Final

Mississippi River Water Reintroduction
Into Bayou Lafourche

Phase 1 Design Report • November 2005

Prepared for

Louisiana Department of Natural Resources

Prepared by

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In association with:
T. Baker Smith & Son, Inc.
FTN Associates, Ltd.
Eustis Engineering, Inc.
Jaymac Consultants

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11-22-05

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Executive Summary

This Phase 1 Design Report for the Mississippi River Reintroduction into Bayou Lafourche project represents the first major evaluation of new and refined alternatives of the Phase 1 Engineering and Design approved by the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Task Force. This work evaluates alternatives that meet the project purpose, defined as follows:

> Maximize the Mississippi River connection to Barataria-Terrebonne Basins to nourish and protect the marsh through the reintroduction of fresh water, sediments, and nutrients. The proposed project has added purposes of ensuring long-term freshwater supply to communities and industries served by the Bayou Lafourche Freshwater District by limiting salt water intrusion and enhancing water quality.

This report presents analyses for evaluation of an array of project alternatives. These alternatives were systematically screened, qualitatively and quantitatively, resulting in a short list of five alternatives. These alternatives are recommended to be further evaluated in the 30 percent design. The 30 percent design evaluation will be conducted concurrently with the environmental review process National Environmental Policy Act. At its conclusion, one project alternative will be recommended for detailed design and construction.

Overview

To formulate and evaluate alternatives, a general approach was devised to characterize, group, define, and evaluate the broad range of possible alternatives that meet project objectives. A goal of this evaluation was to review a combination of previously and newly proposed potential alternatives. The alternatives were then logically screened to narrow the range of options to a short list that more closely reflect the overall objectives of the project.

To define the alternatives, the basic categories of features or components that comprised each alternative were identified. These basic categories are discussed below.

Conveyance System

The conveyance system is composed of Bayou Lafourche and other major new channels constructed as part of the overall system. Conveyance system project components that were included in the evaluation as part of the Phase 1 design effort are the bayou's cross section (including potential dredging extent) and water depth profile along each reach, alternative bypass channel routes around Donaldsonville, and major hydraulic structures that influence capacity and water levels of the system.

Diversion Structures

The diversion structures include the facilities necessary to convey fresh water from the Mississippi River into Bayou Lafourche or the bypass channel. These include pump stations located along the river, intake piping, discharge piping, and sediment control facilities. Sites for the diversion structures included locations at Donaldsonville and Smoke Bend, upstream of Donaldsonville.

System Control and Monitoring

Control and monitoring systems include all systems deployed to control or stabilize water levels during times of pump shutdown, hazardous spill containment, or storm events. These systems generally include deployable weirs, monitoring stations, and monitoring/control linkages to the pump station.

Infrastructure, Utility, and Site Modifications

The alternatives considered will require some level of modification to the various constructed features depending on the alternative. Some require land to be acquired for a new bypass channel and associated improvements. Other impacts to existing roads, bridges, utilities, and other existing infrastructure vary depending on the particular features of the alternatives.

The initial list of potential alternatives was quite large because of the possible combinations of the following physical variables:

- Specific route of the main conveyance channel
- Diversion location and flow rates
- Dredged channel cross section
- Allowable water level

Because of these variables, the Phase 1 analysis focused on refining the general conveyance route and hydraulic capacity of the system, leaving more detailed evaluation of components such as the pump station, for the 30 percent evaluation.

Early in this initial Phase 1 evaluation, several prominent issues became apparent:

1. The number of possible alternatives associated solely with channel geometry is substantial. A systematic methodology for evaluation was required to efficiently reduce the number of potential options based on flow, channel dimensions, and water level profile.

2. Costs attributed to dredging the bayou dominate the overall costs of all the alternatives.

3. Demonstrating the relationships among raised water levels in Bayou Lafourche, property impacts, project alternative conveyance capacity, and costs is vital to environmental and policy-level decisionmakers for subsequent phases of the project.

In light of the broad range of project alternatives, it was necessary to formulate an approach that characterized a potential channel system (depth and cross section along the channel profile, plus other key hydraulic features) and identified the diversion capacity of that system. After characterization of the alternatives, planning-level cost estimates were developed to allow comparisons among project alternatives. Relative costs were used as a quantitative screening mechanism to eliminate alternatives that were clearly not cost effective. The cost estimates developed for the screening were conceptual planning level estimates and not suitable for budgeting purposes.

Evaluation of Alternatives

Formulation and Analysis of Conveyance Alternatives

The conveyance system features used to define alternatives revolve around the following factors: route, hydraulic structures, target water levels, dredge template, and the potential bypass channel depth. By combining the basic features with other alternative options (i.e., variations in bypass channel excavation criteria, modifications to the Union Pacific Railroad crossing, and inclusion of a bayou check structure immediately upstream of Palo Alto Bridge), 144 alternatives were characterized for further evaluation.

For the initial screening of alternative alignments in the Phase 1 design, the hydraulics of the upstream 56 miles of Bayou Lafourche, from the Mississippi River to Lockport, were evaluated. The conveyance capacity, channel size, effect of different dredge templates, target water levels, and alignment alternatives were evaluated with hydraulic models. Figure ES-1 shows the primary study area for the screening of conveyance options in the Phase 1 design.

This initial evaluation was conducted using Hydrologic Engineering Center-River Analysis System (HEC-RAS), a one-dimensional backwater model developed by the U.S. Army Corps of Engineers. Alternatives for evaluation by the model were characterized by the following criteria. Key features describing each conveyance alternative are described in the following subsections.

