HILL	Station 4
Make and Model	Serial #	Calibration Fluid Lot #
YSI 600 XLM	0060192 AA	41004
Calibration Fluid Expiration Date	6-5-04	

Initial Readings

SpCond (uS)	Temp (C)	Time (CST HH:MM)
1027	7.57°C	10:28 AM
	10.36°C	10:35 AM

Calibration Readings

SpCond (uS)	Temp (C)	Time (CST HH:MM)
1000	10.36°C	10:35

H&S

SSC: R. Bitely Notes/Events: Meeting attended: LB, JK, NM

Station Summary

Bayou Lafourche Water Quality Study

Field Event Form

Date (MM-DD-YY) Mobilization Time (CST HH:MM)
 2/16/04 07:00

Stations Visited
7
3

Personnel	Company/Agency
FTL: N. Monroe	CH2M HILL
J. Kase	"
Norm L. Birely	"
L. Hattier	"

Weather (temp, wind, rain?, clear?)
 cool, partly cloudy, breezy (<10mph)
 High = 56°, Low = 40°

Field Instrument Calibration			
Technician	Company/Agency	Location	
L. Hattier	CH2M	Station #7	
Make and Model	Serial #	Calibration Fluid Lot #	Calibration Fluid Expiration Date
YSI 600 XLM	00L0192 HILL	4004	10-5-04
Initial Readings			
SpCond (uS)	Temp (C)	Time (CST HH:MM)	Salinity
998	12.29	10:20 AM	0.5 ppt
Calibration Readings			
SpCond (uS)	Temp (C)	Time (CST HH:MM)	
1001	12.35	10:20 AM	
H&S			
SSC:	Notes/Events:		

Station 7 Summary
 (7) Tide low, very shallow. installed CTD. Attached to the Pillings. Installed Cable Box on bottom of platform. Placed rail (Survey) on the piling. Collected readings. Deployed CTD.

**Bayou Lafourche
Water Quality Study**

Field Event Form Con't

Date (MM-DD-YY)

02-16-04

Station 3 Summary

Low tide, shallow, installed CTD. installed / Drove 21 foot galvanized pipe 9 feet below mudline, 4 feet mud. Top of galvanized pipe is 8 feet above mud. Bolted 2x6 to galv. pipe, screwed PVC pipe to 2x6. Screwed cable box to 2x6. installed CTD, bottom of sensor is 6 inches above sediment surface. installed lock on PVC and cable box. Placed survey nail in sea wall & marked it.

Station ___ Summary

[Empty box for Station Summary]

Photos not at a Station (#, time, description)

[Empty box for Photos not at a Station]

De-Mobilization Time (CST HH:MM)

[Empty box for De-Mobilization Time]

**Bayou Lafourche
Water Quality Study**

Field Event Form

Date (MM-DD-YY) Mobilization Time (CST HH:MM)

2/17/04 0750

Stations Visited

16

Personnel Company/Agency

FTL: N. Monroe	CH2M HILL
J. Kase	"
R. Bitely	"
M. Johnston	"

Weather (temp, wind, rain?, clear?)

Low: 40°F, High: 56°F, breezy (10 mph W), clear

Field Instrument Calibration No CTD today

Technician	Company/Agency	Location

Make and Model	Serial #	Calibration Fluid Lot #	Calibration Fluid Expiration Date

Initial Readings		
SpCond (uS)	Temp (C)	Time (CST HH:MM)

Calibration Readings		
SpCond (uS)	Temp (C)	Time (CST HH:MM)

H&S	
SSC: R. Bitely	Notes/Events:

Station /6 Summary

Installed ADCP, Deployed.
Its installed on Pa

**Bayou Lafourche
Water Quality Study**

Field Event Form

Date (MM-DD-YY)	Mobilization Time (CST HH:MM)	Stations Visited
2/18/04	0700	1
Personnel	Company/Agency	5
FTL: N. Monroe	CH 2M HILL	
J. Kase	"	
R. Bitely	"	
M. Johnston	"	

Weather (temp, wind, rain?, clear?)
 Low 48°F, High 56°F, wind calm N, clear

Field Instrument Calibration			
Technician	Company/Agency	Location	
NM	CH 2M HILL	Station 1	
Make and Model	Serial #	Calibration Fluid Lot #	Calibration Fluid Expiration Date
YSE 600 XLM-D	0060192 AA	4004	6-30/04
Initial Readings			
SpCond (uS)	Temp (C)	Time (CST HH:MM)	
944 ^{pm} 1007	12.46	11:32	
Calibration Readings			
SpCond (uS)	Temp (C)	Time (CST HH:MM)	
1000	12.60	11:40	
H&S			
SSC: R. Bitely	Notes/Events: Tailgate Meeting Electrical hazards, SLIPS/Trips, PPE Boat Safety.		

Station 1 Summary
 Created and assembled the ADCP mounting and pre-fab ed the CTD and staff gauge mounting. We were denied permission to install. Not Deployed.

**Bayou Lafourche
Water Quality Study**

Field Event Form

Date (MM-DD-YY) Mobilization Time (CST HH:MM)

2/18/04 0700

Stations Visited

1
5

Personnel Company/Agency

FTL: N. Monroe	CH 2nd HILL
J. Kase	"
R. Bitley	"
M. Johnston	"

Weather (temp, wind, rain?, clear?)

Low 40°F, High 56°F, wind calm N, clear

Field Instrument Calibration

Technician	Company/Agency	Location
NM	CH 2nd HILL	Station 1
Make and Model	Serial #	Calibration Fluid Lot #
YSE 600 XLM-0	0060192 AA	4004
		Calibration Fluid Expiration Date
		6-57/04

Initial Readings

SpCond (uS)	Temp (C)	Time (CST HH:MM)
946 1007	12.46	11:32

Calibration Readings

SpCond (uS)	Temp (C)	Time (CST HH:MM)
1000	12.60	11:40

H&S

SSC: R. Bitley	Notes/Events: Tailgate Meeting Electrical hazards, slips/trips, PPE Boat Safety.

Station 1 Summary

Created and assembled the ADCP mounting and pre-fab ed the CTD and staff gauge mounting. We were denied permission to install. Not Deployed.

**Bayou Lafourche
Water Quality Study**

Field Event Form Con't

Date (MM-DD-YY)

2/18/04

Station 5 Summary

R. Eitel and J. Kase logged on to the ADCP to verify data collection.

Station ___ Summary

Photos not at a Station (#, time, description)

De-Mobilization Time (CST HH:MM)

1815

**Bayou Lafourche
Water Quality Study**

Field Event Form

Date (MM-DD-YY)	Mobilization Time (CST HH:MM)
2/19/04	0700

Stations Visited
1

Personnel	Company/Agency
FTL: N. Monroe	CH2M HILL
J. Kase	"
R. Bitely	"
M. Johnston	"

Weather (temp, wind, rain?, clear?)
Low 45°F High 58°F, calm wind S, clear

Field Instrument Calibration			
Technician	Company/Agency	Location	
N. Monroe	CH2M HILL	Station 1	
Make and Model	Serial #	Calibration Fluid Lot #	Calibration Fluid Expiration Date
YSI ⁶⁰⁰ XCM-0	0060192 AA	4004	6-5-04
Initial Readings			
SpCond (uS)	Temp (C)	Time (CST HH:MM)	
1013	14.73	10:19 Sal 0.50	
Calibration Readings			
SpCond (uS)	Temp (C)	Time (CST HH:MM)	
1000	14.84	10:20	
H&S			
SSC: R. Bitely	Notes/Events: Tailgate meeting		

Station 1 Summary

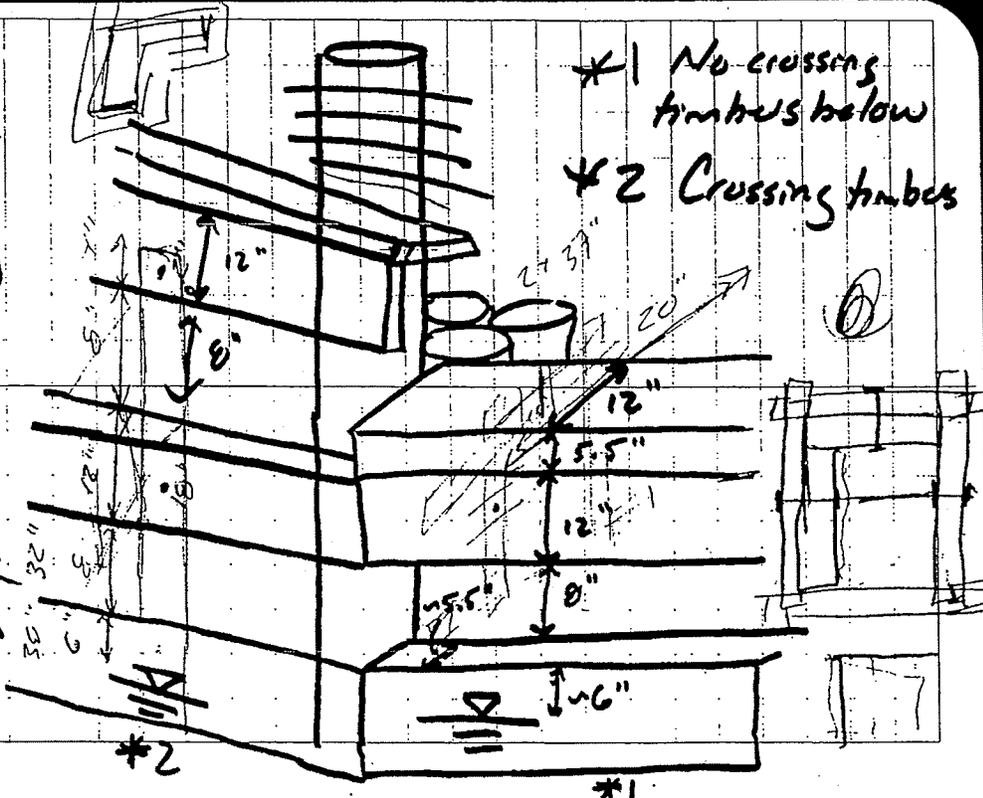
Date

Location

Project / Client

2/10/04

Bayou Terrebonne Lockport



*1 No crossing timbers below
 *2 Crossing timbers

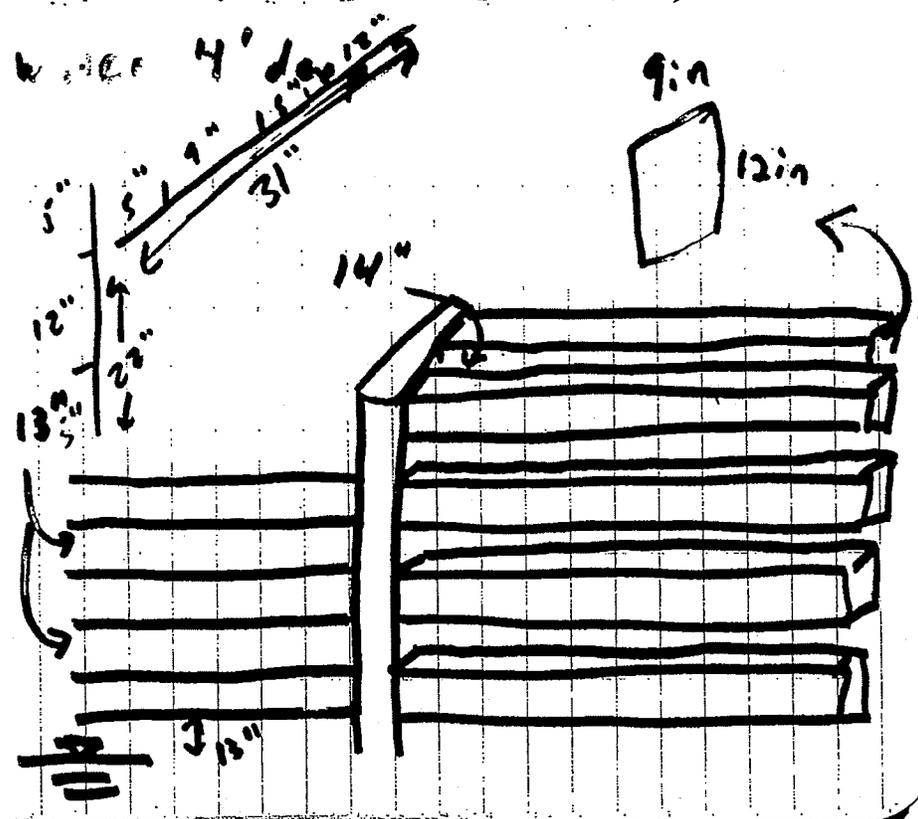
Date

Location

Project / Client

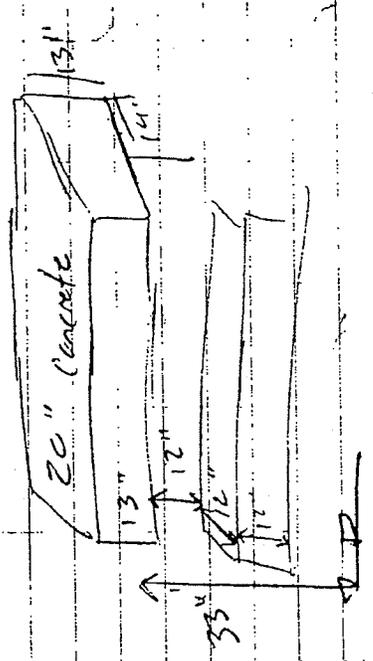
2/10/04

HWY 1 Bridge Lockport



9"
 12"

Location uu Date _____
Project / Client 889E Site diagram @ 61WU



2/13/04
0720 Concrete to shed
0900 Ryan, Nikki, Kevin & Sanket
enroute to Bayou Terrebonne to
install site ARP panel CTD
- Linda Heather arrives
1100 Conch enroute to pick
up scaffold clamps
1200 Conch returns to shed
1215 Enroute to Bayou Terrebonne @
Montgat
1300 Arrive @ site

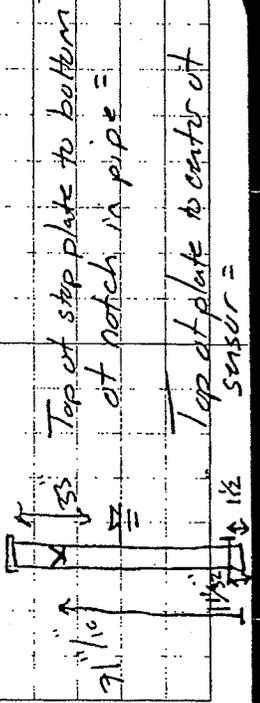
Location _____ Date _____
Project / Client _____

1330 Enroute to BLF below
61WU site
1400 Conch
1500 Arrive @ site by branch
Montgat
1600 Arrive @ site
1745 - Complete installation of
APCD except for deployment
of unit cable to software problem
and late time of day
1805 - Arrive @ boat ramp

1950 Arrive @ shed End work day

2/14
Note: Nikki keeping clay bag

CTD @ ST04
(61WU @ BLF)



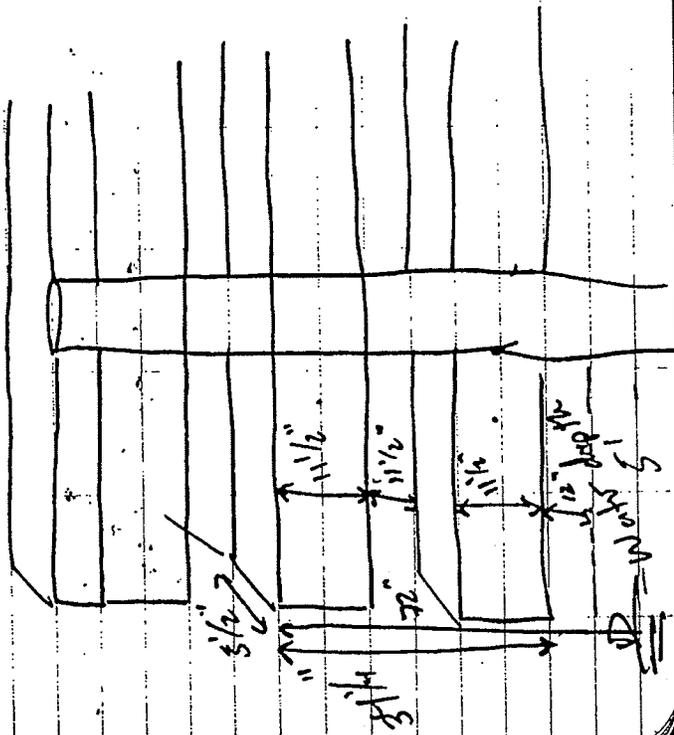
Location _____ Date _____

Project / Client _____

PJ 985-532-5515
Thema-sea boatyard
sponsoring & equipment

BLF clear Company Canal

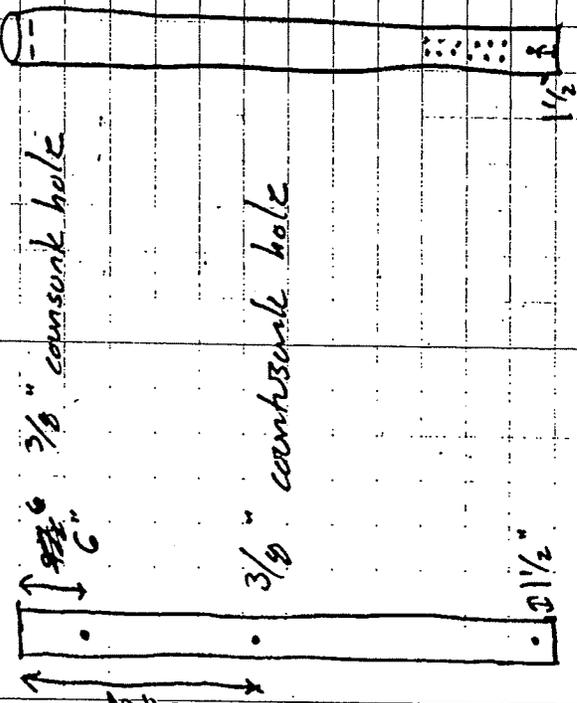
24 to wall



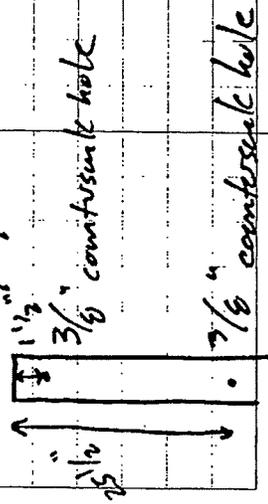
Location _____ Date _____

Project / Client _____

CTD
2x4x8' lumber
2" x 8.3' PVC
Note: 20" clearance



Staff gauge



8 Location: Hanna - Staging Date: 2/13/04
 Project/Client: Bayer Lafourche WQ Study
 Scribe: Nikki Monroe

0800 Loading truck/boat/car
 to install instruments @ Terrebonne.
 Nikki, Ryan and Kevin Labbe to
 do the install. J. Kase & M. Johnston
 will stay and pre-fab out sheet.

ADCP

- 1 Diagnostic - 50 pings
 - record save as STXX_mnoisy
- Folder 4.2 water sampling
 - Database folder
 - briefcase - save files here
- 2 Real Time
 - Ave. Int. = 5 min + Sample Int = 5 min
 - record on calib. sheet (DB)
 - 2 clean readings
- 3 Deployment
 - Ave Int = 5 min Sample Int = 5 min
 - file name: STXX will add extension automatically

Nikki Monroe 2/13/04

9 Location: Montegut Station 8 Date: 2/13/04
 Project/Client: BLF WQ Study / LDNR
 N. Monroe

CTD	Station
file: STXX YXMMDD	
- Record to calibration w/it readings	
and Deployed inst. readings.	
1000 Arrive at location (Station 8)	
Launch boat	
1035 Tailgate meeting	
Run by N. Monroe	
Attended:	
Ryan Bitely	
Kevin Labbe	
1040 Leveling ADCP mounting	
installing ADCP, battery/cable box	
1140 connecting to ADCP on Dig. - Real	
Time file: ST02_021304	
Heading: 96.9° Pitch: 0.5° Roll: 0.0°	
SonTek S/N: C587	
1155 Deployed ADCP file: ST018	
1209 CTD: YSI 600 XLM Readings	
Temp: 12.64°C	
SpCond: 348 μ S	
1207 CTD: YSI Deployed	

10
Location: Hamma LA Date: 2/13/04
Project / Client: LDNR - BLF WQ Study
Scribe: N.K.K. Monroe

0700 I went shopping, Jason Kase went to update records etc. Ryan & I went to storage shed to begin fabrication of mounts. Michael went w/ him.

1211 YSE Conit
Sp Cond: 0.347 nS
Temp: 13.24 C
Depth: 1.283
Sal: .17
Press: 0.554
only about 18" in water due to low tide.
Deployed instrument
1220 Raining, packing up to leave.
1250 Installing lock on CTD well
- 1/2 gate hinge through PVC w/lock
1300 - J. Kase, L. Haffner and M. Johnston arrive w/ 4x4 bump rail.
1350 could not install bump rail, drill batteries died.
- went to lunch, left station 8
N.K.K. Monroe 2/13/04

11
Location: Station 5 Date: 2/13/04
Project / Client: LDNR / BLF WQ Study
Scribe: N. Monroe

1600 Arrive at boat launch
- launch boat, load equip. and supplies.
- light rain, breezy, cold
- some barge traffic on G/WW
1650 At Station 5, at flood gate
- begin installing ADCP mounting hardware
- CTD and battery/cable box is already installed (2/12/04)
1700 Swing bridge was opening, we moved the boat to the back side of the fender.
- installed the staff gauge mounting
1730 Installing ADCP, can diagnostic and Real Time
- software would not run deployment
- its late and raining - heading in.
N.K.K. Monroe 2/13/04

Location Station 5 Date 2/13/04

Project / Client LDNR - BLF wa study

1800 Trailer the boat and in load it.

1835 Heading back to Hanna.

1920 In Hanna at shed, unload trucks, put boat in shed, and lock-up.

1935 Back at Hotel.

~~Mike-Me
2/13/04~~

Location Hanna Date 2/14/04

Project / Client LDNR - BLF wa study
N. Monroe

0815 J. Kase, R. B. Kelly and L. Hatties went to shed to pre-fab.

I went to update the DB and charge project laptop.

0955 HRS meeting on bus R. B. Kelly
Attended by N. Monroe, J. Kase,
L. Hatties

- covered boat hazards

- power tool hazards

- slip-trips

- overhead hazards

- wear PPE

1000 Prefabricating ADCP mount and CTD mount for Station 4.

- at shed, still raining

1130 Prefabing the CTD mount for Station 3.

- at shed, still raining

1230 break for lunch

1350 J. Kase and L. Hatties went to

Horse Depot and R. B. Kelly and

myself went to the shed.

Mike-Me 2/14/04

Location Home Date 2/14/04

Project / Client LDNR - BLF WQ Study
N. Monroe

180/1358 Ryan and I reorganized and put the boat in the shed.

18 1425 Jason and Linda returned from Home-Depot.

- we went through the equipment and procedures, organized a game plan.

19 1500 Jason and Ryan went to DMCAN to re-con and measure.

- Linda and I went to find a 3/4" carbide masonry bit for the rotary hammer. or 1" lag bolt shields.

1525 - Lowers does not have either - made calls to find it.

- Grand Rentals has it - picked-up bit and heading back to hotel.

1655 Back at hotel, Ryan and Jason will be back about 1815-1830.

~~W. H. Hattier~~
2/14/04

Location Home Date 2/15/04

Project / Client LDNR - BLF WQ Study
N. Monroe

0645 Arrive at shed, hook up boat load vehicles.

0715 Go to Home Depot and Walmart - pick-up battery, step stool, etc.

Objective: Install Station 4 and deploy, deploy Station 5 ADCP and install and deploy Station 4m Lake fields station.

Weather: partly cloudy, high 50°F, low 40 wind NNE 15-25 mph

0750 on-route to LaRose, station 4.

0830 Loading and launching.

0835 H2S meeting: Run by R. Bitely

Attended by: N. Monroe, J. Kase, L. Hattier

discussed cold, boat hazards, water hazards, power tools electrical hazards, wear PPE

0850 Arrive at Station 4 prep for ADCP and CTD installation.

0900 Incorrect bit for rotary hammer - heading back then to another station

~~W. H. Hattier~~
2/15/04

12

Location LaRose - Station 4 Date 2/15/04

Project / Client LDNR - BLF WQ Study
N. Monroe

- 18c 0930 Found the correct bit locally
- 0950 Reloaded & Relunched.
- 1020 Began mounting hardware,
- 18 calibrating PSIs and prep-
- 19 1050 Installed ADCP on down rod.
 - plug up shd. flow assumed right.
 - USblts lock tightened
- 1100 C. Haffner has computer batteries in an internal pocket for warmth.
- 1245 The ADCP mounting is complete
- The battery cable box is mounted
 - used 1.5" galv. pipe lag bolted to the concrete
 - lag bolted the battery box
- 1345 Attached ADCP, ran diagnostic, Real Time and deployed.
 - File: ST04 SN: 0590
- 1405 Take CTD calibration unit measurements.
- 1420 Take CTD deployed unit: 0 AC measurements.
- 1435 Leaving Station 4 to go to Stations

N. Monroe 2/15/04

Location LaRose - Station 5 Date 2/15/04

Project / Client LDNR - BLF WQ Study
N. Monroe

- 1450 Arrive at Station 5 to deploy ADCP unit.
- 1500 Run Diagnostic - cell begin: 2m Cell end: 28m
- Deploy: got error, calling Kevin Labbe.
- 1505 ADCP is ~~in~~ CS82.
- 1515 ADCP is deployed. File: ST0501
- 1520 Locked up box and left station 5.
- 1545 Pull out boat and unloaded.
- 1550 Lunch.
- 1600 No open restaurants in area, heading back to Hanna.
- 1650 At shed, unload and lock-up boat.
- 1700 Done for the day.

N. Monroe 2/15/04

12

Location Point Aux Chene Date 2/16/04

Project / Client CWR - BLF WQ Study

N. Monroe

18c 0700 At Sked, loading truck

0900 J. Kase, R. Bitley, C. Haffner and myself are en-route to Point Aux Chene

19 0840 Arrive at Point Aux Chene, unload trucks, launch boat.

0955 Arrive at station #7

Water is VERY low - 1ft

- Installing CTD and box on pilings, not on top.

1220 Leaving Station #7 heading back to dock.

1255 At dock; trailering and unloading boat.

14:20 Leave Pointe Aux Chene, heading to LaRose to return the concrete bit then to Lockport and Station 3, Lake Fields.

1515 Launching & loading boat at Lockport

1555 Arrive at Station 3 location.

- begin fabrication of CTD installation.

1630

N. Monroe 2/16/04

Location Lake Fields Date 2/16/04

Project / Client LDNR - BLF WQ Study

N. Monroe

1620 Installation: 2' galv. pipe drive 9' below mudline, 4' mud.

- Approx. 2' water and 6' above water line.

- 2"x6" bolted onto pipe

- pipe and board are plum

- 2" PVC is bolted to one side

- PVC is CTD well, has stop

bolt that measures 80 3/4"

from top of bolt to top of

lock plate. PVC has app.

1' of well screen.

- Cable box (fiberglass) is mounted on the board

- CTD measurements are logged and CTD is deployed

- File: 03040216

- Installation is approximately

9' off of the bulkhead

in front of Mr. Lee's camp.

1750 Packing up, heading back to

launch.

N. Monroe 2/16/04

12

Location Lockport Date 2/16/04

Project / Client BLF - WQ Study

N. Monroe

- 18c 1825 Trailering boat, unloading, heading back to shed in Houma
- 18 1815 Drop L. Batter at Hotel, she is leaving for New Orleans.
- 19 1930 Unload at Shed, end of work for the day.

1c

Station
 2/16/04

Location Houma -> Cocodrie Date 2/17/04

Project / Client CDNR - BLF WQ Study

N. Monroe

- 0700 R. Bitley and J. Kase load truck and boat, pick-up galv. pipe and are heading to Cocodrie to find a location for the ADCP.
- 0730 Myself and M. Johnston go to Home Depot for supplies and then head to Cocodrie.
- 0915 Arrive at Cocodrie, waiting for Ryan and Jason to return to dock.
- 1015 Loading boat, prep. for Station 16
- 1100 At location, about 1/4 mile upstream from launch
 - off dock of Mr. Patrick Lerou
 Low tide only 3' of water
 - tested signal of ADCP, 558)
 - got good signal at 17" depth - 36m
- 1130 Began prep and installation of ADCP.
- 1150 (985) 594-6573 - Mr. Lerou's phone #.
N. Monroe 2/17/04

Location Cocodrie - Station 16 Date 2/17/04

Project / Client LDR - BLF WQ Study
N. Monroe

- 1800 1400 532-5515 (PJ) at the Lockport shipyard - spoke to them over lunch
- 1900 1401 Installing ADCP mounting under dock.
- 1500 ADCP installed. Running Diagnostic
- 1600 Battery/cable enclosure is installed - the enclosure is slightly high and the battery could slide out. BE CAREFUL when opening.
- 1550 ADCP Deployed.
- 1630 - after deployment, we rotated the heading a couple of degrees down stream.
- 1700 Boat back to launch
- 1700 - took scenic route to locate USGS Left Cocodrie, LA
- 1800 - heading to Houma
- 1800 back in Houma, unload, lock-up boat
- Done for the Day.

Nick Miller 2/17/04

Location Home Date 2/18/04

Project / Client LDR - BLF WQ Study
N. Monroe

- 0645 Home Depot List
PVC-10' (1)
Padlocks (2)
Exchange drill
1/4 Conduit clamp 3/8"x1"
short built w/ ~~fasteners~~
- 0800 R. Bitely and J. Kase go to recon. in Lockport for Station 1 location.
- 0820 Myself and M. Johnita leave Houma, in Route to Lockport.
- 0850 Meet J. Kase and R. Bitely at launch. Go to recon.
- 0900 The boat yard bulkhead is in poor condition and shallow.
- 0915 We are going to Bayou Bridge Rd. to see if there is an opportunity there.
- 1000 The bridge is now construction - Jason spoke w/ Joe Perio of CDOT about installing here and due to a contract issue the construction contractor must give the OK.

Nick Miller 2/18/04

Location Mathews - Station 1 Date 2/18/04

Project / Client LDNR - BLF WQ Study

N. Moore

1800 The upstream, thug 1 side bridge fender looks like a good location.

1800 - J. Kase recorded measurements and made design.

10:45 J. Kase and M. Johnston begin pre-fab of CTD and ADCP mounting.

1900 - R. Bitley and myself go to get a well lock and the restream.

1100 All back at boat, next to new bridge - pre-fabing and calibrating CTD instruments.

1210 CTD instruments are calibrated, CTD mount is pre-fabed.

- survey nail is 69.0" from top of CTD stay bolt

- CTD pressure transducer is 4.0" from bottom of instrument.

1220 J. Kase and myself went to pick-up lunch and R. Bitley and M. Johnston stayed w/ the boat.

1300 Begin mounting ADCP mounting - not bolting into the timbers, clamping

Nick M 2/18/04

Location Mathews - Station 1 Date 2/18/04

Project / Client LDNR - BLF WQ Study

N. Moore

1430 Non-invasive mounting of ADCP is complete.

- ADCP S/N: C585

- waiting on authorization to lay/bolt into timbers. Need authorization to install Battery cable enclosure, gauge mount and CTD.

1500 R. Bitley and J. Kase take the boat back to trailer it.

- M. Johnston and myself prep. and wait for wind to install the battery/cable box and CTD.

1600 Jason called, we cannot use this bridge - we are disassembling the ADCP mounting and packing up to leave.

1615 R. Bitley called, M. Johnston has the truck keys.

- I drive the keys to the ramp in lockport.

- M. Johnston will not work, just wait w/ the equipment

Nick M 2/18/04

Location: Hanna - Lockport Date: 2/19/04

Project / Client: LDNR - BLF WQ Study
N. Moore

0700 Meet at the station
 - load up equip. + supplies for Station 1 on R. Bitely's truck and J. Kase's truck
 - The rest of the supplies and equip. are put into M. Johnston's or my car.
 0800 The storage unit is clean, empty and in the same condition that we found it. (good condition)
 - Jof properties personnel were not in the office to inspect.
 - checked out of unit and I left to meet the rest at the launch in Lockport.
 0850 Loaded and launched the boat heading for Station 1, upstream on Bayou Lafourche.
 - We got permission from J.P. at Thom-Ahasim Boat Yard to install the ADCP, (TD) and staff gauge.
 0925 picked location on sea wall and began clearing brush.
N. Moore 2/15/04

Location: Mathews - Raceland Date: 2/18/04

Project / Client: LDNR - BLF WQ Study
N. Moore

1645 Gave truck keys to J. Kase the head back to the bridge in Mathews to disassemble and pack
 1700 J. Kase and R. Bitely arrive at the Mathews Bridge to load the long wood and pipe.
 1715 J. Kase and myself go to recon a bridge upstream in Raceland.
 - The Bridge is 5 miles upstream and has minimal fenders.
 1730 Leave Raceland for Hanna
 1800 Meet R. Bitely and M. Johnston at the shed and unload.
 1815 Finished for the day.

N. Moore
 2/18/04

Location Station I - Lockport Date 2/19/04

Project / Client LDNR - BLF WQ Study

N. Monroe

0730 At Station I the water depth is about 6'

0945 Began fabricating the ADCP, CTD and Battery/Cable enclosure mounting.
- double 2x6's lagbolted vertically to a piling

1030 The CTD's are calibrated and the wood is being mounted to the piling
- 10" lag bolt is too long, going to get shorter lag bolts or a bit.

1130 Back at launch w/ bits and lunch
- head back out to Station I

1145 Installing mounting.

1230 mounting needs adjusting

1300 ADCP is mounted beginning Diag.
(Heading: 96.0 Pitch: 0.0 Roll: -1.2)

1400 CTD mounting and well installed
Calibration Instrument readings: 600x1
Temp: 12.99°C SpCond: 258µS
Sal: 12

1412 CTD: 03m0432AE

Temp: 13.65°C SpCond: 258µS

Sal: 12.12 Press: 1.147 Depth 2.655

Volts: 6.2V

2/19/04

Location Station I - Lockport Date 2/19/04

Project / Client LDNR - BLF WQ Study

N. Monroe

1413 Deploying CTD, file: 01040219
S/N: 03m0432AE

- Logging Diagnostics and Real Time were run earlier. Setting up for logging/Deployment.

- Software gave Check Sum error - corrected

- File: st01001

1505 Installing staff gauge mount

- a 2x4, plumb, 2' below water and 6' above

- a 60d survey nail was inserted

1520 Leaving Station I

1525 At launch, unload boat, trailer boat, sort equipment.

1600 Leaving launch

- R. Bitley heading to Gulfport, MS to return the boat to Bossorg

- M. Johnston, J. Kane and myself are going back to New Orleans.

1700 Returned generator rotary hammer and Sawzall to HERTZ.

2/19/04

Attachment 3
Stations 1 through 8 Descriptions

CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 1- LOCKPORT, LA

**Written by: Michael Johnston
7-23-2004**

LOCATION.-- Lat 29°35' 24", long -90°59' 23", This station is located on East Side of Bayou Lafourche just upstream from Company Canal in Lockport, LA. The HDCP is on the seawall of Thoma-sea boatyard via timber piling

DCP.-- The DCP was established on the seawall of Thoma-sea boatyard via timber piling. The DCP was constructed by attaching a fabricated 4”X6” timber vertically to a bulkhead piling. Then the ADCP deployment pole (a 1.9” OD galvanized pipe) was attached to the fabricated 4”X6” via two swivel clamps. The CTD stilling well (a 2” PVC pipe attached to a treated 2”x4” timber) was then mounted to the side of the fabricated 4”X6” timber.

ESTABLISHMENT AND HISTORY.— Established on February 19, 2004. Record of data is available from March 01, 2004 to January 10, 2005.

INSTRUMENTS.-- YSI 600LS, Serial Number 03M0432AE
Paramters: Water Temperature, Depth, Specific Conductance, and Salinity

Argonaut (500kH), Serial Number C585
Paramters: Velocity

REFERENCE MARKS.--

CTD: The “mark” associated with the HDCP is a 60d nail driven in the side of the HDCP. **Elevation 3.352 ft NAVD 88.**

STAFF: A water level reference mark (60d nail) painted is into bulkhead piling approximately five feet upstream from the HDCP. **Elevation 1.955 ft NAVD 88.**



CTD Platform

ADCP Mounting

Water Level Reference Mark

CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 1- LOCKPORT, LA (AMENDED)

**Written by: Michael Johnston
1-21-2004**

LOCATION.-- Lat 29°35' 24", long -90°59' 23", This station is located on East Side of Bayou Lafourche just upstream from Company Canal in Lockport, LA. The HDCP is on the seawall of Thoma-sea boatyard via timber piling

DCP.-- The DCP was established on the seawall of Thoma-sea boatyard via timber piling. The DCP was constructed by attaching a fabricated 4”X6” timber vertically to a bulkhead piling. The CTD stilling well (a 2” PVC pipe attached to a treated 2”x4” timber) was then mounted to the side of the fabricated 4”X6” timber.

ESTABLISHMENT AND HISTORY.— Established on February 19, 2004. Record of data for temperature, salinity and specific conductivity is available from March 01, 2004 to January 10, 2005. Record of data for velocity is available from March 01, 2004 to November 09, 2004.

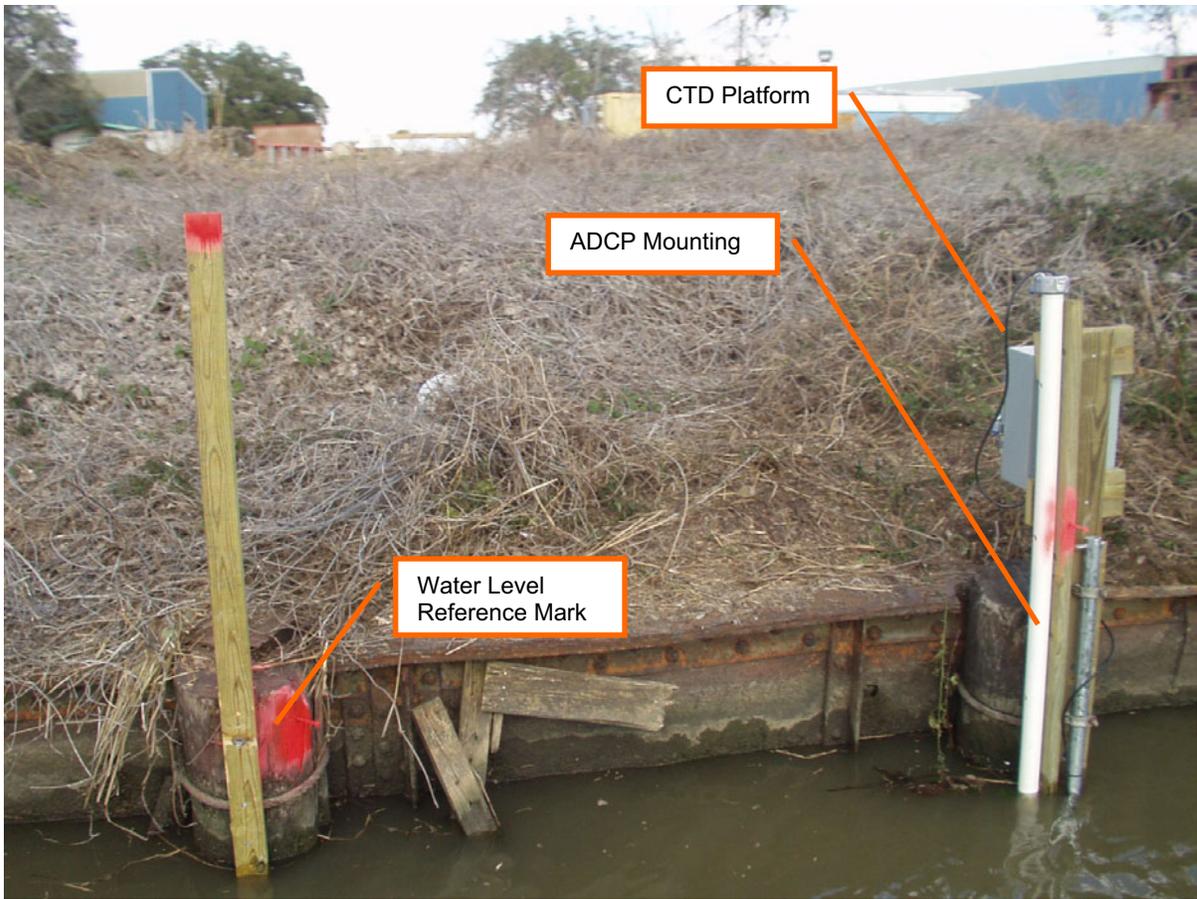
INSTRUMENTS.-- YSI 600LS, Serial Number 03M0432AE
Parameters: Water Temperature, Depth, Specific Conductance, and Salinity

Argonaut (500kH), Serial Number C585
Parameters: Velocity

REFERENCE MARKS.--

CTD: The “mark” associated with the HDCP is a 60d nail driven in the side of the HDCP.
Elevation 3.352 ft NAVD 88.

STAFF: A water level reference mark (60d nail) painted is into bulkhead piling approximately five feet upstream from the HDCP. **Elevation 1.955 ft NAVD 88.**



CTD Platform

ADCP Mounting

Water Level
Reference Mark

CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 2- LOCKPORT, LA

**Written by: Michael Johnston
7-23-2004**

LOCATION.-- Lat 29°28' 48", long -90°04' 24", This station is located in Lockport, LA on the Highway 1 Bridge crossing Company Canal. The DCP is on the fender of the Highway 1 Bridge on the upstream, north side of Company Canal.

DCP.—This site was established in conjunction with existing USGS instruments. The DCP consists of tightly enclosed four pieces of 1.9” OD galvanized pipe with treaded rod and four right angle scaffolding clamps around single timber of the bridge fender. The horizontal pieces of the enclosures extends away from the fender on the in-stream side in which ADCP deployment pole is attached.

ESTABLISHMENT AND HISTORY.— Established on February 12, 2004. Record of data is available from March 01, 2004 to January 10, 2005.

DATA COLLECTION.-- Argonaut (500kHz), Serial Number C586
Parameters: Velocity

USGS Equipment
Parameters: Water Temperature, Water Surface Elevation,
Specific Conductance, and Salinity

REFERENCE MARKS.--

None



CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 3- LAKE FIELDS, LA

**Written by: Michael Johnston
7-23-2004**

LOCATION. -- Lat 29°35' 28", long -90°50' 08", The station is located on the center of the northeast bank of Lake Fields.

DCP.-- The DCP consists of a 21' galvanized pipe driven nine ft below the mud line approximately nine feet out from an existing seawall approximately 6.5 ft deep. A 2"X6" timber is mounted onto the galvanized pipe and the CTD stilling well, is attached to the 2"X6" timber.

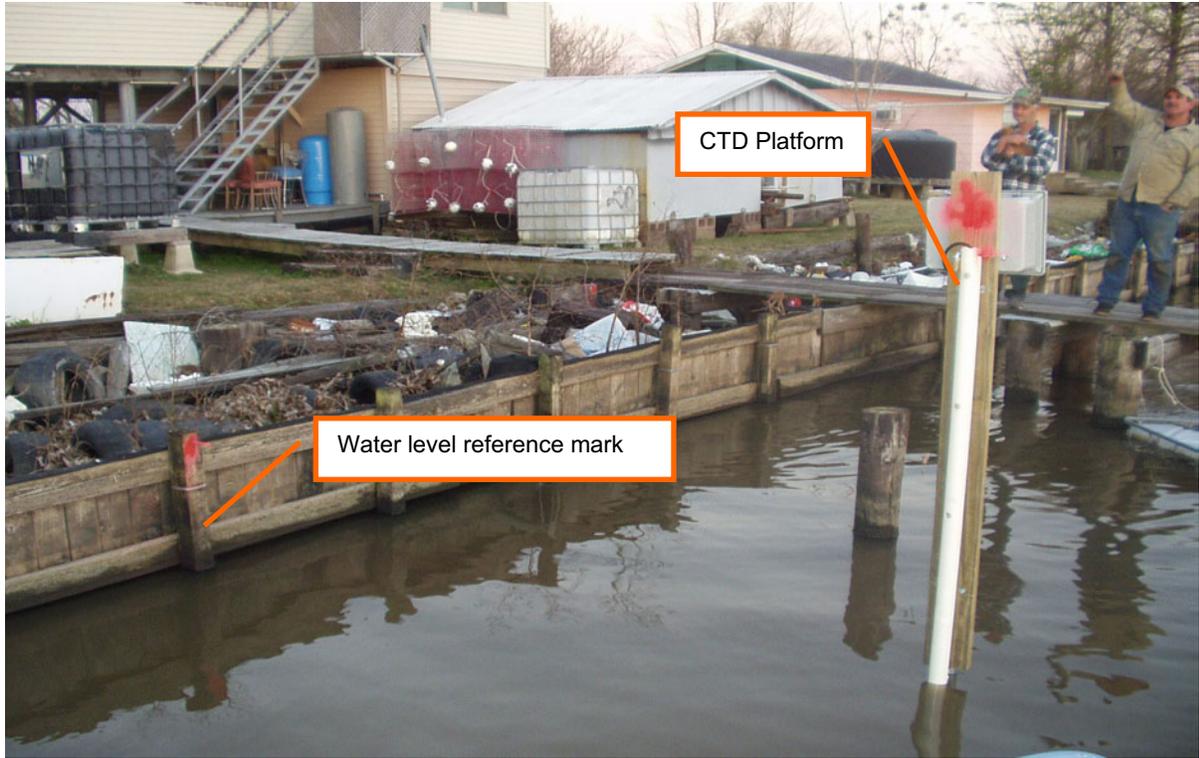
ESTABLISHMENT AND HISTORY.— Established on February 16, 2004. Record of data is available from March 01, 2004 to January 10, 2005.

INSTRUMENTS.-- YSI 600LS, Serial Number 03M0432AE
Parameters: Water Temperature, Depth, Specific Conductance, and Salinity

REFERENCE MARKS.--

CTD: The "mark" associated with the HDCP is the top of the PVC well lock plate.
Elevation 5.769 ft NAVD 88.

STAFF: The water level reference mark is a 60d nail driven into a bulkhead piling at the nearest point to shore from the instrument the HDCP. **Elevation 2.662 ft NAVD 88.**



CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 4- LAROSE, LA

**Written by: Michael Johnston
7-23-2004**

LOCATION.-- Lat 29°39' 37", long -90°15' 03", This station is located in Larose, LA under Hwy 308 Bridge on the south side of the GIWW.

DCP.-- The ADCP and CTD are established on the south retaining wall of the GIWW directly under the bridge. The ADCP and CTD mounting is constructed of four pieces of 1.9" OD galvanized pipe secured to the concrete top of the retaining wall with shielded lag bolts and four right angle scaffolding clamps. The horizontal pieces of the enclosures protrude inward in the GIWW with the CTD stilling well and ADCP deployment pole attached.

ESTABLISHMENT AND HISTORY.— Established on February 15, 2004. Record of data is available from March 01, 2004 to January 10, 2005.

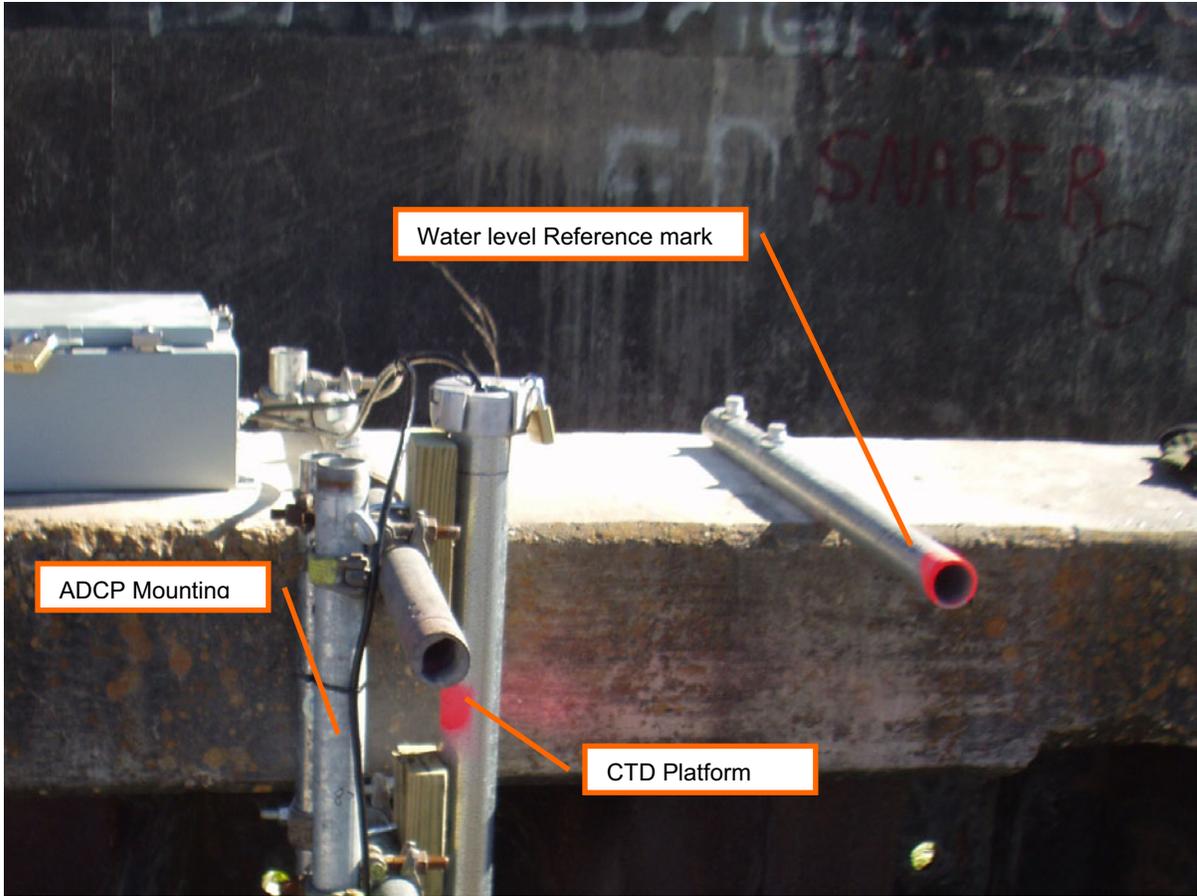
INSTRUMENTS.-- YSI 600LS, Serial Number 03M0432AC
Parameters: Water Temperature, Depth, Specific Conductance, and Salinity

Argonaut (500kH), Serial Number C590
Parameters: Velocity

REFERENCE MARKS.--

CTD: The "mark" associated with the HDCP is filed etch of the side of the CTD stilling well. **Elevation 4.520 ft NAVD 88.**

STAFF: A water level reference mark is a piece of 1.9" OD galvanized pipe attached to the top of the retaining wall with shielded lag bolts adjacent to the DCP. **Elevation 5.120 ft NAVD 88.**



Water level Reference mark

ADCP Mounting

CTD Platform

CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 4- LAROSE, LA (AMENDED)

Written by: Michael Johnston
7-23-2004

LOCATION.-- This station is located in Larose, LA under Hwy 308 Bridge on the south side of the GIWW.

DCP.-- The ADCP and CTD are established on the south retaining wall of the GIWW directly under the bridge. The ADCP and CTD mounting is constructed of four pieces of 1.9" OD galvanized pipe secured to the concrete top of the retaining wall with shielded lag bolts and four right angle scaffolding clamps. The horizontal pieces of the enclosures protrude inward in the GIWW with the CTD stilling well and ADCP deployment pole attached. Protective hardware consisting of 1.9" OD galvanized pipe was added after the collision event.

ESTABLISHMENT AND HISTORY.— Established on February 15, 2004. Record of data is available from March 01, 2004 to January 10, 2005. However, the instrument was involved in a collision event on May 12, 2004, which required the DCP to be reinstalled. The DCP was successfully reinstalled on May 21, 2004. A data gap exists as a result.

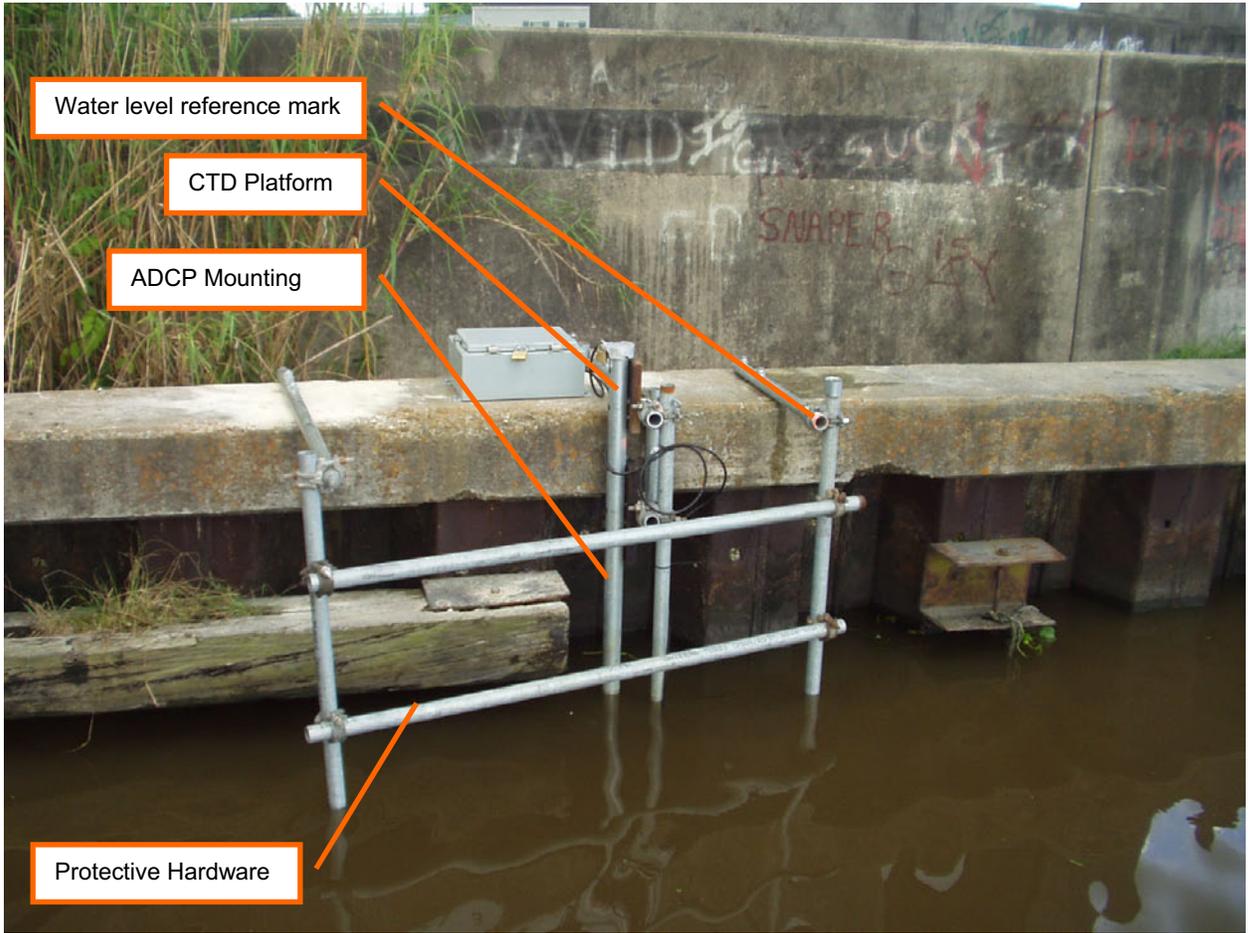
INSTRUMENTS.-- YSI 600LS, Serial Number 03M0432AC
Parameters: Water Temperature, Depth, Specific Sonductance, and Salinity

Argonaut (500kH), Serial Number C590
Parameters: Velocity

REFERENCE MARKS.--

CTD: The "mark" associated with the HDCP is filed etch of the side of the CTD stilling well. **Elevation 4.71 ft NAVD 88** (Post Collision).

STAFF: A water level reference mark is a piece of 1.9" OD galvanized pipe attached to the top of the retaining wall with shielded lag bolts adjacent to the DCP. **Elevation 5.120 ft NAVD 88.**



CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 5- LAROSE, LA

**Written by: Michael Johnston
7-23-2004**

LOCATION.-- Lat 29°41' 35", long -90°07' 54", The station is located in Larose, LA on the northeast side of Bayou Lafourche. The DCP was established on the northeast, downstream fender of the floodgate on Bayou Lafourche.

DCP.-- The DCP is constructed of four pieces of 1.9" OD galvanized pipe with treaded rod and four right angle scaffolding clamps tightly enclosed around a single timber of the floodgate fender. The horizontal pieces of the enclosures extend away from the fender on the in-stream with ADCP deployment pole attached. The CTD stilling well is lag screwed to the fender adjacent to the ADCP.

ESTABLISHMENT AND HISTORY.— Established on February 15, 2004. Record of data is available from March 01, 2004 to January 10, 2005.

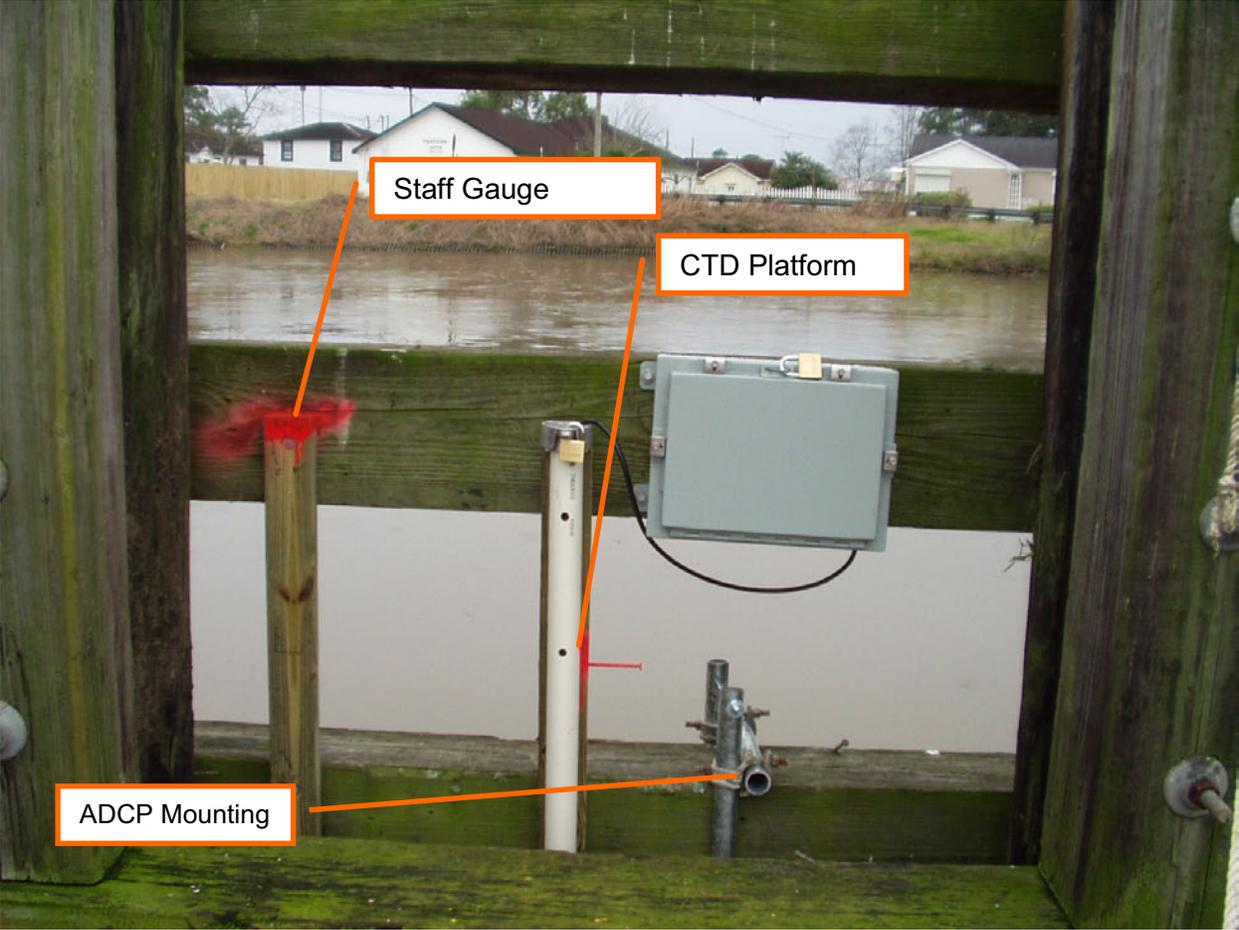
INSTRUMENTS.-- YSI 600LS, Serial Number 03M0432AD
Parameters: Water Temperature, Depth, Specific Conductance, and Salinity

Argonaut (500kH), Serial Number C582
Parameters: Velocity

REFERENCE MARKS.--

CTD: The "mark" associated with the HDCP is a 60d nail driven in the side of the HDCP with fluorescent orange survey paint. A staff gauge platform along with survey mark on piling is installed adjacent to the HDCP. **Elevation 5.711 ft NAVD 88.**

STAFF: A water level reference mark (60d nail) painted is into bulkhead piling approximately five feet upstream from the HDCP. **Elevation 4.291 ft NAVD 88.**





CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 5- LAROSE, LA (AMENDED)

Written by: Michael Johnston
7-23-2004

LOCATION.-- The station is located in Larose, LA on the northeast side of Bayou Lafourche. The DCP was established on the northeast, downstream fender of the floodgate on Bayou Lafourche.

DCP.-- The DCP is constructed of four pieces of 1.9" OD galvanized pipe with treaded rod and four right angle scaffolding clamps tightly enclosed around a single timber of the floodgate fender. The horizontal pieces of the enclosures extend away from the fender on the in-stream with ADCP deployment pole attached. The CTD stilling well is lag screwed to the fender adjacent to the ADCP.

ESTABLISHMENT AND HISTORY.— Established on February 15, 2004. Record of data is available from March 01, 2004 to January 10, 2005. This Station was involved in a collision event on June 11, 2004 and was moved to a more secure location on the floodgate fender on July 9, 2004. The CTD platform was not affected.

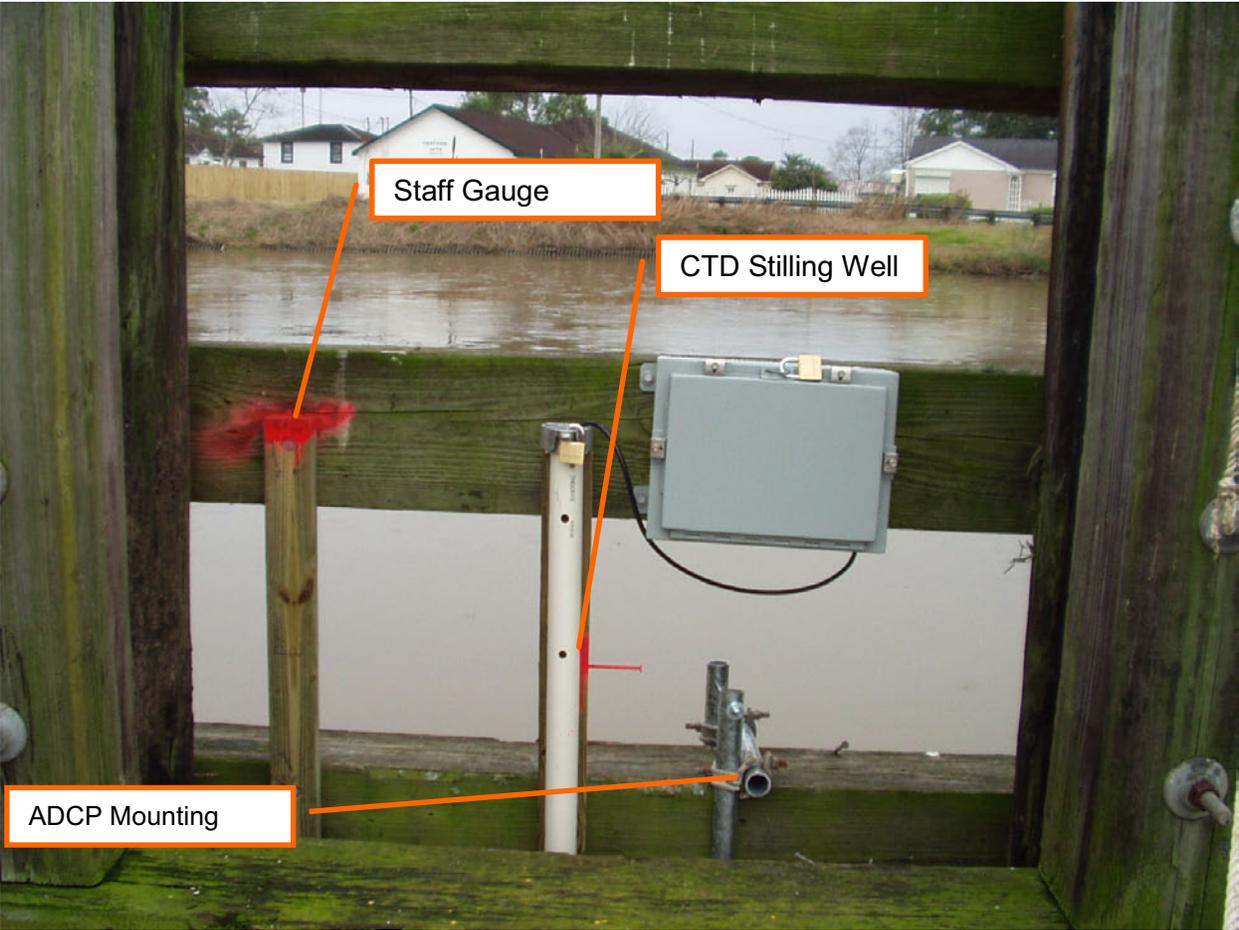
INSTRUMENTS.-- YSI 600LS, Serial Number 03M0432AD
Parameters: Water Temperature, Water Surface Elevation, Specific Conductance, and Salinity

Argonaut (500kH), Serial Number C582
Parameters: Velocity

REFERENCE MARKS.--

CTD: The "mark" associated with the HDCP is a 60d nail driven in the side of the HDCP with fluorescent orange survey paint. A staff gauge platform along with survey mark on piling is installed adjacent to the HDCP. **Elevation 5.711 ft NAVD 88.**

STAFF: A water level reference mark (60d nail) painted is into bulkhead piling approximately five feet upstream from the HDCP. **Elevation 4.291 ft NAVD 88.**





ADCP Mounting

CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 7- GRAND BAYOU MARSH

**Written by: Michael Johnston
7-23-2004**

LOCATION.-- Lat 29°55' 36", long -90°07' 36", The station is located in Grand Bayou Marsh approximately 3 miles northeast of Pointe Au Chein, LA.

DCP.-- The CTD is on the existing platform pilings owned by and with the permission of the USGS. The CTD installation is a 2" PVC well bolted to two horizontal 2x4 cross-timbers (between 2 pilings) on the side of the platform.

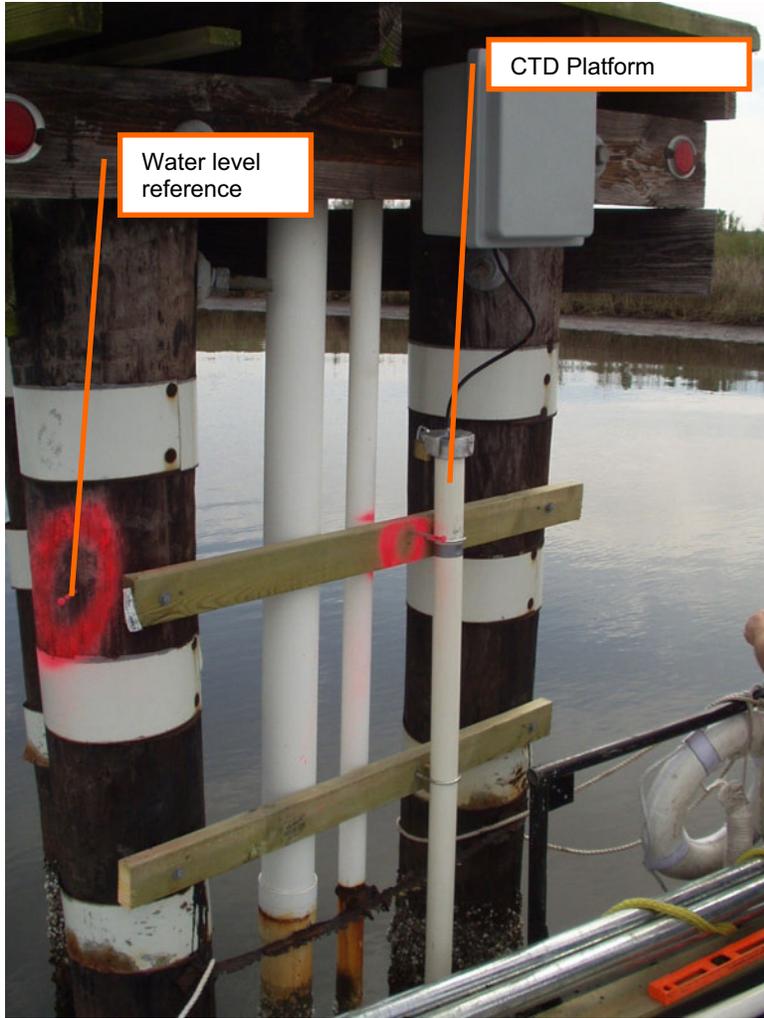
ESTABLISHMENT AND HISTORY.— Established on February 16, 2004. Record of data is available from March 01, 2004 to January 10, 2005.

INSTRUMENTS.-- YSI 600LS, Serial Number 03M0432AB
Parameters: Water Temperature, Water Surface Elevation, Specific Conductance, and Salinity

REFERENCE MARKS.--

CTD: The "mark" associated with the HDCP is a 60d nail next to the CTD stilling well driven in the 2"x4." **Elevation 4.864 ft NAVD 88.**

STAFF: The survey mark is a 60d nail installed in the platform piling adjacent to the DCP. **Elevation 4.784 ft NAVD 88.**



CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 8- MONTEGUT, LA

**Written by: Michael Johnston
7-23-2004**

LOCATION.— Lat 29°07' 24", long -90°05' 24", This Station is located on the fender of the LA 58 Bridge on the upstream, east side of Bayou Terrebonne.

DCP.-- The DCP is constructed of four pieces of 1.9" OD galvanized pipe with treaded rod and four right angle scaffolding clamps tightly enclosed around a single timber of the bridge fender. The horizontal pieces of the enclosures extend away from the fender on the in-stream side with the ADCP deployment pole attached. An additional piece of galvanized pipe and right angle scaffolding clamp is bolted to a piling for additional stability.

ESTABLISHMENT AND HISTORY.— Established on February 13, 2004. Record of data is available from March 01, 2004 to January 10, 2005.

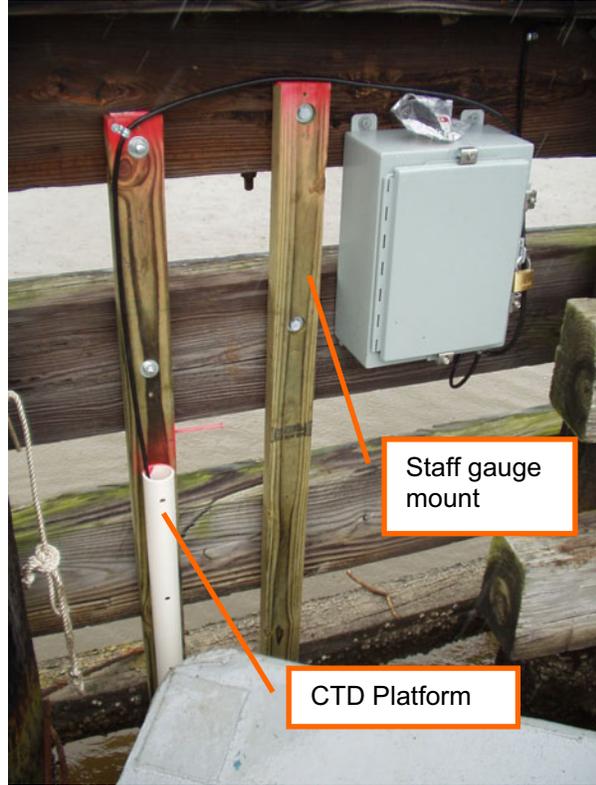
INSTRUMENTS.-- YSI 600LS, Serial Number 03M0432AA
Parameters: Water Temperature, Water Surface Elevation, Specific Conductance, and Salinity

Argonaut (500kH), Serial Number C587
Parameters: Velocity

REFERENCE MARKS.--

CTD: The "mark" is a 60d nail installed in the 2"X4" timber that the CTD well is mounted on. **Elevation 3.712 ft NAVD 88.**

STAFF: A staff gauge platform is treated 2"X4", which mounted adjacent to the CTD unit. **Elevation 5.803 ft NAVD 88.**



CH2M HILL/LDNR

GAUGING-STATION DESCRIPTION

STATION 16- COCODRIE, LA

**Written by: Michael Johnston
7-23-2004**

LOCATION.— Lat 29°53' 56", long -90°52' 09", This station is located on the west side of the Bayou Petite Caillou in Cocodrie, LA.

DCP.-- The DCP consists of two level pieces 1.9" OD galvanized pipe attached approximately one ft apart between two pilings at the end of a dock via lag screws. This ADCP deployment pole is attached to those cross pieces via right angle scaffolding clamps.

ESTABLISHMENT AND HISTORY.— Established on February 17, 2004. Record of data is available from March 01, 2004 to January 10, 2005.

DATA COLLECTION.-- Argonaut (500kHz), Serial Number C581
Parameters: Velocity

LUMCON Equipment:
Parameters: Water surface elevation and salinity

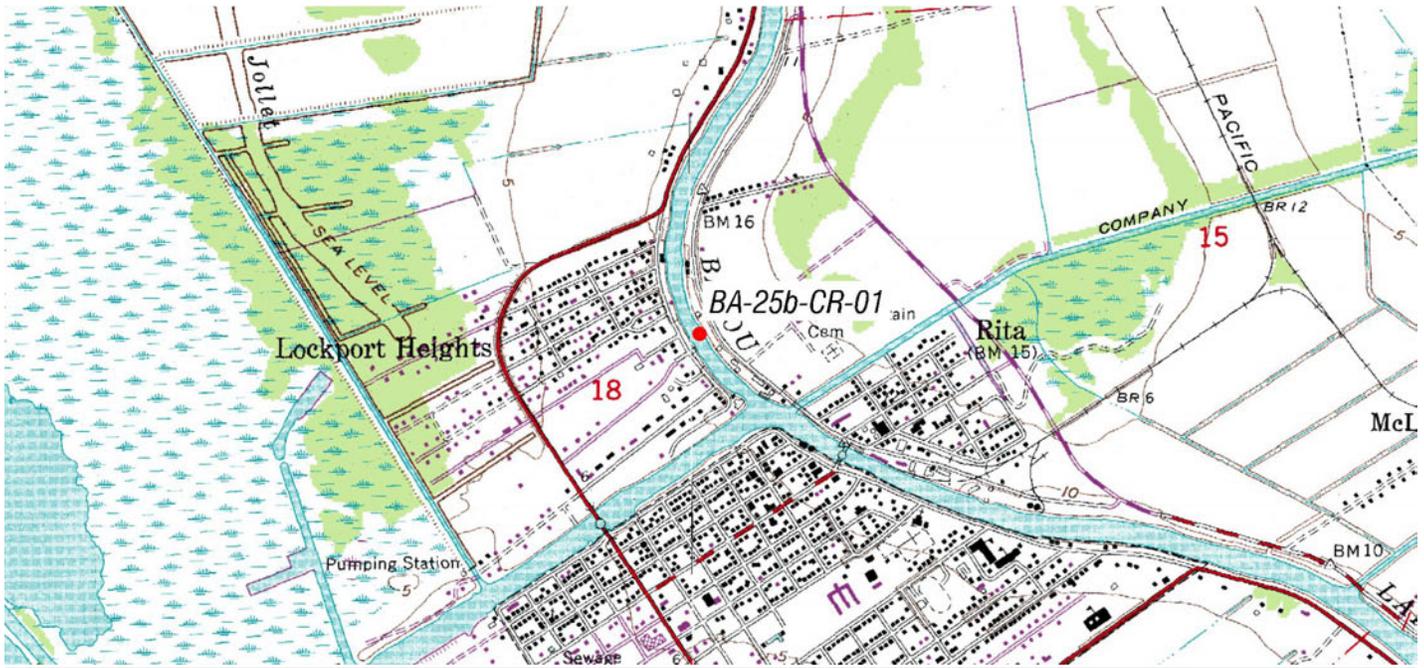
REFERENCE MARKS.--

None:



ADCP Mounting

Attachment 4
Stations 1 through 8 Information



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Lockport" Quadrangle

Station Name: "BA-25b-CR-01"

Location: From the intersection of Bayou Lafourche and the Company Canal in Lockport travel by boat northwest along Bayou Lafourche for 0.2 mile to the continuous recorder on the right. The recorder is located along the bank of the bayou.

Gage Description: The gage is a continuous recorder type gage attached to a 2" x 4" treated wood post with a reference nail driven horizontally into the wood post.

Date of Survey: April 23, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 38' 58.850" N
 Long. 90° 32' 27.198" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 418,967.66
 E= 3,532,546.44

UTM NAD 83 Datum Meters

N= 3,282,496.19
 E= 738,041.80

Elev. Of Top of 60d nail attached to Recorder Post

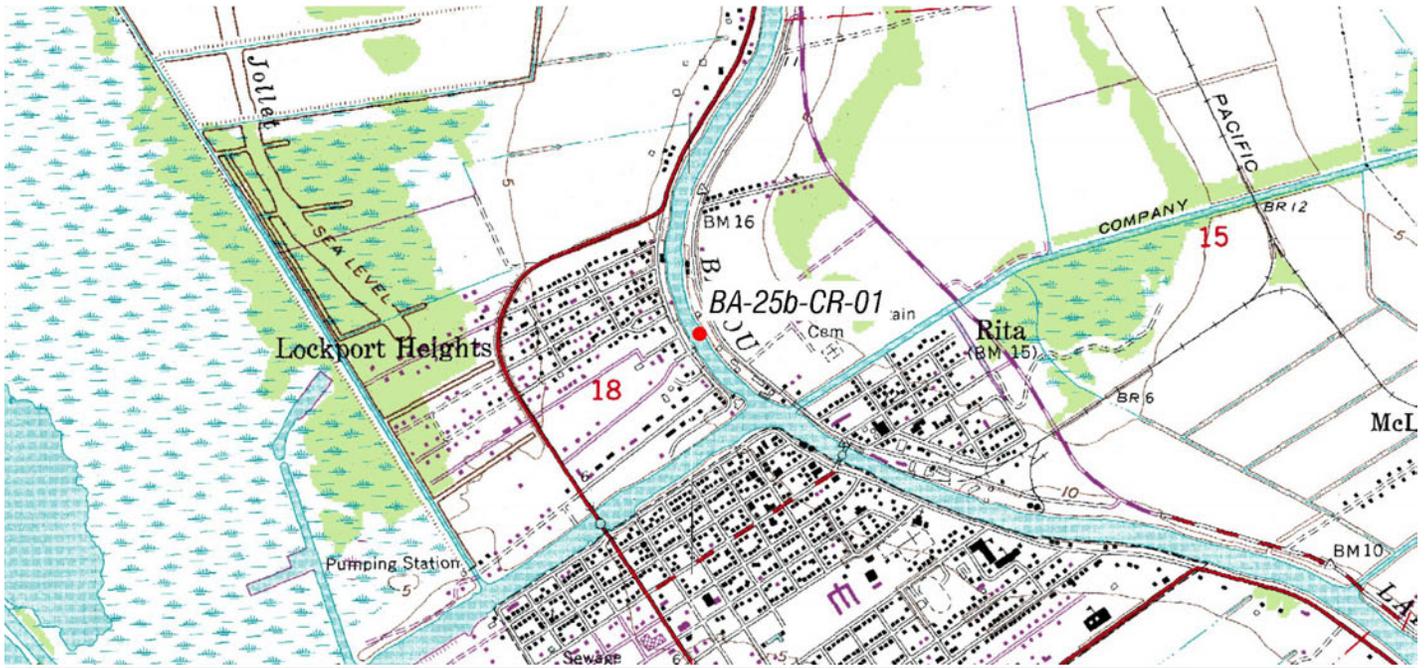
Elevation = 3.35 feet (NAVD 88)

Elev. Of Top of 60d nail attached to 12" dia. Piling Holding gage board

Elevation = 1.95 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "BA-25b-SM-11". This position was surveyed by T. Baker Smith & Son, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division.



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Lockport" Quadrangle

Station Name: "BA-25b-CR-01"

Location: From the intersection of Bayou Lafourche and the Company Canal in Lockport travel by boat northwest along Bayou Lafourche for 0.2 mile to the continuous recorder on the right. The recorder is located along the bank of the bayou.

Gage Description: The gage is a continuous recorder type gage attached to a 2" x 4" treated wood post with a reference nail driven horizontally into the wood post.

Date of Survey: December 27, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 38' 58.920" N
 Long. 90° 32' 27.253" W

Adjusted NAD 83 Datum LSZ (1702) Feet

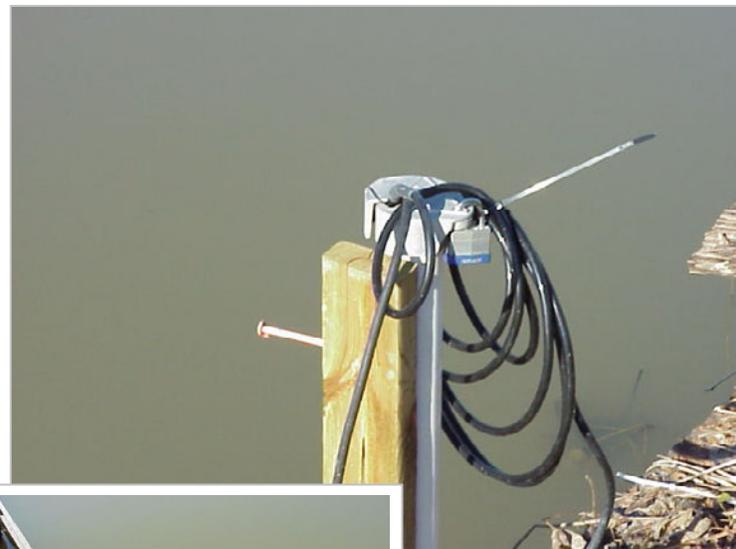
N= 418,974.81
 E= 3,532,541.62

UTM NAD 83 Datum Meters

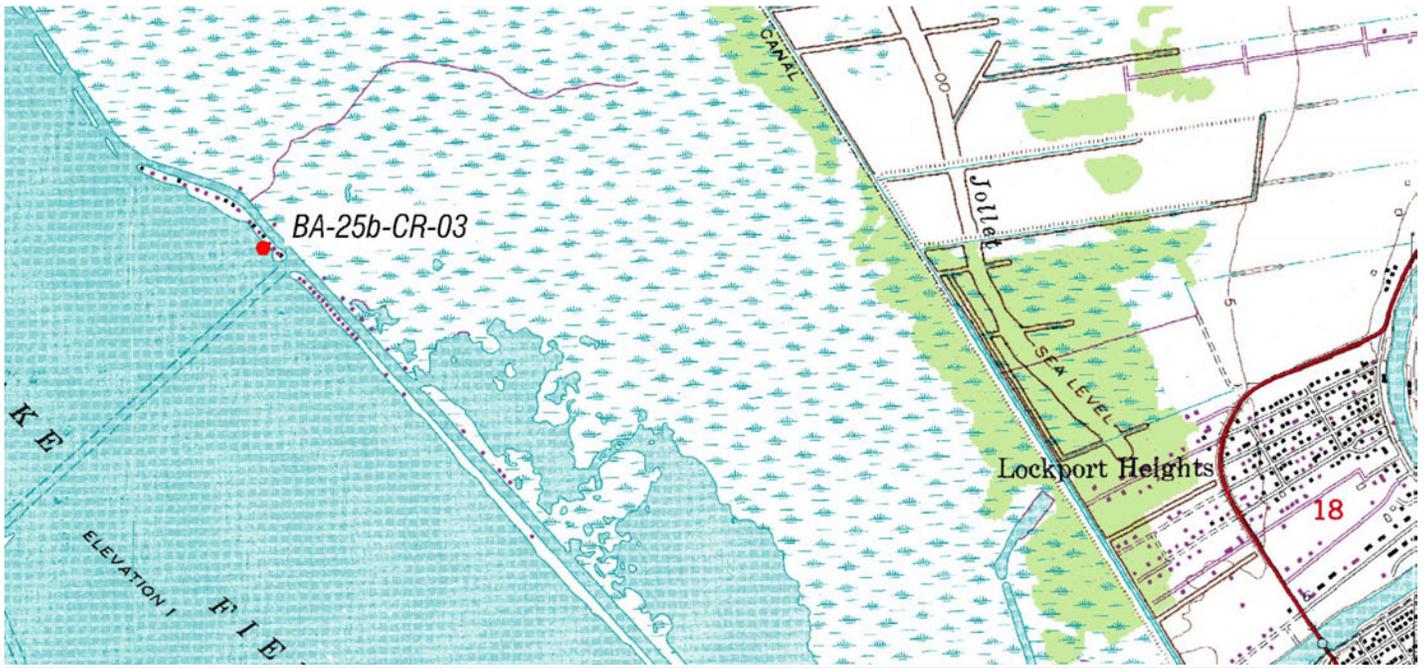
N= 3,282,498.34
 E= 738,040.28

Elev. Of Top of 60d nail attached to Recorder Post

Elevation = 3.39 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "BA-25b-SM-11". This position was surveyed by T. Baker Smith & Son, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division.



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Lockport" Quadrangle

Station Name: "BA-25b-CR-03"

Location: From the intersection of the La. State Hwy. 1 bridge and the Company Canal in Lockport travel, by boat, southwest along the Company Canal for 1 mile to Lake Fields. Once in Lake Fields travel northwest for 1.9 miles to the recording device on the right. The recorder is on the bank near a gray camp.

Gage Description: The gage is a continuous recorder type gage attached to a 2" x 6" treated wood post. A reference nail is driven into a 4" x 4" wood post attached to a wood bulkhead.

Date of Survey: April 23, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 39' 26.508" N
 Long. 90° 34' 48.236" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 421,677.58
 E= 3,520,083.97

UTM NAD 83 Datum Meters

N= 3,283,267.92
 E= 734,230.48

Elevation of top of lock plate through PVC

Elevation = 5.77 feet (NAVD 88)

Elevation of top of 60d Nail in 4" x 4" post

Elevation = 2.62 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "BA-25b-SM-11". This position was surveyed by T. Baker Smith & Son, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division.



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Larose" Quadrangle

Station Name: "BA-25b-CR-04"

Location: From the intersection of the Gulf Intracoastal Waterway and Bayou Lafourche in Larose, travel approximately 0.4 mile northeast to the La. State Hwy. 308 overpass. The continuous recorder is located on the bridge fender system to the north of the bridge and near the east bank of the waterway.

Gage Description: The gage is a continuous recorder type gage attached to the top of a sheet pile cap made of concrete. A reference mark is on the top of a 1 1/2" galvanized iron pipe. The pipe has a cap on it with a gap so a cable can be passed through. The reference mark is the top of the pipe in the gap. A second reference mark is the top of a horizontal 1 1/2" galvanized iron pipe which is laying on the concrete cap near the recorder.

Date of Survey: May 24, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 34' 37.922" N
 Long. 90° 22' 47.688" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 393,000.91
 E= 3,583,896.93

UTM NAD 83 Datum Meters

N= 3,274,803.00
 E= 753,811.28

Elevation at top of a 1.9" O.D. horizontal iron pipe laying on concrete cap

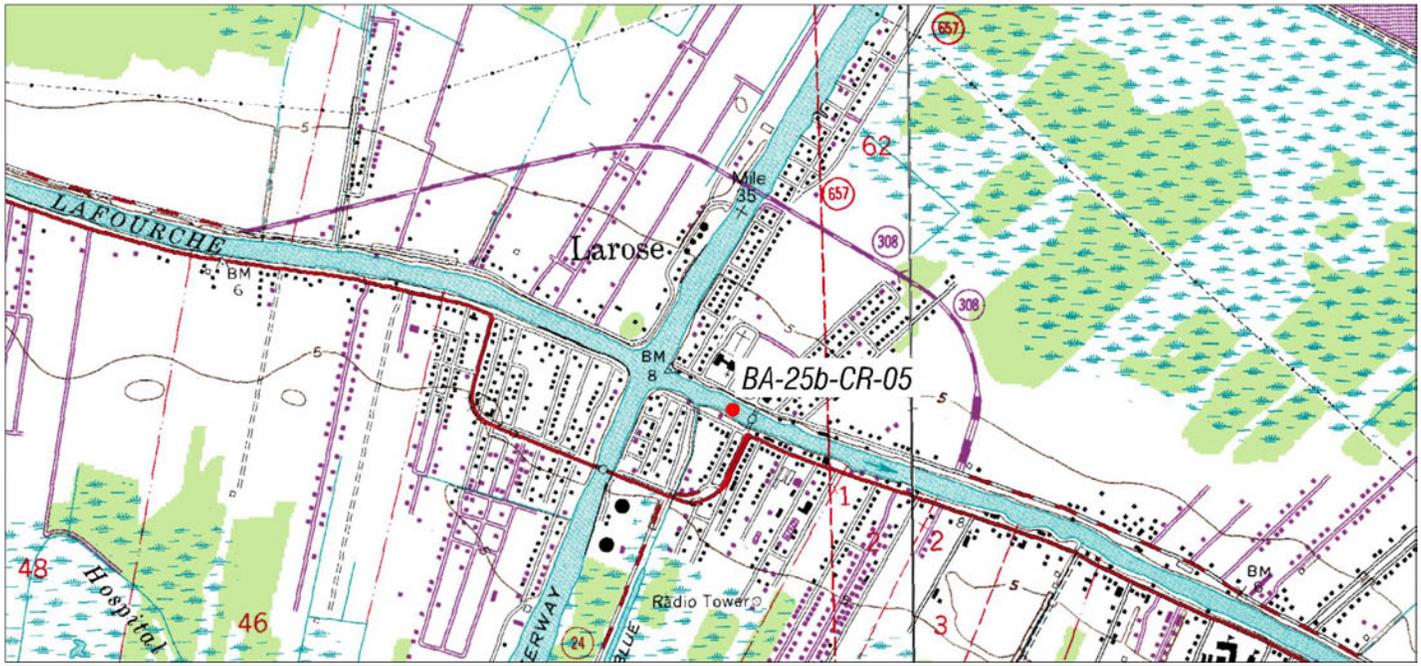
Elevation = 5.12 feet (NAVD 88)

Elevation of top of a vertical 1 1/2" iron pipe with cap.

Elevation = 5.75 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "BA-25b-SM-12". This position was surveyed by T. Baker Smith & Son, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division.



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Larose" Quadrangle

Station Name: "BA-25b-CR-05"

Location: From the intersection of Bayou Lafourche in Larose and the Gulf Intracoastal Waterway travel by boat southeasterly for approximately 1000' to the Larose Floodgate. The continuous recorder is located on the southeast side of the floodgate on the northeast fender.

Gage Description: The gage is a continuous recorder type gage attached to a bridge fender system and a reference nail is attached to a vertical 2" x 4" wood post near the recorder.

Date of Survey: April 22, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 34' 15.439" N
 Long. 90° 22' 52.032" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 390,726.76
 E= 3,583,532.27

UTM NAD 83 Datum Meters

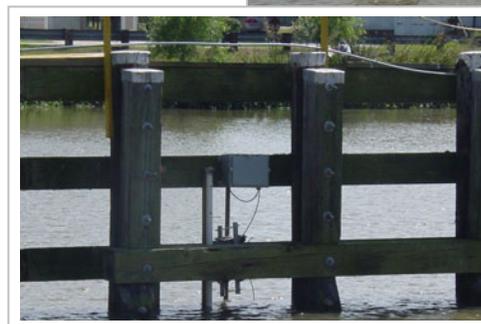
N= 3,274,108.02
 E= 753,709.98

Elevation at Top of 60d nail on 2"x4" board near recorder

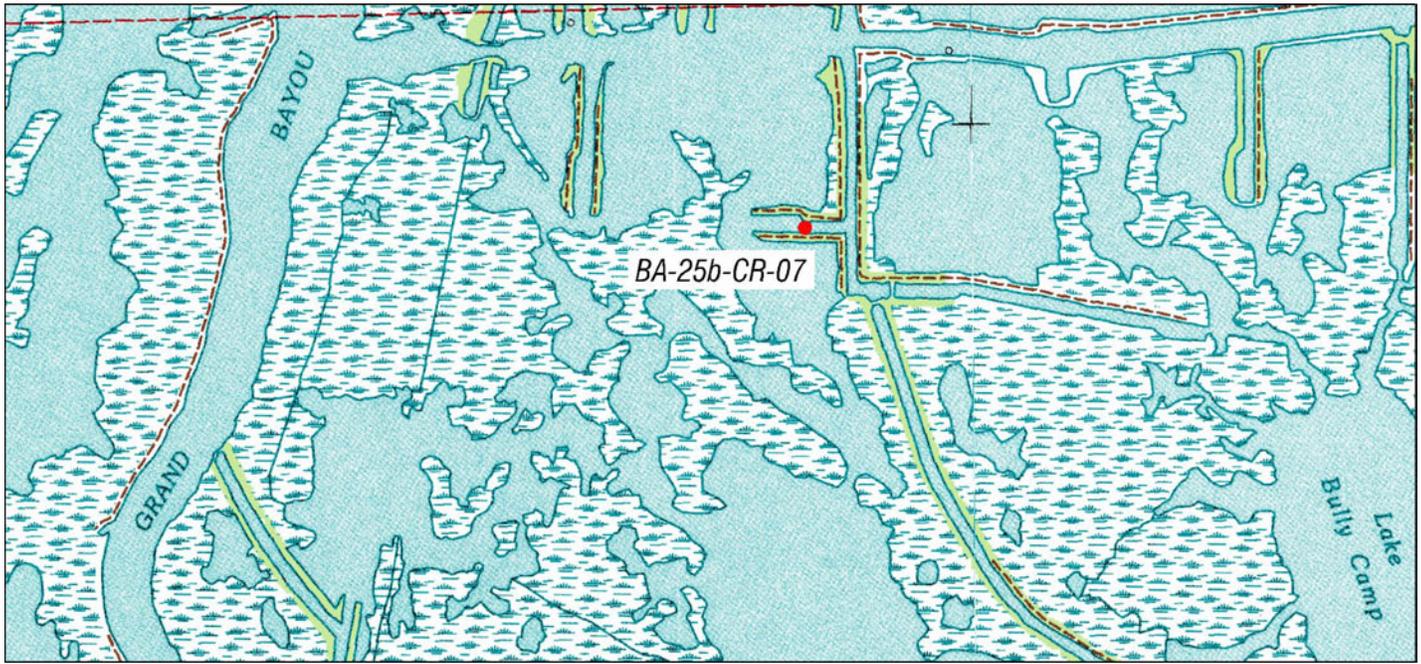
Elevation = 4.29 feet (NAVD 88)

Elevation of Mark on 2"x4" board for Tide gage.

Elevation = 4.00 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "BA-25b-SM-12". This position was surveyed by T. Baker Smith & Son, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division.



VICINITY MAP Scale: 1" = 2"000'

Reproduced from USC&GS "Lake Bully Camp" Quadrangle

Station Name: "BA-25b-CR-07"

Location: From the boat launch at the end of Hwy. 665 in Pointe au Chien, proceed by boat to the intersection of Cutoff Canal and Bayou Pointe au Chien. Travel northeast approximately 0.6 mile to the intersection with Grand Bayou. Travel northerly along Grand Bayou for approximately 1.6 miles and veer to the right to a canal. Travel east along the canal for approximately 1 mile to a pipeline canal. Travel south along the pipeline canal for approximately 0.4 mile to a slip. Travel west along the slip to the recording device on a platform.

Gage Description: The gage is a continuous recorder type gage attached to a 3-pile structure. Reference nails are located on a horizontal 2" x 4" wooden board approximately +/- 4' above the top of the water. One nail is located near the center of the board and the other is located at the end of the board.

Date of Survey: April 26, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 27' 20.118" N
 Long. 90° 25' 20.250" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 348,668.67
 E= 3,570,778.02

UTM NAD 83 Datum Meters

N= 3,261,229.28
 E= 750,003.62

Elevation at Top of 60d nail near center of horizontal 2"x4" board

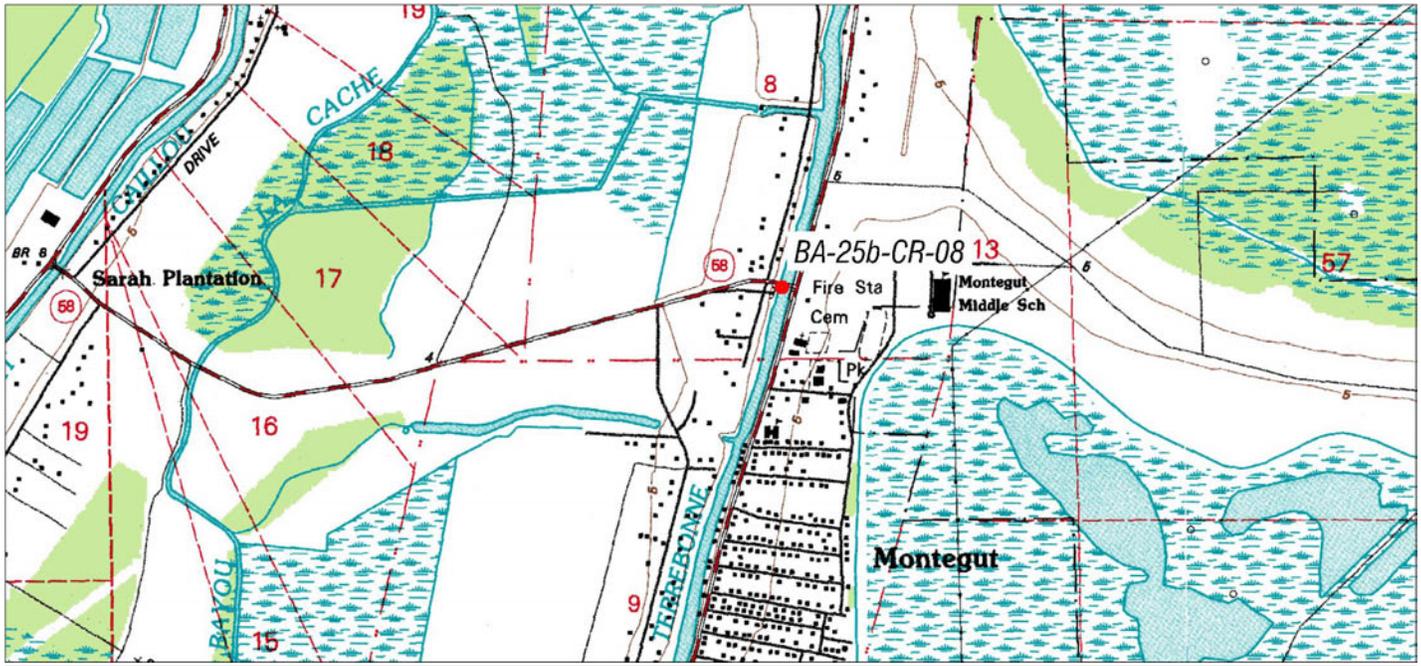
Elevation = 4.86 feet (NAVD 88)

Elevation at Top of 60d nail attached to end of horizontal 2"x4" board

Elevation = 4.78 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "BA-25b-SM-13". This position was surveyed by T. Baker Smith & Son, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division.



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Montegut" Quadrangle

Station Name: "BA-25b-CR-08"

Location: From the intersection of La. State Hwy. 55 and La. State Hwy. 665 north of Montegut proceed south 1.1 miles to the Hwy. 58 bridge crossing Bayou Terrebonne. The recording device is located on the bridge fender system near the east bank of the bayou and on the north side of the bridge.

Gage Description: The gage is a continuous recorder type gage attached to a bridge fender horizontal wooden board. A reference nail is attached to a vertical 2" x 4" wooden post which has an attached PVC pipe.

Date of Survey: April 21, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 28' 54.967" N
 Long. 90° 33' 17.744" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 357,938.31
 E= 3,528,501.06

UTM NAD 83 Datum Meters

N= 3,263,872.34
 E= 737,074.05

Elevation of top of 60d nail in 2"x4" board with PVC pipe attached

Elevation = 3.71 feet (NAVD 88)

Elevation of mark on staff gage board next to recorder box

Elevation = 4.02 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "Ramp". This position was surveyed by T. Baker Smith & Son, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division.

Attachment 5
Remaining Station Descriptions

**DEPARTMENT OF THE INTERIOR
U.S. Geological Survey, WRD
Baton Rouge, Louisiana**

GAUGING-STATION DESCRIPTION

07381350 Company Canal at Lockport, La.

Revised by: S. M. Perrien

Date: 12/11/03

Checked by:

Date:

LOCATION.--Lat 29°38'41", long 90°32'41", T.16 S., R.19 E. S. 18, Lafourche Parish, Hydrologic Unit 08090302. The site is located on the downstream side of the north support pier of La. Hwy. 1 draw bridge, crossing Company Canal in Lockport.

DRAINAGE AREA.--Indeterminate.

ESTABLISHMENT AND HISTORY.--Established as a stage and velocity site.

History: The gauge-house was installed on July 30, 1997 by Errol P. Meche and Glen T. Stevens. The equipment was installed by C. K. Labbe' and A. N. Tarver on July 31, 1997. The first stage recorder was a Design Analysis pressure transducer and the flowmeter was an acousonic acoustic velocity meter (AVM). On December 22, 1997 an Isco flowmeter replaced the AVM. This unit also collected stage data. For the time the Isco meter was installed, two stage values were recorded for comparison. The Design Analysis stage was the primary stage used and reported. On May 5, 1998 the Isco flowmeter was removed and replaced by a Marsh McBirney electro-magnetic flowmeter.

All equipment was removed on November 1, 1999. No data was collected from November 2, 1999 until April 23, 2002. On April 23, 2002 a YSI 600R was installed by Errol P. Meche and Todd E. Baumann. Site is programmed to collect stage, water temperature, specific conductance, and salinity

CHANNEL.--One channel at all stages. Site is 680 yards from Bayou Lafourche. Well defined banks and very soft bottom.

GAUGE.-- Aluminum shelter bolted to hand rail that surrounds bridge pier. A 4" PVC pipe is U-bolotted to angle iron which is attached to the bridge pier. The YSI 600R is placed in this pipe.

CONTROL.--Wind and possible tide affected throughout range of stage.

DISCHARGE MEASUREMENTS.--None

FLOODS.--none

POINT OF ZERO FLOW.--Indeterminate.

COOPERATION.--Bayou Lafourche Fresh Water District

SKETCH.--See attached map

PHOTOGRAPHS.—none

COMPARISON SITES.-- 07381355 Company Canal at Salt Barrier nr Lockport, LA
07381235 GIWW West of Bayou Lafourche at Larose, LA
07381331 GIWW at Houma, LA

REFERENCE MARKS AND BENCH MARKS.—

TBM 2 -- lat. 29°38'47", long. 90°32'13" Chiseled 'x' in right downstream headwall at station #250. The mark is in the abutment immediately streamward of bridge traffic arms on Bayou Lafourche in Lockport. Elevation: **18.349**

R.M. 1 -- Top of fire hydrant at corner of La. Hwy. 1 and La. Hwy. 655 across street from Exxon station. Corner of Vacherie St. and Crescent St. Elevation: **7.899**

RP-1 -- Two file notches on Bridge rail approximately in center of bridge span on the upstream side of bridge. Elevation: **16.093**

RP-2 -- Two file notches under back left corner of gauge house on metal plate anchoring handrail. Elevation: **4.132**

**DEPARTMENT OF THE INTERIOR
U.S. Geological Survey, WRD
Baton Rouge, Louisiana**

GAUGING-STATION DESCRIPTION

07381235 GIWW West of Bayou Lafourche at Larose, La.

Revised by: S. M. Perrien

Date: 02/21/03

Checked by:

Date:

LOCATION.--Lat 29°34'06", long 90°23'07", T.17 S., R.20 E. S. 45, Lafourche Parish, Hydrologic Unit 08090302, on the right bank of stream, one hundred yards upstream of the Highway 1 bridge at Larose, 450 yards upstream from crossing of Bayou Lafourche.

DRAINAGE AREA.--Indeterminate.

ESTABLISHMENT AND HISTORY.--Established as a discharge site for a one-year project that became a permanent site. The gauge was installed in March of 1997.

History: The original gauge-house was installed by Errol P. Meche and Glen T. Stevens in March of 1997. The equipment was installed later on March 28, 1997 by C. Kevin Labbe' and Andrew N. Tarver. After several failed attempts of keeping the site functioning at the original location, the site was abandoned and moved one-half mile downstream to the Hwy. 308 bridge where it collected data for two months before being destroyed. On April 7, 2000 the site was reinstalled just upstream of the Hwy 1 bridge on the bulkhead of the right bank.

CHANNEL.--One channel at all stages. Channel is straight for 1.2 miles upstream and 6.0 miles downstream from gauge. Sheet pile and wooden containment walls, intermittently line both banks. Heavy concrete and steel debris line the bottom of the measurement cross-section.

GAGE.-- Aluminum shelter bolted to two 2" aluminum pipes, concreted into bank. One ten-watt solar panel is attached to the top of the shelter. The water quality/water level probe is located in a two-inch PVC pipe, attached to pile on retaining wall. The velocity probe is a Sontek Argonaut SL which is mounted to the right wing wall of the Hwy. 1 bridge, approximately 100 yards downstream from the site. SDI radios were installed on Sept 9, 2002 when the velocity probe was moved to the wing wall of Hwy. 1 bridge. The probes are attached to a Handar 555 data logger with a GOES radio.

CONTROL.--Wind and tide affected throughout range of stage. Boat traffic has significant effect on doppler type measurements and velocity readings.

DISCHARGE MEASUREMENTS.--Measurements are made 200 ft. upstream of site. The cross section starting and ending points are defined by waypoints that can be found in the giwwway.wpt file on BRFO archive computer. All measurements used to define rating are made with an ADCP. Lots of boat traffic makes measurements difficult.

FLOODS.--none

POINT OF ZERO FLOW.--Indeterminate.

COOPERATION.--U.S. Army Corps of Engineers.

SKETCH.--see attached map

PHOTOGRAPHS.--In BRFO photo archive

REFERENCE MARKS AND BENCH MARKS.--

GPSBM1--Chiseled square, on concrete slab, located in junk yard behind Mobil station, on the north west corner of slab, approximately fifteen feet from west end of shed. The mark is painted blue and recessed below level of slab. The slab of concrete is situated west of Bayou Lafourche, south of GIWW and just east of Hwy. 1 bridge approximately 150 feet east south-east of BM-J220. **Elevation- 5.639 ft (5-10-00).**

BM J220--Bronze disk located about .15 miles west of the east end of the concrete drawbridge over intracoastal waterway at Larose (Hwy. 1). About .1 mile west of the junction of state highway 24 leading south under the east end of the bridge, set vertically in the east face of the most northeasterly one of four concrete pillars supporting the bridge, 102 feet west of the bottom edge of the bottom concrete step of a stairway leading to the control tower on top of the bridge, and about three feet above the ground level. **Elevation- 7.899 ft (5-10-00).**

RP 1--Destroye .

RP 2--Two file notches in the support bracket for the flowmeter. **Elevation- 4.444 ft (5-10-00)**

**DEPARTMENT OF THE INTERIOR
U.S. Geological Survey, WRD
Baton Rouge, Louisiana**

GAUGING-STATION DESCRIPTION

07380401 BAYOU LAFOURCHE SW OF DONALDSONVILLE, LA.

Revised by: C. K. Labbe

Date: 05/28/2002

Checked by:

Date:

LOCATION.--Lat 30°05'47", long 91°00'21", in sec. 35, T. 11 S., R. 2 E., Ascension Parish, Hydrologic Unit 08070204, on the downstream side of bridge connecting Hwy. 1 and Hwy. 308, located 1.0 mile south of Marchand Drive (Hwy. 3089).

DRAINAGE AREA.--Not determined.

ESTABLISHMENT AND HISTORY.--Established July 20, 1995 by M.L. Ross and C.L. Jones as a miscellaneous measurement site only. December 17, 1996, converted to a stage/discharge site by E. Meche, B. E. McCallum, and J. C. Resweber. On December 22, 1999, after it was found that stage could not be related to discharge, a magnetic flowmeter was installed to collect velocity. On April 4, 2002, a Sontek Argonaut SL Doppler current meter was installed to eventually replace the Marsh McBirney.

GAGE.--Handar 555 data-collection platform, a Handar 436b encoder, a Marsh-McBirney model 2000 flow meter, Sontek Argonaut SL and a tipping bucket rain gauge, in a metal shelter on a 24-inch CMP well.

CHANNEL AND CONTROL.--Channel control at all stages. The channel is straight above and below the gauge.

DISCHARGE MEASUREMENTS.--Discharge measurements are made approximately one-hundred feet upstream of the bridge using a Doppler current profiler.

REGULATION.--Flow is regulated by the Lafourche Fresh Water District Pumping Station located at the Mississippi River.

DIVERSION.--Pumping plant at Donaldsonville pumps water into Bayou Lafourche from the Mississippi River. Water is pumped from Bayou Lafourche above and below gauge for public water supply, irrigation, and sugar mill operations, at a rate of 3.3 mgd.

ACCURACY.--Fair

COOPERATION.--La. Department of Environmental Quality.

TRAFFIC CONTROL.--See Traffic Control Handbook: p. 8.

REFERENCE MARKS.—

BME 363 1982: Monument located in 6-inch sleeve with metal access cover. Monument is 63 ft. west of center line of a road crossing Bayou Lafourche, 1.0 mi. from Hwy. 70, 1.3 ft. east of a power pole 27 ft. from the center line of Hwy. 308. Elevation, 22.487 ft. NAVD 88.

RM-1: Chiseled square on left upstream walkway 0.6 ft. from the upstream edge of walkway and 0.4 ft. from the left edge of walkway. Elevation, 22.819 ft. NAVD 88. (Levels of 04/04/96).

RP-1: Top edge of a 1-1/4-inch nut painted orange at Station 110 on the upstream side of the bridge, across from the gauge house Elevation, 22.500ft. NAVD 88. (Levels of 04/04/96)

**DEPARTMENT OF THE INTERIOR
U.S. Geological Survey, WRD
Baton Rouge, Louisiana**

GAGING-STATION DESCRIPTION

07381000 BAYOU LAFOURCHE AT THIBODAU, LA.

Revised by: C. K. Labbe

Date: 05/22/2002

Checked by: T. Bauman

Date: 02/06/2004

LOCATION.--Lat 29°47'52", long 90°49'21", in lot 117, T.15 S., R.16 E., Lafourche Parish Hydrologic Unit 08090301 on downstream side of the left pier of old drawspan of bridge, on State Highway 20 at Thibodaux, 2.7 miles upstream from Laurel Valley Canal.

DRAINAGE AREA.--Indeterminate.

ESTABLISHMENT.--May 14, 1954, by M.F. Cook and J.H. Holm as a continuous recording gauge.

HISTORY.--U.S. Army Corps of Engineers operated this from July 28, 1949 to May 14, 1954, collecting intermittent gauge heights obtained from a Staff Gauge, Section 0-8 ft, graduated to tenths. A Stevens water-stage recorder installed in 1954. Fisher-Porter recorder was replaced with a Sutron 8400 electronic data logger on August 5, 1996 by J.C. Resweber and W. B. Snee. The Sutron was replaced with a Handar 560 DCP on February 19, 1997 by G. B. Ross and J. C. Resweber.

On April 2, 2002, a Sontek Argonaut SL Acoustic Doppler Velocity meter was installed on the same bridge pile as the stilling well. The Handar 560 was replaced with a Vaisala 555A. The shaft encoder was upgraded from an 436A to 436B.

GAGE.--Vaisala 555A data-collection platform, equipped with float-tape gauge, acoustic velocity meter, Yagi antenna and solar panel, in metal shelter on 24-inch CMP well attached to downstream side of pier on bridge at intersection of Hwy. 1 and 20. The datum of the gauge is NAVD 88, as determined from B.M. M-229 (elevation 18.440 ft).

Auxiliary gauge: Sutron 8400 Electronic water-stage recorder, replaced on June 30, 1999 with a Handar 555 DCP, in metal shelter over CMP well attached to third pile from left bank on downstream side of bridge on Hwy. 20. Wire-weight gage attached to downstream handrail. Installed May 2, 1984.

CHANNEL AND CONTROL.--Channel control at medium and high water. A weir 1,000 ft below the gauge is the control at low water. The channel is straight above and below the gauge.

DISCHARGE MEASUREMENTS.--Discharge measurements were made from the first bridge below the weir. As of June 6, 2000 measurements will be made from the first bridge where the base gauge is located.

As of April 2, 2002, all discharge measurements are made with an acoustic doppler current profiler approximately seventy-five feet downstream of the bridge. Using a tagline.

REGULATION.--A concrete weir constructed May 1970, 1,000 ft below gauge.

DIVERSION.--Pumping plant at Donaldsonville pumps water into Bayou Lafourche from the Mississippi River. Water is pumped from Bayou Lafourche above and below gauge for public water supply, irrigation, and sugar mill operations, at a rate of 3.3 mgd.

ACCURACY.--

COOPERATION.--Department of Environmental Quality.

REFERENCE MARKS.--BM-M-229 brass disk set in walkway on south end of concrete bridge over Bayou Lafourche at the intersection of State Highways 1 and 20. Elev., 18.440 ft., NAVD 88.

RM-158, (previously BM-158). In the city of Thibodaux at north end of main bridge over Bayou Lafourche, in top of north end east curbing of bridge, chiseled square. Chiseled square in left upstream corner of the left downstream walkway of bridge. Elevation, 18.059 ft. above sea level. (levels of April 6, 1996), (Used as origin on August 5, 1999), NAVD 88.

RM-1: Chiseled "x" on downstream corner of left downstream abutment of bridge over Bayou Lafourche. Elevation, 15.913 ft. (Levels of April 6, 1996), not ran to in 1999, NAVD 88. (not located during levels of 1999)

RM-2: Destroyed

RP-1: High point of hexagon nut on 1/2-inch bolt on outside of right side of gauge house. Elevation, 17.082 ft. (Levels of August 5, 1999), NAVD 88.

**DEPARTMENT OF THE INTERIOR
U.S. Geological Survey, WRD
Baton Rouge, Louisiana**

GAUGING-STATION DESCRIPTION

295501090190400 Davis Pond Diversion near Bogalusa, La.

Written by: V.G. Bergeron

Date: 02/05/03

Checked by:

Date:

LOCATION.--Lat. 29°55'00" N., long 90°19'04" W., Quad. New Orleans West, T14 S, R 22 E., located in Jefferson Parish. The site can be reached by traveling east on Interstate 10, turn south on Interstate 310 crossing the Mississippi River on the Luling Bridge, turn east on Highway 90 travel 11.5 miles. Site is located on the upstream side of bridge.

ESTABLISHMENT AND HISTORY.--The site was established January 17, 2002 by Errol Meche and Troy Devillier.

DRAINAGE-AREA--Indeterminate

GAGE.--Gaugehouse is a 28" x 28" x 24" watertight aluminum enclosure mounted on upstream concrete bridge rail. Site is equipped with a Handar 555A DCP, YSI 600XL water quality monitor collecting water level, temperature, conductance, salinity and a Sontek velocity meter. All equipment collects data hourly. Site also collects battery voltage at 4-hour intervals. Transmissions are made on channel 39 at an assigned time of 013900 and every 4 hours thereafter.

CHANNEL-CONTROL-- A man-made channel to divert Mississippi river water to the coastal zone.

DISCHARGE--None

REGULATIONS-DIVERSIONS--The Davis pond fresh water diversion of the Mississippi River.

COOPERATION.--Louisiana Department of Natural Resources

PURPOSE.--To monitor the effects of the fresh water diversion.

ACCURACY.--Good.

REFERENCE MARKS.- Datum of gauge is -6.962 (NAVD 88) established by GPS surveying September 20, 2001.

RM GPS: Chiseled square in downstream right corner of right abutment. Elevation is 10.732 feet (NAVD 88).

RM 1: Chiseled square in left corner near abutment in upstream wingwall. Elevation is 10.548 (NAVD 88).

RP 1: File notch in aluminum angle 1 foot to the right of the gauge house. Mounted to the bridge rail. Gauge Height = 20.00 feet.

**DEPARTMENT OF THE INTERIOR
U.S. Geological Survey-WRD
Baton Rouge, Louisiana**

GAUGING-STATION DESCRIPTION

2951190901217 L. Cataouatche at Whiskey Canal

Written by: V. G. Berenson

Date: 01/24/2003

Checked by:

Date:

LOCATION.--Lat. 29°51' 19", long 90°12' 17", R 9 E, T 14 S, New Orleans Quadrangle, Jefferson parish near Bayou Segnette State Park, on a 4 by 4 ft. wooden platform 30 ft. west of the end of Whiskey Canal in L. Cataouatche. Station can be reached from Baton Rouge by driving south on Interstate 10, crossing the Mississippi River on Interstate 310, turning left at Highway 90, then veering to the right once on Highway 90, 17 mi. to Waggaman, La. Then right off Highway 90 to Bayou Segnette Federal Park. From the landing at Bayou Segnette Park, proceed south down Waggaman Canal 6 mi. to Whiskey Canal, then left on Whiskey Canal 1 mi to L. Cataouatche.

DRAINAGE AREA.--Indeterminate.

ESTABLISHMENT AND HISTORY.--Established November 7, 2000 by Garron B. Ross, Errol P. Meche and Troy Devillier.

GAGE.-- Datum of gauge is 10.00 ft. and is assumed. A Handar 555A data collection platform with a YSI 600XL multi-probe was installed to collect water level, water temperature, specific conductance, and salinity.

COOPERATION.--Louisiana Department of Natural Resources.

PURPOSE.--Part of a coastal monitoring network of gauges.

COMPARABLE STATIONS.

073802375 Lake Salvador near Lafitte, La.

DISCHARGE MEASUREMENTS.--None.

REGULATION AND DIVERSION.-- Davis Pond Fresh Water Diversion Project.

ACCURACY.-- Site is affected by wind and tide.

REFERENCE MARKS.--Datum of gauge is -2.96 ft.(NAVD 88). Established by GPS surveying on September 2001.

RM 1: Nail in center of 4 X 4 platform. **Elevation is 7.450 feet (NAVD 88).**

RP 1: Top of 3/4" lag bolt head in 2 X 4 deck support on east side of platform directly above 4" PVC pipe housing YSI probe, facing Whiskey Canal. Gauge height = 7.040 feet. (NAVD 1988) of levels run on March 25, 2002.

**DEPARTMENT OF THE INTERIOR
U.S. Geological Survey-WRD
Baton Rouge, Louisiana**

GAUGING-STATION DESCRIPTION

073802375 LAKE SALVADOR NEAR LAFITTE, LA

Written by: P. A. Ensinger

Date: 01/18/01

Checked by:

Date:

LOCATION.--Latitude: 29° 46' 07", Longitude: 090° 11' 15", T 15S, R 22E, Quad 201C, Jefferson Parish, Hydrologic Unit Code 08090301, installed on an oil production platform in the Bayou Villars Oil Field 3 miles south of Couba Island on Lake Salvador. Station can be reached from Baton Rouge by driving South on I-10 to the Hwy 310 exit, head south on Hwy 310 to the US-90. Travel west on US-90 to the West Bank Express Way, go southeast on the West Bank Express Way and make right on Drake Avenue at Bayou Segnette State Park Entrance. From Bayou State Park Boat Launch, travel south by boat approximately 5 miles along Bayou Segnette to Bayou Bardeaux. Travel 1 mile south along Bayou Bardeaux to entrance of Lake Salvador, continue south-southwest for about 3 miles to station.

DRAINAGE AREA.--Indeterminate.

ESTABLISHMENT AND HISTORY.--Period of record held by the USGS is from August 1999 to present. Site was established on August 24, 1999 by C. K. Labbe' and T.A. Devillier.

GAGE.-- A Handar 555a GOES data transmitter with satellite telemetry is mounted inside a 16"x 16" fiberglass gauge house with a YSI 6600 multi-parameter sensors submerged in a four-inch pvc pipe approximately four feet from the surface collecting water level, specific conductance, salinity, water temperature, pH, Turbidity, and Chlorophyll. A Handar 425 A wind speed and direction sensor is mounted on a 1" aluminum pipe approximately 15' above the gauge house. Datum of the gauge is an assumed elevation.

COOPERATION.--Jefferson Parish Environmental and Development.

PURPOSE.--Part of EMPACT program, measuring water temperature, specific conductance, salinity, water level, pH, turbidity, and chlorophyll of Lake Salvador pre-, and post- Davis Pond Diversion conditions.

DISCHARGE MEASUREMENT.--None.

CONTROL.--None.

HIGHWAY STRUCTURES.--None.

REGULATION AND DIVERSION.—Davis Pond freshwater diversion, station number 295501090190400.

ACCURACY.--Records for specific conductance, salinity, and water temperature are good. Elevation record is good within the limits of the GPS survey.

FLOODS.--None.

REFERENCE MARKS.--

R.M. 1: Top edge of painted Lag Bolt located approximately 2' from the upper platform northeast corner. Assumed Elevation is 7.17 ft.

R.M. 2: Top edge of painted Lag Bolt located on pile between lower and upper platform. Assumed Elev. 5.30 ft.

**DEPARTMENT OF THE INTERIOR
U.S. Geological Survey, WRD
Baton Rouge, Louisiana**

GAUGING-STATION DESCRIPTION

073802515 BARATARIA BAY PASS EAST OF GRAND ISLE

Revised by: V.G. Beron

Date: 11/19/03

Checked by:

Date:

LOCATION.--Lat 29°16' 32", long 89°56' 29", Quad-Barataria Pass, Jefferson Parish, Hydrologic unit 08090301, on a walkway between buildings near the Grand Terre Marine Lab on Grand Terre Island, 1.0 mi east of Grand Isle. Station can be reached from Baton Rouge by driving south on Interstate 10, crossing the Mississippi River on Interstate 310, turning east on State Highway 90 and traveling to Highway 45, then turning south on Highway 45. Travel south to Lafitte, La. Launch at C-Way Marina. Travel, by boat south in Barataria Waterway from the launch 23 miles to the Grand Terre Marine Lab on Grand Terre Island.

DRAINAGE AREA.--Indeterminate.

ESTABLISHMENT AND HISTORY.--Established at present site by Louisiana State Wildlife & Fisheries at an unknown time as an Endeco 1152 datalogger, then acquired by Louisiana Department of Natural Resources, and taken over by the USGS on July 27, 1992.

GAUGE.--On October 19, 1995, a Handar 555A data collection platform was installed within an aluminum shelter mounted on the same walkway where the Endeco gauge was located. Specific conductance, water temperature, salinity, and vented water level are measured by a YSI 600XL probe. Rainfall is measured by a Handar 444A tipping bucket raingage. No rain fall being collected as of October, 1999. Datum of gauge is 0.000 feet referenced to 1988 NAVD. Prior to October 1, 1998, a datum adjustment of +0.282 feet is needed to correct to current datum.

COOPERATION.--Louisiana Department of Wildlife and Fisheries.

PURPOSE.--Part of a coastal monitoring network of gauges to measure water temperature, specific conductance, salinity, and water level.

COMPARABLE STATIONS.--This station can be compared with the following stations:

07380335 Little Lake near Cutoff, LA

07380340 Tennessee Canal near Cutoff, LA,

073802512 Hackberry Bay NW of Grand Isle, LA
07380251 Barataria Bay North of Grand Isle, LA

DISCHARGE MEASUREMENT.--None.

ACCURACY.--Data from DCP is good for all parameters. Site is affected by wind and tide.

FLOODS.--Tropical Storm Frances and Hurricane Georges in September, 1998 and tropical storm Isadore and Hurricane Lily September, 2002.

REFERENCE MARKS.--Datum of gauge is 0.000 feet, referenced to the 1988 NAVD.

RP 1: Top of railroad spike driven in south side of south walkway piling. Elevation was 3.836 feet (1929 NGVD). **Current elevation is 4.118 feet (1988 NAVD) from levels of March 19, 1999.**

RP 2: Top of head of lag bolt in 12-inch piling on the north side of the walkway, approximately six feet to the left of the gauge house. **Elevation is 4.313 feet (1988 NAVD) from levels of March 19, 1999.**

RP 3: Top of 1 1/4" square bolt head in 12-inch piling (same as one with RP 1) on the south side of the walkway, approximately 3 feet to the right of the gauge house. **Elevation is 8.845 feet (1988 NAVD) from levels of March 19, 1999.**

RM 1: DESTROYED.

RM 2: DESTROYED.

RM 3: Top of 60 # nail in center of walkway approximately 6 feet to the left of the gauge house and 2.5 feet from the north edge of the walkway. **Elevation is 9.796 feet (1988 NAVD) from levels of October 29, 1998.**

RM 4: Top of 1 1/2" square bolt head in 12-inch piling on the north side of the walkway (same piling as RP 2) about 6 feet left of the gauge house. **Elevation is 9.313 feet (1988 NAVD) from levels of March 19, 1999.**

RM 5: 1/2 inch lag bolt in top of piling on left end of downstream walkway. 20 feet left of gauge house. **Elevation is 8.941 feet from GPS levels of September 21, 2001.**

DEPARTMENT OF THE INTERIOR
U.S. Geological Survey, WRD
Baton Rouge, Louisiana.

STATION DESCRIPTION

07381328 Houma Navigation Canal at Dulac, La.

Revised by: L. Simmons

Date: 11/12/2003

Checked by:

Date:

LOCATION--.Lat. 29°23'06"N, Long. 90°43'47" W, Quad: Dulac, LA, in Sec. 86, T. 19 S., R. 17 E., St. Helena Meridian, Terrebonne Parish Hydrologic Unit 08090302. Mounted on several bound piles located approximately 200 ft. downstream of the Houma Navigational Canal Pontoon Bridge, and approximately 150 ft. east of the right bank. The site can be reached from Baton Rouge by driving east on I-10 to I-310, travel south on I-310 to Hwy. 90 in Houma; take a left on La. 661 and go to La. 315, take a right and travel south to Du Large. Travel by boat from Falgout Canal Marina through the Falgout Canal Swing Bridge, and eastward along Falgout Canal for 3.5 miles. Turn southward into Houma Navigational Canal and pass through the pontoon bridge.

ESTABLISHMENT AND HISTORY--This site was moved from its original location on July 23, 2002 by L.B. Simmons, C.P. Frederick, and E.P. Meche. It was re-established on a group of piles located downstream from the pontoon bridge as a water quality and discharge station.

History: The site was initially established in April 10, 1992 by, M.L. Ross, E.P. Meche, and C.L. Jones as a stage and water quality station. Equipment was originally attached to the downstream side of the pontoon bridge. It was moved in order to accommodate a SonTek acoustic doppler profiler.

GAUGE-- It is equipped with a Vaisala 555 GOES data collection platform, a YSI 600XL water quality sensor collecting stage, specific conductance, salinity and water temperature. It is also equipped with a SonTek acoustic doppler profiler, and a Vaisala 452A acoustic wind speed and direction sensor. Prior to the relocation of the site on July 23, 2002, a Handar 436B shaft encoder was used for collecting stage data which is currently collected by the YSI multiprobe, and a Marsh McBirny bi-directional velocity sensor was used to collect velocity data which is currently collected with the SonTek ADP. The wire-weight gauge located on the downstream side of the bridge (50 ft. to the right of the site's original location), is still functional as a reference gauge.

DRAINAGE AREA--Indeterminate.

CHANNEL AND CONTROL---Channel is composed of mud and silt. Flow is smooth and confined to one channel. Stream flow is bi-directional and is affected by tide, wind and heavy boat traffic.

PURPOSE.--To manage wetland projects in area.

DISCHARGE.— Measurements are made at least 6 times a year. Discharge is affected by the tide and reverses accordingly, yet the site maintains a net positive discharge.

REGULATIONS/DIVERSIONS.—Houma Navigation Canal has no Flood Gates or Control Structures. It is openly connected to Falgout Canal, Bayou Grand Caillou and many other bayous and small bays between Houma and Terrebonne Bay.

COOPERATION.--United States Army Corps of Engineers.

FLOODS.--unknown.

REFERENCE MARKS.— Datum of Gauge NGVD '29.

R.M. 1: Chiseled "X" in top of the wingwall at the right downstream abutment on Bouquet Bridge over Bayou Grand Caillou, 2 miles east of site. **Elevation 6.248 ft. NGVD (levels of 3-26-1992).**

R.M. 2: Chiseled square in concrete on right traffic control guard rail base. **Elevation 9.059 ft. NGVD. (levels of 07-23-2002).**

R.P. 2: Head of 3/8" lag screw driven horizontally into 12"x12" timber to left of gauge. **Elevation 5.07 ft. NGVD (levels of 07/23/2002)**

Chec bar: Wire- weight located five feet to the right of gauge house on downstream hand rail. **Elevation 9.499 ft. NGVD (levels of 07/23/2002).**

**DEPARTMENT OF THE INTERIOR
U.S. Geological Survey, WRD
Baton Rouge, Louisiana**

GAUGING-STATION DESCRIPTION

07381331 Gulf Intracoastal Waterway (GIWW) at Houma, La.

Revised by: S. M. Perrien

Date: 02-28-03

Checked by:

Date:

LOCATION.--Lat 29°35'53", long 90°42'36", T.17 S., R.17 E. S. 39, Terrebonne Parish, Hydrologic Unit 08090302, on the right bank of stream, south of Main Street Bridge.

DRAINAGE AREA.--Indeterminate.

ESTABLISHMENT AND HISTORY.--Established as a discharge site for a one-year project that became a permanent site. The gauge was installed in March of 1997.

History: The original gauge-house was installed by Errol P. Meche and Glen T. Stevens in March of 1997. The equipment was installed later on March 6, 1997 by C. Kevin Labbe' and Andrew N. Tarver. After several failed attempts of keeping the site functioning at the original location, the platforms were abandoned and moved one-quarter mile downstream to the existing location on July 23, 1997. Flowmeter and water quality equipment was installed on July 25, 1997. The main site with the gauge house was hit several times by boat traffic and was eventually moved to the auxiliary site on February 17, 2000. All attempts to keep submarine cable systems in working order was abandoned due to industrial traffic on the waterway.

CHANNEL.--One channel at all stages. Channel is straight for 0.60 miles upstream and 0.50 miles downstream from gauge. Sheet pile and wooden containment walls, intermittently line both banks. Heavy concrete and steel debris line the bottom of the measurement cross section.

GAGE.-- Aluminum shelter bolted flat to wooden platform, supported by four 2" diameter pipes, butted up to retaining wall of Main Street Bridge. One ten-watt solar panel is attached to the top of the shelter. The water sensing probe, a SonTek Agronaut-SL and YSI 600R are located in two 2" galvanized pipes attached to the upstream left side of the pipe platform. The probes are attached to a Handar 555 datalogger with a GOES radio.

CONTROL.--Wind and tide affected throughout range of stage. Boat traffic has significant effect on doppler type measurements.

DISCHARGE MEASUREMENTS.--Measurements are made 100 ft. upstream of site. The cross section starting and ending points are defined by waypoints that can be found in the giwwway.gps file on the BRFO Archive computer. All measurements used to define rating are made with an ADCP. Lots of boat traffic makes measurements difficult.

FLOODS.--none

POINT OF ZERO FLOW.--Indeterminate.

COOPERATION.--U.S. Army Corps of Engineers.

SKETCH.--see attached map

PHOTOGRAPHS.--In BRFO photo archive

REFERENCE MARKS AND BENCH MARKS.—

GPS RM 1: chiseled square next to emergency generator, in parking lot of the Houma Morgue, at the base of the south Main Street Bridge crossing the GIWW, directly across the stream from the site. Elevation **8.278 feet. NAVD 88 (01-29-99)**

BM-C4612: standard bronze survey marker set in west shoreward side of the base of the downstream metal power line support on raised concrete platform directly across the stream from the gauge. Elevation **11.228 feet. NAVD 88 (1996)**

RP 1: head of one-inch bolt in bulkhead approximately five feet upstream of old gauge platform and approximately 200 feet upstream of GPS RM 1. The bolt is painted blue. Elevation **3.778 feet. NAVD 88 (03-23-00)**

RM 2: chiseled square at west base of metal power pole on the east bank approximately 75 feet east of gauge. Elevation **9.439 feet. NAVD 88 (03-23-00)**

RP 2: file notches on angle-iron flowmeter support bracket, facing retaining wall. Elevation **6.974 feet. NAVD 88 (03-23-00)**

 Local Weather

[Back to
Local Weather](#)

[LUMCON
Marine Center](#)

[Terrebonne Bay](#)

[Lake
Pontchartrain](#)

[Audubon](#)

[Tambour Bay](#)

Station Information

Location: Marine Center

Latitude: 29° 15.200' N

Longitude: 90° 39.800' W

Elevation: 1 meters

Located behind the LUMCON Marine Center Facility. Note that the Wind Instrument is positioned approx 13.2 meters above Mean Sea Level, NAVD88.

Last Inspection Date:2/11/2005



Instruments

Meteorologic Instrumentation

Description	Model #	Manufacturer
Air Pressure Sensor	PTB101B	Vaisala
Humidity & Temp Probe	HMP45AC	Vaisala
Quantum Light Sensor	LI-190SB-L	Li-Cor
Radiation Shield, Multi-Plate	41002	R.M. Young Company
RM Young Wind Monitor	05103	R.M. Young Company
RM Young Wind Monitor	05103	R.M. Young Company
Solar Radiation Sensor	LI-200SZ	Li-Cor
Tipping Bucket Rain Gauge	TB30.01	Hydrological Services PTY LTD

Hydrographic Instrumentation

Description	Model #	Manufacturer
Conductivity Probe	6560	YSI
Sonde, 6600	YSI 6600-SV	YSI

Electronic Instrumentation

Description	Model #	Manufacturer
Antenna, Yagi 890-960 MHz	YA5 900	Radiall/Larsen Antenna Technologies
Battery Base w/charger 12V	CR23X	Campbell Scientific
Cable, Sonde vented 10 ft	063380-10-NM	YSI
Micrologger CR23X	CR23X	Campbell Scientific
Photo Voltaic Panel, 10 watt, Solarex	MSX-10	Solarex
Solar Panel, 20 Watt	MSX20U	Solarex
Surge Suppressor, Antenna	IS-B50LN-C2	PolyPhaser
Surge supressor, Dataline RS232	DB9	Tripp Lite
Wireless Data Transiever	FGR-115RC	FreeWave Technologies

Maintenance History (3 Months) [\[View Entire History\]](#)

<u>Date</u>	<u>Action</u>	<u>Comments</u>
2/11/2005	Inspection	
1/12/2005	Maintenance	
12/2/2004	Maintenance	

Station Elevation Information

A survey was conducted on July 12, 2003 to determine the vertical elevation of a reference point near the Pump House located behind the DeFelice Marine Center. To review the full version of this survey in PDF format [Click Here](#). The survey was conducted by:

*Morris P. Hebert Inc.
Surveying - Engineering - Environmental Services
283 Corporate Drive
PO Box 3106
Houma, LA. 70361*

The following correction factors should be applied:

	Feet	Meters
NAVD 88 Correction Term (Subtract from Database Sonde Value)	4.10	1.25

EXAMPLE: Given a water height reading from the sonde of 5.25 feet (1.6 meters) the following calculation can be made:

Water Height = Sonde Water Height - NAVD 88 Correction Term

1.6 meters (5.25ft) - 1.25 meters (4.1 ft) = 0.35 meters (1.15 ft)

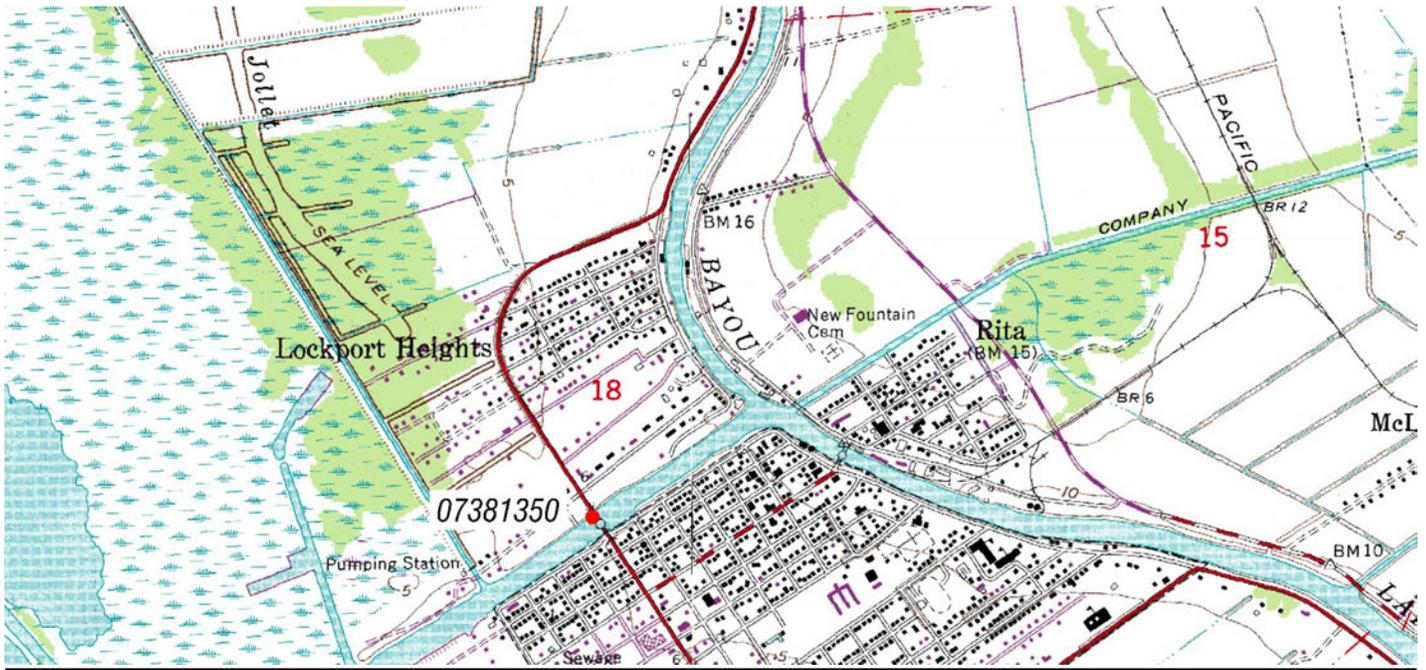
RESULT: 0.35 meters (1.15 ft) Relative to NAVD 88 Datum

Note: All archive depth data is reported in meters.



[Return to
LUMCON Home](#)

Attachment 6
Remaining Stations Information



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Lockport" Quadrangle

Station Name: "07381350"

Location: From the intersection of Hwy 655 and La. St. Hwy. 1 in Lockport travel northwest approximately 950' to the gage on the right. The gage house is adjacent to the drawbridge crossing the Company Canal. The site is on the downstream side of the north support pier of the bridge.

Gage Description: The gage is a continuous recorder type gage housed in an aluminum shelter bolted to a hand rail that surrounds the bridge pier.

Date of Survey: July 14, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 38' 41.970" N
 Long. 90° 32' 40.836" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 417,254.32
 E= 3,531,354.86

RM-1 (top of fire hydrant at corner of La. Hwy 1 and La. Hwy. 655)

Elevation = 7.80 feet (NAVD 88)

RP-1 (two file notches on bridge rail approx. in center of bridge span on upstream side of bridge.)

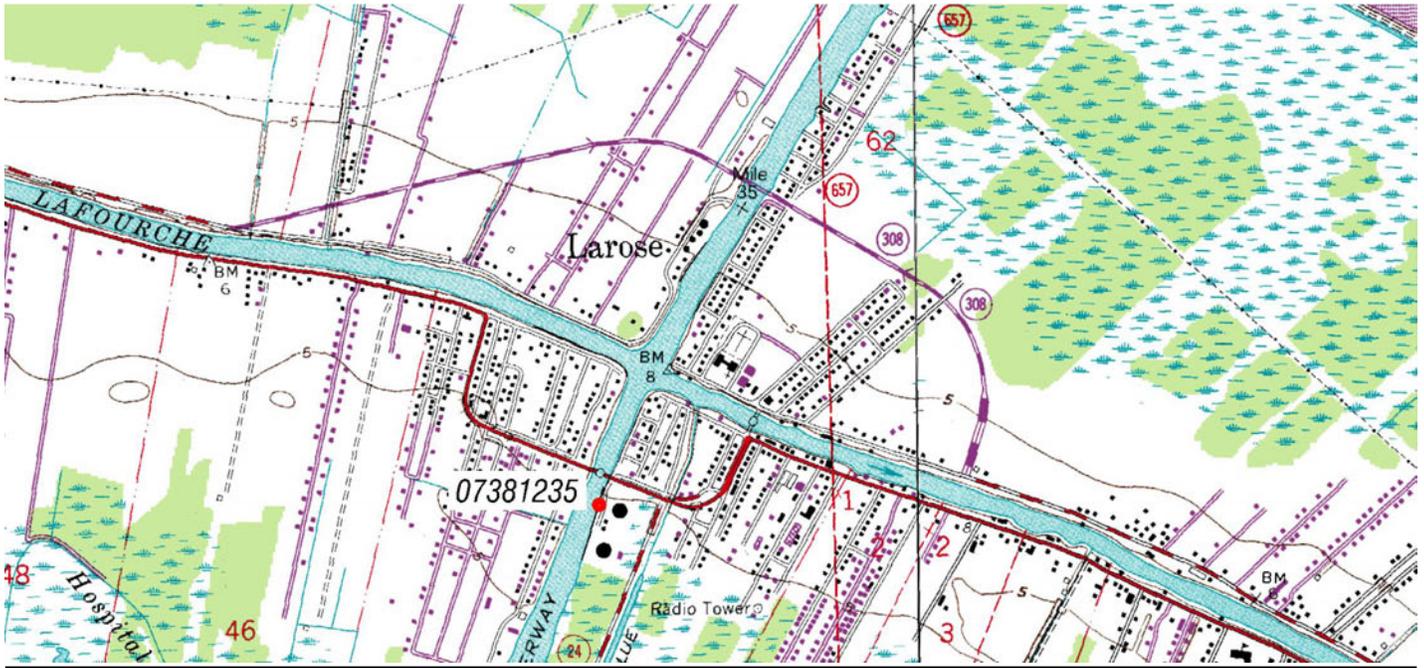
Elevation = 16.02 feet (NAVD 88)

RP-2 (two file notches under back left corner of gage house on metal plate anchoring handrail.)

Elevation = 4.00 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "BA-25b-SM-11". This position was surveyed by T. Baker Smith & Son, Inc



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Larose" Quadrangle

Station Name: "07381235"

Location: From the intersection of La. St. Hwy 1 and La. St. Hwy. 24 in Larose travel west along Hwy. 24 for 0.2 mile to the intersection with the Gulf Intracoastal Water Way. Travel south approximately 350' to the recorder on the right. The recorder is located near a bulkhead on the canal.

Gage Description: The gage is a continuous recorder type gage housed in an aluminum shelter bolted to two two-inch aluminum pipes, concreted into bank.

Date of Survey: July 2, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 34' 05.775" N
 Long. 90° 23' 07.547" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 389,739.15
 E= 3,582,170.34

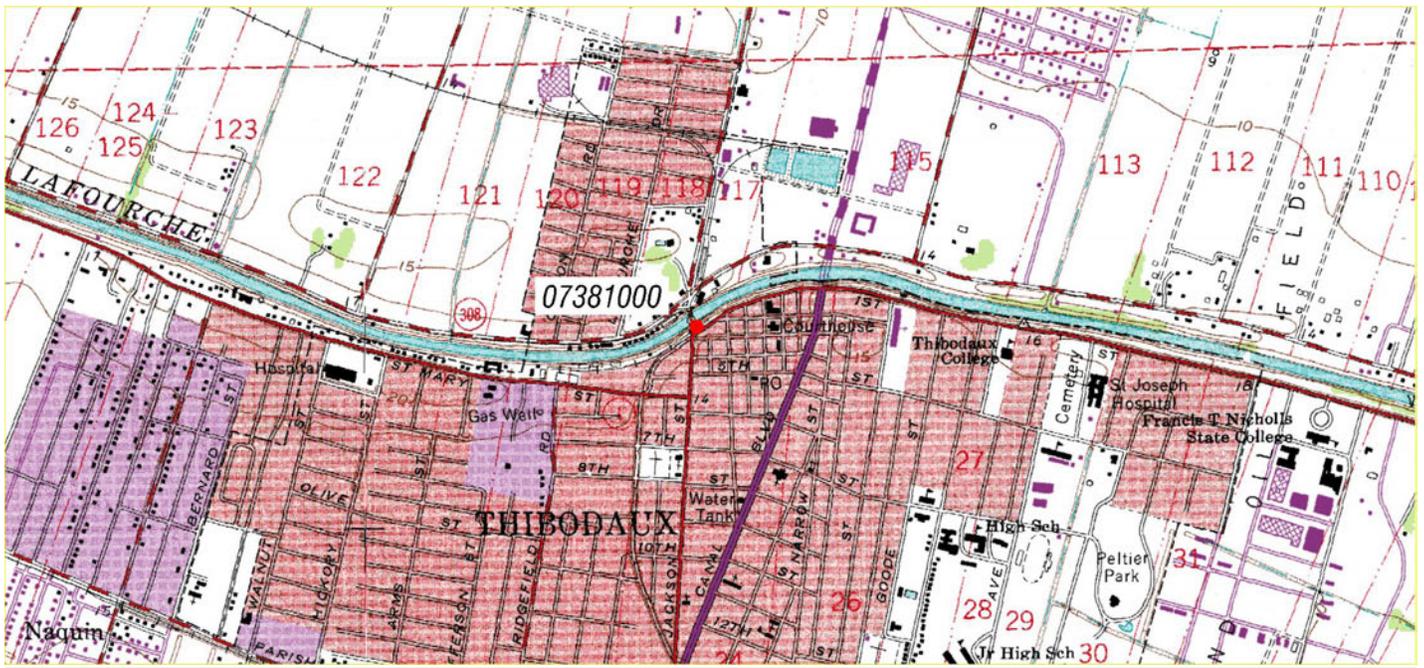


J220 (Bronze disk located about 0.15 miles west of the east end of the concrete drawbridge over the Gulf Intracoastal Water Way in Larose)
 Elevation = 7.76 feet (NAVD 88)

RP2 (Two file notches in the support bracket for the flowmeter. Flowmeter is located on bridge fender)
 Elevation = 4.24 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monuments "M358" & "BA-25b-SM-12". This position was surveyed by T. Baker Smith & Son.



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Thibodaux" Quadrangle

Station Name: "07381000"

Location: From the intersection of La. St. Hwy. 20 (Jackson Street) and La. St. Hwy. 1 in Thibodaux proceed north approximately 200' to the gage location on the right. The gage is adjacent to the Jackson Street bridge which connects La. St. Hwy 1 and La. St. Hwy 308.

Gage Description: The gage is a continuous recorder type gage with metal shelter attached to a 24" CMP on the downstream side of the Jackson St. bridge (Hwy 20).

Date of Survey: July 1, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 47' 53.101" N
 Long. 90° 49' 20.715" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 472,425.41
 E= 3,442,880.31

M-229 (Brass disk on walkway of bridge)

Elevation = 18.24 feet (NAVD 88)

RM-158 (chiseled square on walkway of bridge)

Elevation = 17.91 feet (NAVD 88)

RP-1 (hexagon nut on outside of gage house)

Elevation = 16.84 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "BA-25b-SM-07". This position was surveyed by T. Baker Smith & Son, Inc.

2

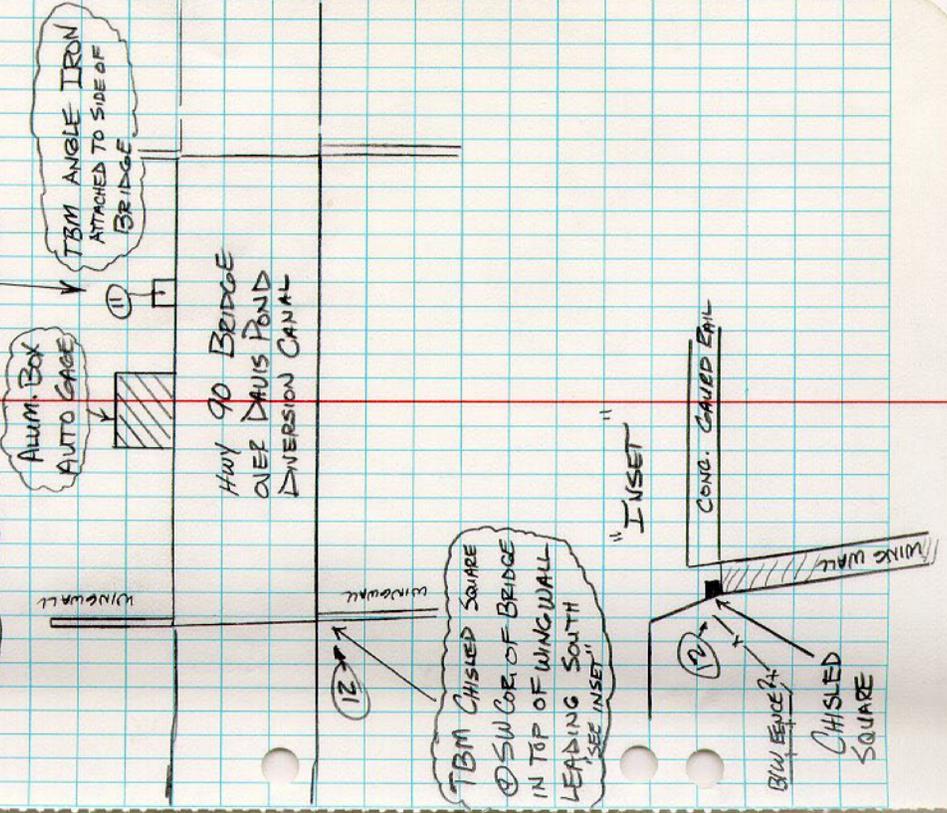
BASE @ BAOI-SM-01

USGS 295501090190400

03/11/03 2

C. BORDELON
A. HARTLEY

TBM ALUM. ANGLE IRON ATTACHED TO SIDE OF
HWY 90 BRIDGE OVER DAVIS POND DIVERSION CANAL.
AT E OF BRIDGE NEXT TO AUTO GAGE.



PICTURES 4, 5, 6

12A CHECK

12 TBM CHISED SQUARE ON WINGWALL @ SW COR. OF HWY 90 BRIDGE

1= TOP 2= FAIRING 3= DISTANT

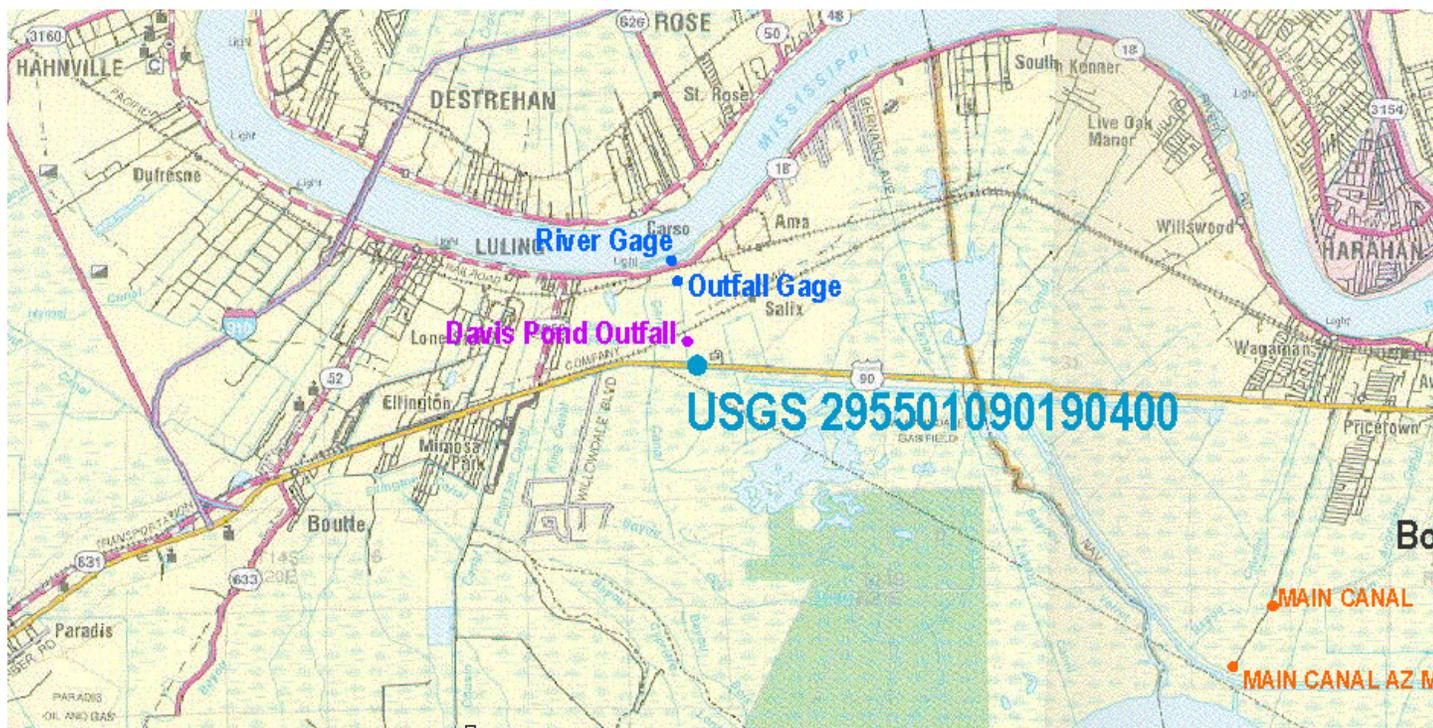
PICTURES 1, 2, 3

11A CHECK

11 TBM ALUM. ANGLE IRON NEXT TO AUTO GAGE

10 CHECK ON ALUM CAP NEAR BASE

9 BAOI-SM-01 BASE KEVED IN



VICINITY MAP

Scale: N.T.S.

Reproduced from "The Roads of Louisiana"

Gage Name: "USGS 295501090190400"

Location: Staff gage is located approximately 4 miles easterly Boutte, Louisiana, on U.S. Highway 90, on the north guardrail of the bridge crossing Davis Pond Diversion Canal, and is located in St. Charles Parish, Louisiana.

Gage Description: The gage is a continuous recorder type gage: YSI 6920 Sensor within a PVC pipe attached to a concrete bridge guardrail with a meta-data transmitter and an Aluminum Angle Reference Mark.

Date of Survey: March 11, 2003

USGS GAGE

NAD 83 Geodetic Position:

Lat. 29° 55' 01.49310"N

Long. 90° 19' 03.42692" W

NAD 83 Datum LSZ (1702) Ft:

N= 516,764.4

E= 3,602,602.5

Elevation at Top of Al. Angle

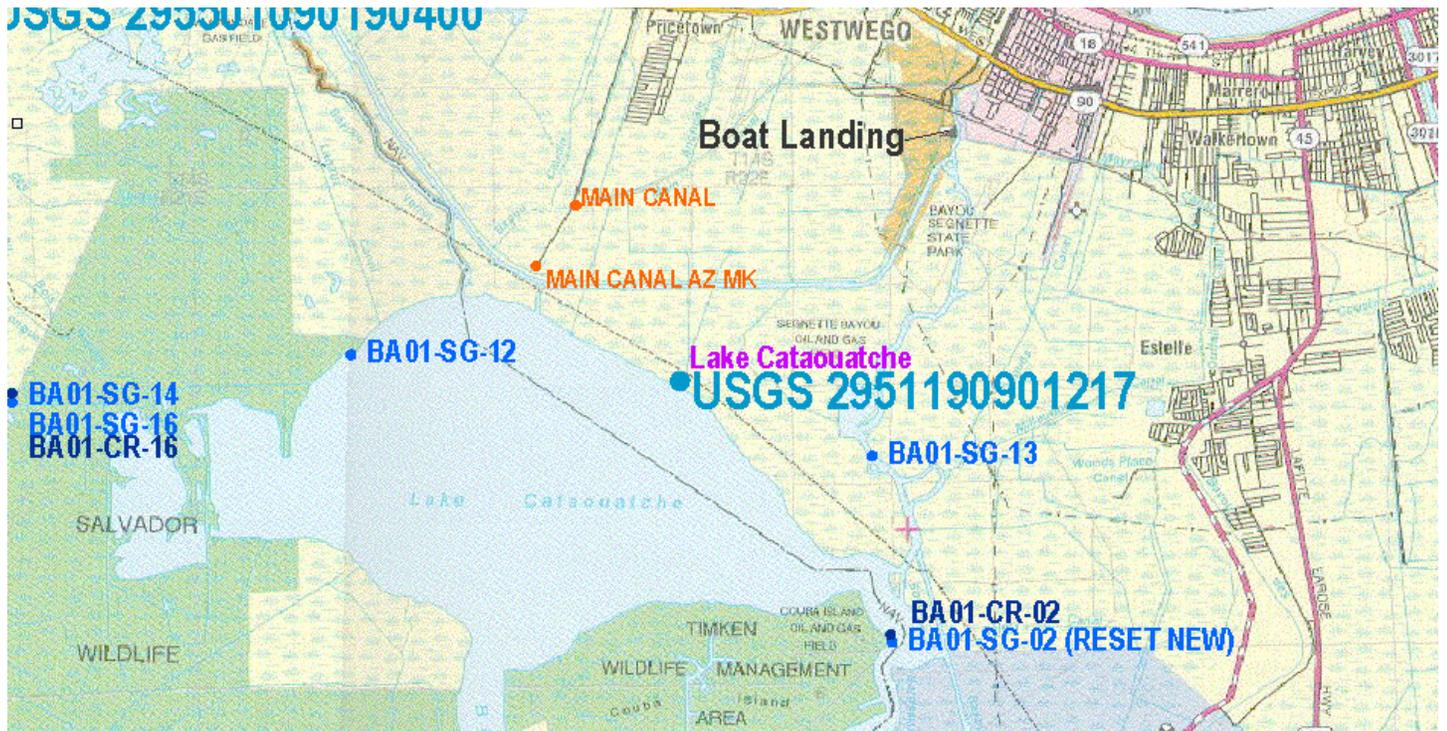
12.91 feet (NAVD 88)



USGS Real-time Gage Info on the Web:

http://waterdata.usgs.gov/la/nwis/nwisman/?site_no=295501090190400&agency_cd=USGS

Position determined by using Real-time Kinematic (RTK) survey from Secondary GPS Monument "BA01-SM-01"
 Position established by John Chance Land Surveys, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division



VICINITY MAP

Scale: N.T.S.

Reproduced from "The Roads of Louisiana"

Gage Name: "Lake Cataouache DCP" (USGS 2951190901217)

Location: Located near the northeast bank line of Lake Cataouache in Jefferson Parish, approximately 4 miles southerly from the Bayou Segnette Boat Landing in Westwego, Louisiana, to Lake Cataouache, then northwesterly for approximately 3 miles to the Station.

Gage Description: The gage is a continuous recorder type gage attached to a wooden platform with a meta-data transmitter and Reference Bolt attached horizontally into the wood platform.

Date of Survey: March 7, 2003

USGS GAGE

NAD 83 (1993) Geodetic Position:

Lat. 29° 51' 18.57391"N
 Long. 90° 12 '17.11274" W

NAD 83 Datum LSZ (1702) Feet:

N= 494,581.7
 E= 3,638,577.8

Elevation at Top of Lag Bolt above Sensor

6.98 feet (NAVD 88)

Elevation at PK Nail on Platform

7.27 feet (NAVD 88)



USGS Real-time Gage Info on the Web:

http://waterdata.usgs.gov/la/nwis/nwisman/?site_no=2951190901217&agency_cd=USGS

Position determined by using Real-time Kinematic (RTK) survey from Secondary GPS Monument "BA01-SM-02"
 Position established by John Chance Land Surveys, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division

BASE @ BA01-SM-02

TOP OF EXISTING LAG BOLT
MEASUREMENT ON CONTINUOUS
RECORDING DATA COLLECTOR
LAKE CATAOUCHE @ WHISKEY CANAL

PICTURES 1, 2

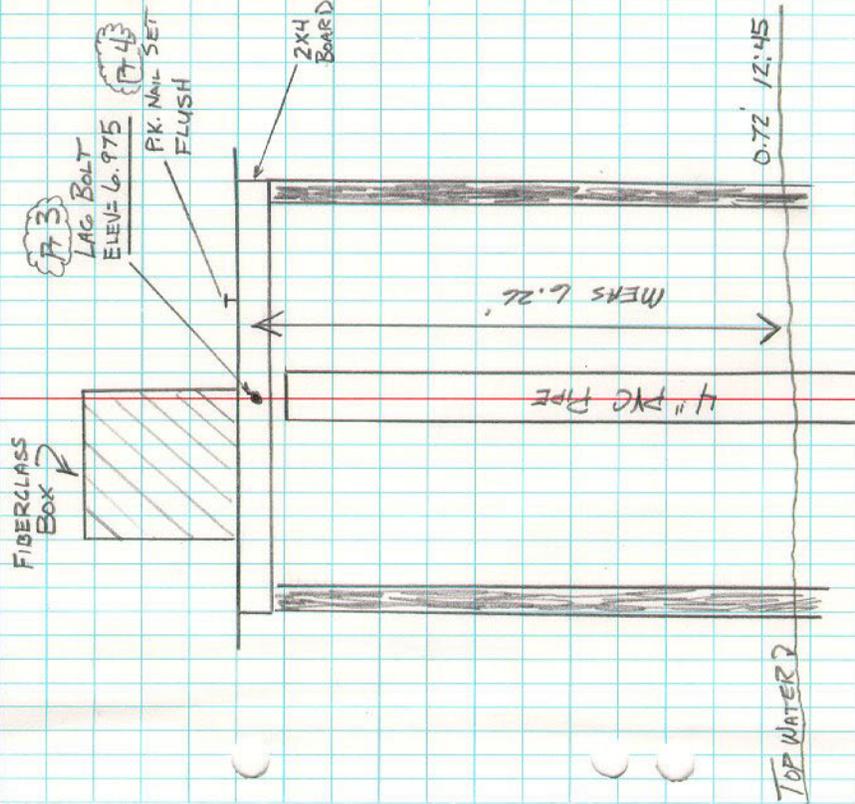
CALCULATED TOP WAT. ELEV 0.72 12:45

MEAS. DIST FROM TOP OF LAG BOLT
TO TOP WATER 6.26 12:45

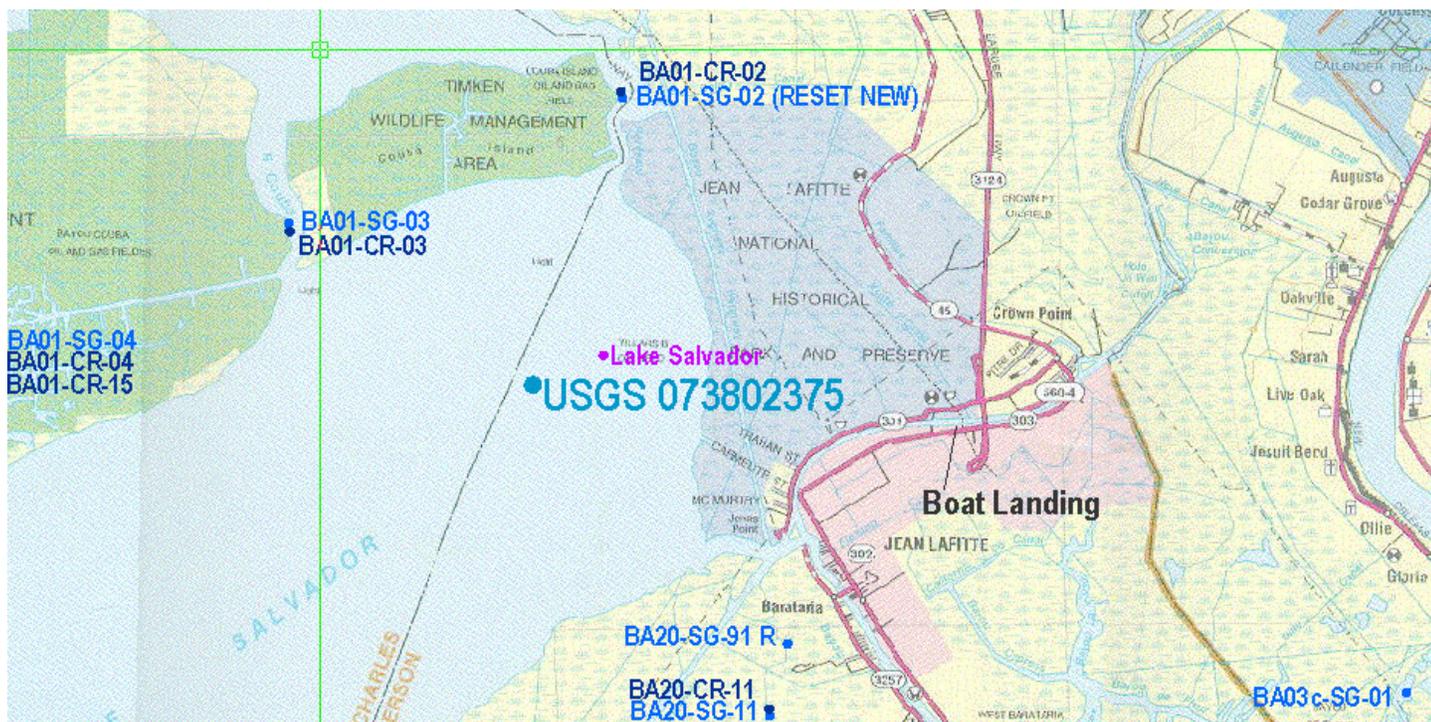
- 4 P.K. NAIL SET FLUSH WITH FLOOR OF PLATFORM
- 3B CHECK 2 6.967
- 3A CHECK 1 6.874
- 3 TOP OF LAG BOLT ABOVE 4" PVC PIPE 6.975
- 2 CHECK ON "MAIN CANAL AZ MK"
- 1 BA01-SM-02 (BASE)

03/07/03
C. BERDELO
M. GAUTHIER

Lake Cataouche DCP
(USGS 145119091217)



CJB0003



VICINITY MAP

Scale: N.T.S.

Reproduced from "The Roads of Louisiana"

Gage Name: "Lake Salvador DCP" (USGS 073802375)

Location: Station is located in north Lake Salvador, Jefferson Parish, Louisiana, and is approximately 6 miles westerly from the boat landing in Jean Lafitte, Louisiana.

Gage Description: The gage is a continuous recorder type gage: YSI 6920 Sensor within a PVC pipe attached to a wooden Platform with a meta-data transmitter and a Reference Nail.

Date of Survey: March 14, 2003

USGS GAGE

NAD 83 Geodetic Position:

Lat. 29° 45' 59.69888"N
 Long. 90° 10' 59.48608"W

NAD 83 Datum LSZ (1702) Ft:

N= 462,440.2
 E= 3,645,736.1

Elevation at Top of Ref. Nail

6.55 feet (NAVD 88)



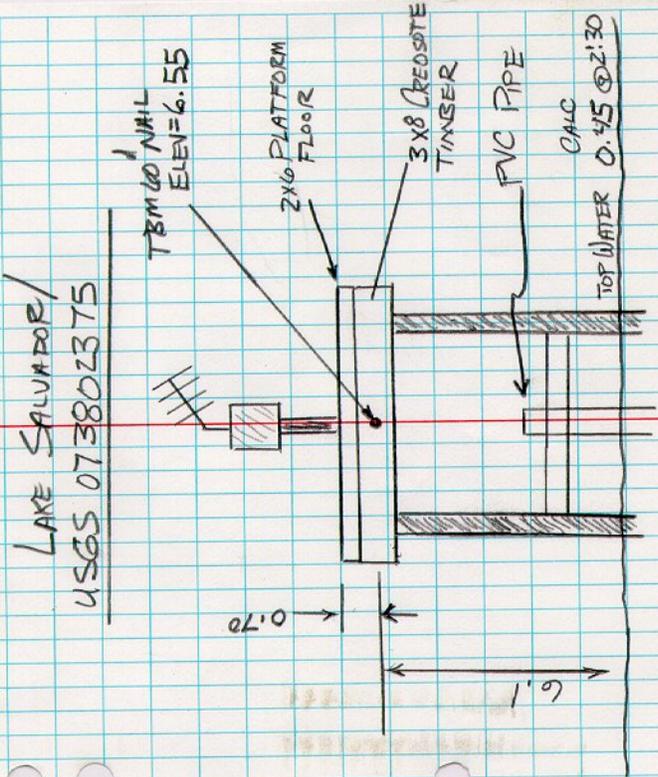
USGS Real-time Gage Info on the Web:

http://waterdata.usgs.gov/la/nwis/nwisman/?site_no=073802375&agency_cd=USGS

Position determined by using Real-time Kinematic (RTK) survey from Secondary GPS Monument "LAFITTE 2"
 Position established by John Chance Land Surveys, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division

BASE @ BA01-SM-05

SET 60° NAIL FOR TBM ON CROSS BRACE OF PLATFORM SUPPORTING C.R. (LAKE SALVADOR)



LAKE SALVADOR / USGS 073802375

NOTE: 2 TO 3 SEAS @ TIME OF SURVEY

PICTURES 4, 5, 6

CALC WATER ELEV. FROM 60° NAIL 0.45 @ 2:30

32A CHECK ~~6.539~~

32 TOP OF SHANK OF 60° NAIL FOR TBM 6.55

31 QC CHECK ON TOP CAP SG (BA01-SG-02 NEW)

30 BA01-SM-05 KEYED N (BASE)



VICINITY MAP

Reproduced from U.S. Geological Survey, National Wetlands Research Center 2001 Aerial

Gage Name: "USGS 073802515"

Location: The Station is located at a facility on the western end of Grand Terre Islands near Fort Livingston, approximately 1 mile across Barataria Pass, by boat, from the U.S. Coast Guard Station in Grand Isle, Louisiana.

Gage Description: The gage is a continuous recorder type gage attached to a wooden bridge walkway.

Date of Survey: March 31, 2003

USGS GAGE

NAD 83 Geodetic Position:

Lat. 2 ° 16 31.8617
 Long. 8 ° 6 30.23 30

NAD 83 Datum LSZ (1702) Ft:

28 ,727.
 E 3,72 , 08.2

Elevation at 60d Nail in Side of Piling

.00 eet A D 88

Elevation at R/R Spike in Side of Piling

3. 3 eet A D 88



USGS Real-time Gage Info on the Web:

http://waterdata.usgs.gov/la/nwis/nwisman/?site_no=073802515&agency_cd=USGS

Position determined by using Real-time Kinematic (RTK) survey from Secondary GPS Monument "876 1724 C TIDAL"
 Position established by John Chance Land Surveys, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division

BASE 876 1724 C TIDAL

TBM SET AND EXISTING TBM TIED IN USGS C.R. @ FORT LIVINGSTON NORTH OF GRAND ISLE. TBM IS A 60" NAIL ON THE EAST FACE OF A FLUNG SUPPORTING A WALKWAY OVER A CANAL.

PICTURES 050, 051, 052 FACING WEST 053 FACING EAST

CALC. WATER ELEV FROM 60" NAIL 0.07 @ 3.45

10 41A CHECK 9.025

10 41 60" NAIL TBM 9.004

10 40A CHECK 4.208

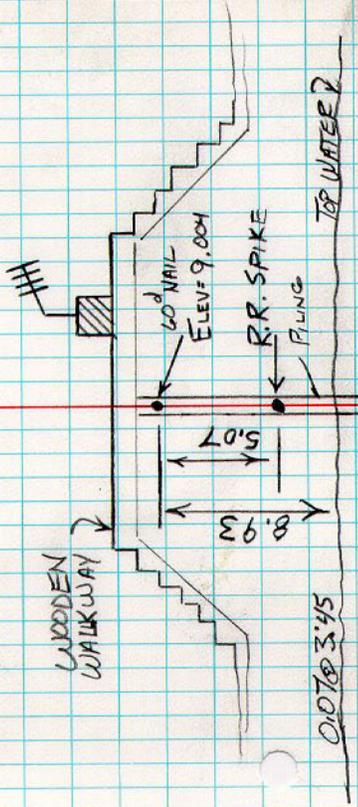
10 40 TOP RR SPIKE 4.24

NOTE: BASE ANT HT = 7.025 FT
 10 39 876 1724 C TIDAL BASE KEVED IN

03/31/03

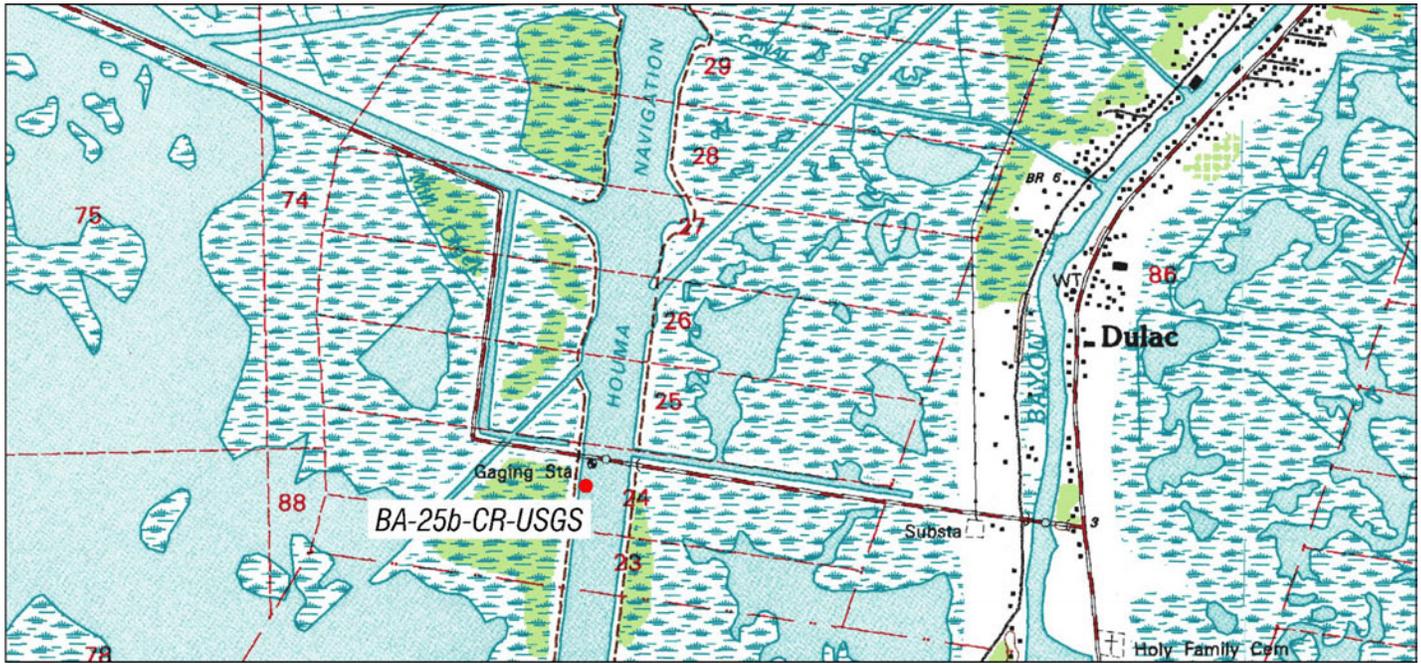
C. BORDEN
 D. HARTLEY

USGS 073802515



SIDE VIEW FACING WEST

NOTE: RIMS WAS HIGH AND THE SHOT TOOK LONG TO COLLECT DUE TO OBSTRUCTION AROUND ANT. THE ANT WAS RESET AND WAS CLEAR OF OBSTRUCTION FOR SHOT HI (60" NAIL). CALC. ELEV OF RR SPIKE FROM 60" NAIL = 3.93



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Dulac" Quadrangle

Station Name: "BA-25b-CR-USGS"

Location: From the intersection of the Houma Navigation Canal and the PR 10 bridge (Falgout Canal Rd) in Dulac travel by boat south for approximately 300' to the continuous recording device attached to a mooring pile cluster.

Gage Description: The gage is a continuous recorder type gage attached to the top of a mooring pile cluster with a reference bolt attached to a horizontal wooden board.

Date of Survey: April 21, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 29° 23' 02.161" N
 Long. 90° 43' 49.250" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 321,964.30
 E= 3,472,875.71

UTM NAD 83 Datum Meters

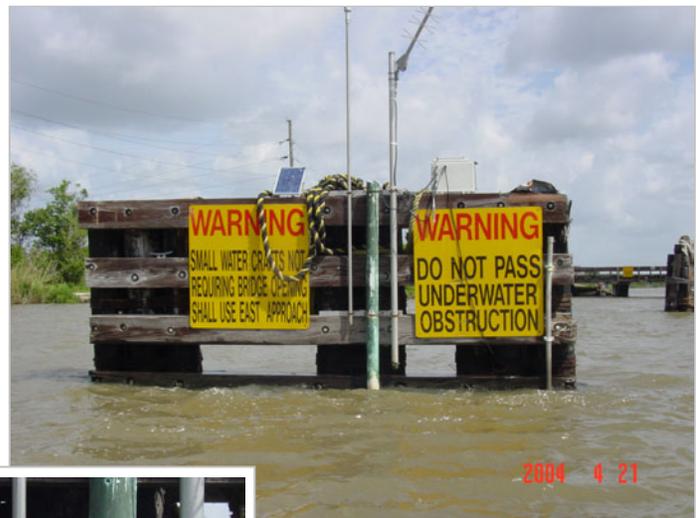
N= 3,252,664.77
 E= 720,272.26

Elevation of Top of Reference Bolt Shank

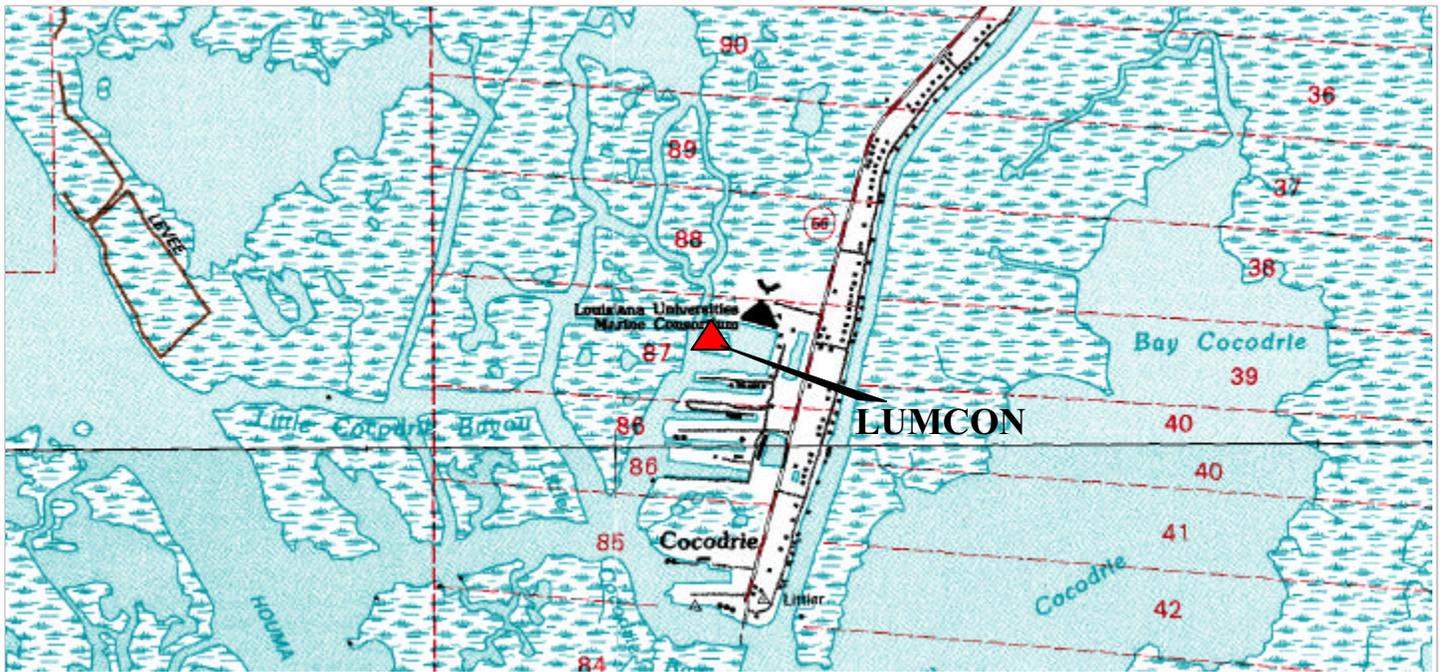
Elevation = 5.26 feet (NAVD 88)

Elevation at Top of 4" PVC pipe

Elevation = 8.00 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "TE-01-SM-01". This position was surveyed by T. Baker Smith & Son, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division.



VICINITY MAP Scale: 1" = 2000' Reproduced from USC&GS "Cocodrie, La" & "Lake Quitman, La" Quadrangles
Station Name: "LUMCON"

Location: Located behind the LUMCON Marine Center Facility.

Monument Description: NGS style floating sleeve monument; datum point set on 9/16" stainless steel sectional rods driven 112 feet to refusal, set in sand filled 6" PVC pipe with access cover set in concrete.

Stamping: LUMCON

Monument Established By: Morris P. Hebert, Inc.

Monument Installation Date: 7/12/03 **Date of Survey:** 7/12/03

Gage Description: The Gage is a LUMCON tide gage with a continuous recorder. It collects the following information: Air Temperature, Wind Direction, Wind Speed, Relative Humidity, Barometric Pressure, Solar Radiation, Quantum Radiation, Water Temperature, Water Height and Salinity.

Date of Survey: 7/12/03 by Morris P. Hebert Inc.

Gage Established By: LUMCON

For: Louisiana Department of Natural Resources, CRD

Adjusted NAD 83 Geodetic Position

Lat. 29°15' 13.84217" N
 Long. 90°39' 49.19508" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 274,776.34
 E= 3,494,389.15

Adjusted NAVD88 Height

Elevation = 2.64 feet (0.805 Mtrs)

Geoid99 Height = -24.597 Mtrs.

Ellipsoid Height = -23.792 Mtrs.

Surveyed Water Elevation on 10/16/2003 at 9:07am

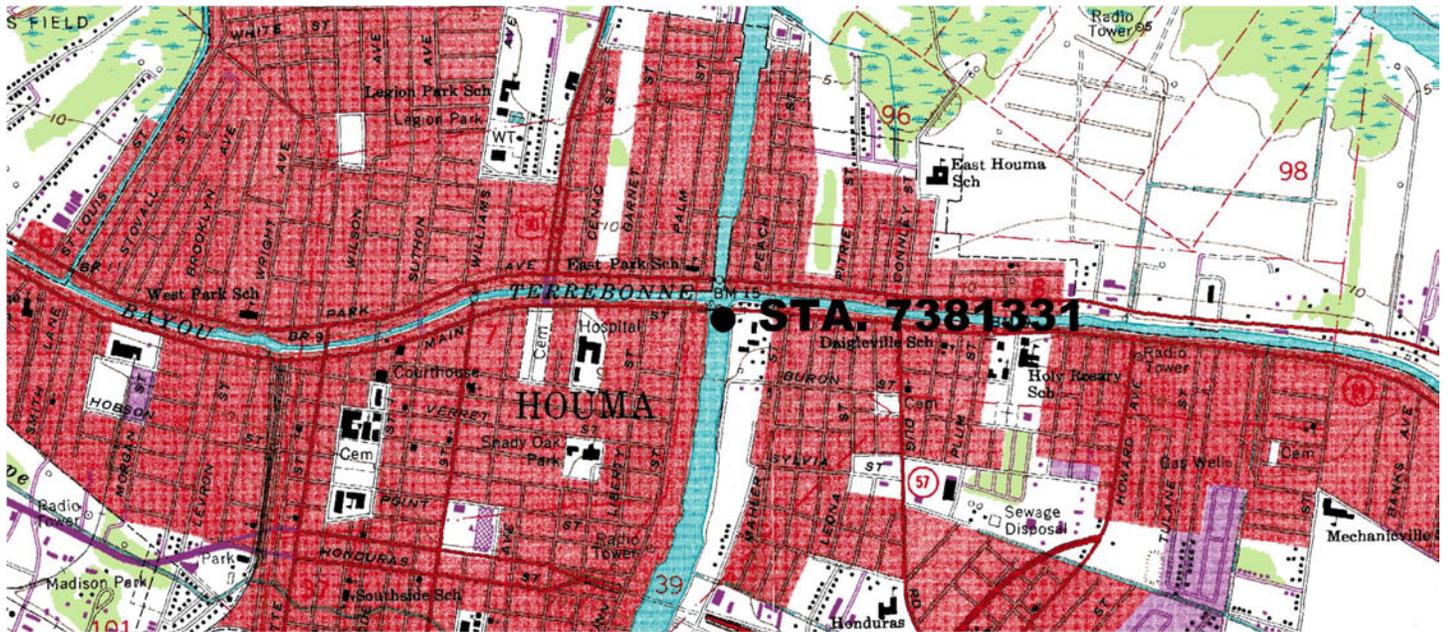
Elevation = 1.26 Feet (NAVD 88)

Lumcon Weather Web Site on 10/16/2003 at 9.07am

Reading = 5.54 Feet

Correction = -4.27 Feet





VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "HOUMA" Quadrangle

Gage Name: "7381331"

Location: From the boat launch on Bayou Black at the Fire Station in Houma, Louisiana, by boat, proceed easterly in the Gulf Intracoastal Waterway (GIWW) toward the Twin Span bridges crossing the canal at Houma. The recorder device and staff are located on the southern bank at the intersection of the GIWW and Bayou Terrebonne in Houma.

Gage Description: The gage is a continuous recorder type gage attached a small platform that is adjacent to a concrete bulkhead on the GIWW.

Date of Survey: September 5, 2003

CONTINUOUS RECORDER GAGE

NAD 83 (1993) Geodetic Position:

Lat. 29°35'53.8572" N
 Long. 90°42'36.1327" W

NAD 83 Datum LSZ (1702) Feet:

N= 399,949.30
 E= 3,478,920.18

UTM NAD 83 Datum Meters:

N= 3276464.122
 E= 721776.190

Elevation at Top of Platform

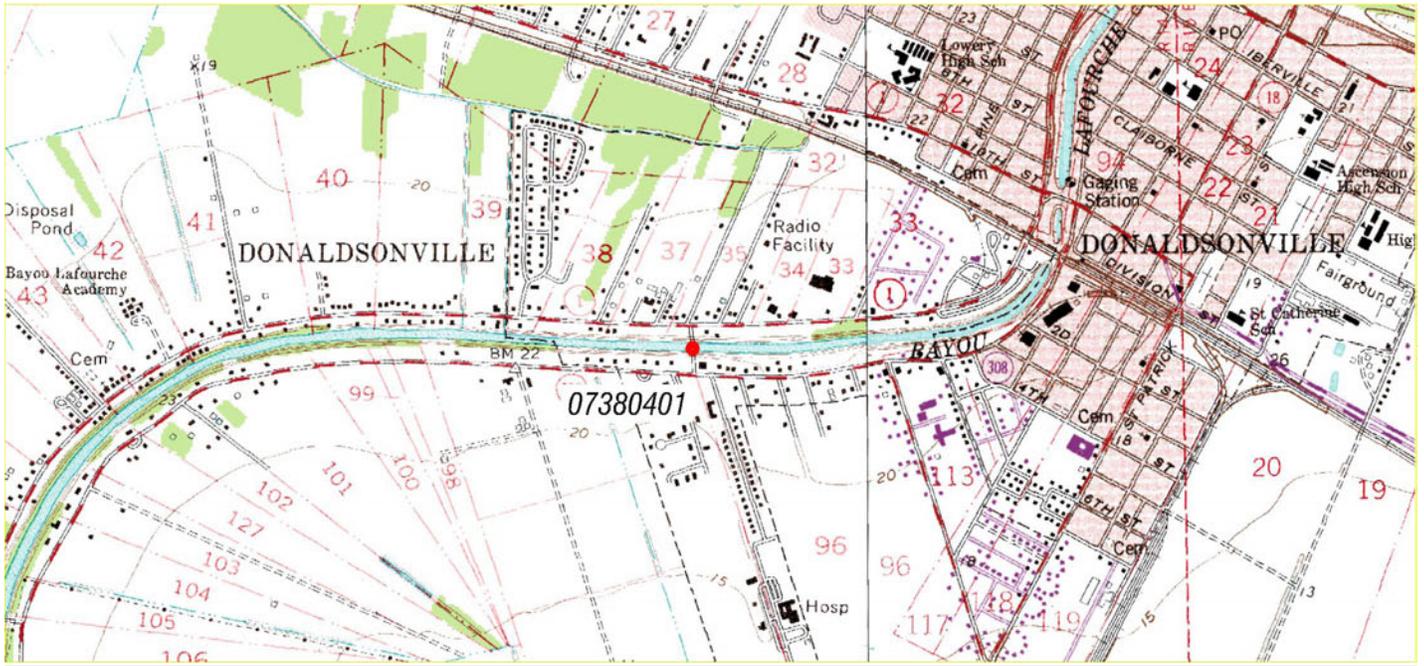
6.78 feet (NAVD 88)

Elevation at Top Shank of Reference Nail

6.58 feet (NAVD 88)



Position determined by using Real-time Kinematic (RTK) survey from Secondary GPS Monument "CHET"
 Position established by T. Baker Smith & Son, Inc. for the Louisiana Department of Natural Resources, Coastal Restoration Division.



VICINITY MAP Scale: 1" = 2000'

Reproduced from USC&GS "Belle Rose" Quadrangle

Station Name: "07380401"

Location: From the intersection of 10th Street and La. St. Hwy. 1 in Donaldsonville travel south along Hwy 1 for 0.85 mile to a bridge crossing Bayou Lafourche. The continuous recorder is on the downstream side of the bridge that connects La. St. Hwy. 1 and La. St. Hwy. 308. The bridge is located 1.0 mile south of Marchand Drive (Hwy. 3089).

Gage Description: The gage is a continuous recorder type gage in a metal housing shelter attached on a 24" CMP.

Date of Survey: June 28, 2004

CONTINUOUS RECORDER GAGE

Adjusted NAD 83 Geodetic Position

Lat. 30° 05' 47.787" N
 Long. 91° 00' 21.448" W

Adjusted NAD 83 Datum LSZ (1702) Feet

N= 580,772.98
 E= 3,384,357.63

RM-1 (Chiseled square on left upstream walkway)

Elevation = 22.74 feet (NAVD 88)

RP-1 (Top edge of a 1-1/4" nut painted orange on the upstream side of the bridge across from gage house)

Elevation = 22.46 feet (NAVD 88)



Position established utilizing Real-Time Kinematic (RTK) surveying from Secondary GPS Monument "BA-25b-SM-01". This position was surveyed by T. Baker Smith & Son, Inc.

Attachment 7
Water Quality Data Collection Standard
Operating Procedures

Bayou Lafourche Water Quality Data Collection Standard Operating Procedures

Prepared for
Louisiana Department of Natural Resources

May 2004

Prepared by
CH2MHILL

Contents

1.0	Introduction.....	1-1
2.0	Mobilization.....	2-1
2.1	Project Mobilization	2-1
2.1.1	Internal Project Mobilization	2-1
2.1.2	Project Mobilization	2-1
2.2	Project Demobilization	2-2
2.2.1	End of Day	2-2
2.2.2	End of Field Event	2-2
3.0	Field Documentation	3-1
3.1	Field Logbooks.....	3-1
3.2	Calibration Logs	3-2
4.0	Water Quality Data Collection.....	4-1
4.1	Station Conditions	4-1
4.2	Monitoring Stations.....	4-1
4.3	CTD Operation.....	4-2
4.3.1	Uploading Files.....	4-2
4.3.2	Collecting Readings	4-2
4.3.3	Cleaning the CTD	4-3
4.3.4	Changing Batteries	4-3
4.3.5	Logging/Deployment.....	4-3
4.4	ADCP Operation	4-3
4.4.1	Diagnostic Mode.....	4-3
4.4.2	Recorder Mode	4-4
4.4.3	Deployment Mode.....	4-4
4.4.4	Realtime Mode.....	4-4
4.4.5	Processing Mode.....	4-4
4.4.6	ADCP Cleaning	4-4
5.0	Field Instrument Calibration	5-1
5.1	CTD Calibration.....	5-1
5.1.1	Temperature Meter	5-1
5.1.2	Specific Conductance Calibration	5-1
5.1.3	Depth Calibration.....	5-2
5.2	ADCP Calibration.....	5-2
6.0	Variances and Field Changes	6-1
	Station Actions/Tasks Flow Sheet	6-1
	ADCP Operation (if applicable)	6-1
	CTD Operation (if applicable)	6-1

1.0 Introduction

This Standard Operating Procedure (SOP) provides field personnel with instructions regarding activities to be performed before, during, and after field investigations. This SOP contains general details about procedures and equipment which apply to water quality data collection operations.

The collection and documentation of data should be performed as described in the specific SOPs that follow.

These general instructions are intended to clarify the role of field personnel during water quality data collection operations.

These instructions will ensure that field personnel will take the proper precautions to understand the site, the objectives, and the schedule for the field program, their authority, and responsibilities described in the work plan.

This plan provides procedures on the following activities:

- Section 2 Mobilization
- Section 3 Field Documentation
- Section 4 Water Quality Data Collection
- Section 5 Instrument Calibration
- Section 6 Variances and Field Changes

2.0 Mobilization

Mobilization to the site will occur once a notice to proceed is issued by the client Point of Contact (POC). Mobilization includes the set-up of the site as station as the mobilization of necessary equipment, materials, and staff resources.

2.1 Project Mobilization

2.1.1 Internal Project Mobilization

Several internal tasks must be carried out before personnel proceed with fieldwork. These comprise project readiness review and include, but are not limited to, the following:

- Briefing field personnel on:
 - The field assignment
 - The organization and chain of responsibility for the field team
 - An overview of the specific field tasks to be performed
 - A review of the Health and Safety procedures
 - Unique aspects of the work
- Arranging a Field Contact List of numbers potentially needed while in the field (Field Contact List in Attachment 7A)
- Charge batteries (sample Battery Log in Attachment 7A)
- Prepare project computer
- Arranging transportation and hotel reservations for field personnel
- Notification of property owners
- Reserve and order equipment and instruments (Equipment List in Attachment 7A)
- Designate a meeting location and time if personnel or sub-contractors are traveling separately

2.1.2 Project Mobilization

A field team meeting will be conducted where an initial Health and Safety briefing will be performed and tasks will be assigned. These include, but are not limited to, the following:

- Assembling and preparing equipment for transport to the field (Equipment List in Attachment 7A)
 - utilize checklists
 - verify that equipment and supplies are secure and tied down if necessary

- Assembling and preparing expendable supplies for transport to the field (Equipment List in Attachment 7A)
- When loading the boat, load only the necessary equipment for the stations to be serviced on that trip
 - verify that equipment and supplies are secure, organized and tied down if necessary
- Upon boarding the boat and while traveling on the boat, all personnel must wear PFDs and obey the captain's commands

2.2 Project Demobilization

Upon completion of field activities, the Field Team Leader will assure that all demobilization activities have been completed and the site has been restored to the conditions as found before the commencement of field activities.

2.2.1 End of Day

The end of the day activities are as follows:

1. Verify all records and data are complete and accurate.
2. Assess the next day's tasks and delegate assignments to the field team members.
3. Secure all equipment and supplies
4. Designate the next meeting location and time.

2.2.2 End of Field Event

The end of the field event activities are as follows:

1. Verify all records and data are complete and accurate.
2. Transportation and destinations are coordinated.
3. All tools are accounted for and returned to vendor, office or owner.
4. Post-field event tasks are assigned.