Target Water Levels

To evaluate hydraulic capacity, assumptions were made about the project's affect on water surface level throughout the bayou. As part of the alternative formulation process, the design team considered a wide range of potential flows. Flow limits were achieved by developing alternatives that varied by target water level. Three not-to-exceed water level profiles were developed and termed target water levels. The allowable diversion flows were developed by modeling the average existing water level in Bayou Lafourche, historical mean low, and mean Mississippi River elevations at Donaldsonville (extrapolated linearly down to sea level at the Gulf of Mexico) for higher target water levels.

Dredge Templates

Increasing the capacity of the bayou depends on two factors: raising the water level and dredging. For alternative formulation, cross-sectional areas were varied by dredge template. For this Phase 1 design analysis, three different channel geometries were proposed: no dredge, 2-foot dredge, and 8-foot dredge (as measured by the depth from the bottom of the existing channel invert). The three geometries were applied in various combinations, resulting in seven different dredge template scenarios. Dredging was confined to the segment of the bayou between Donaldsonville and Lockport.

Construction of New Bypass Channel

A new bypass channel around Donaldsonville beginning at Smoke Bend on the Mississippi River is included in the alternatives. The new bypass channel would be approximately

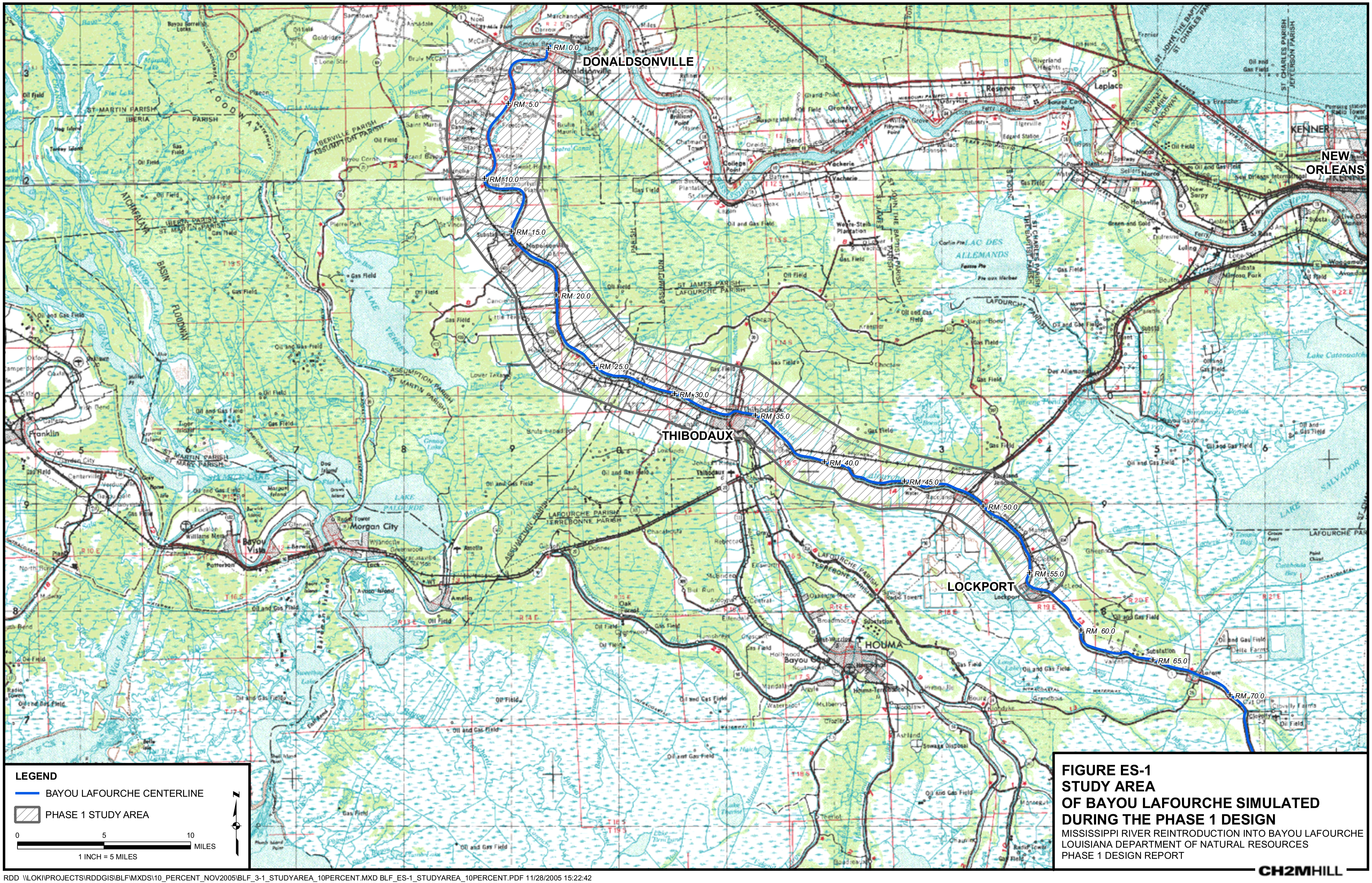

FIGURE ES-1
STUDY AREA
OF BAYOU LAFOURCHE SIMULATED
DURING THE PHASE 1 DESIGN

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PHASE 1 DESIGN REPORT

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13,500 feet long with a trapezoidal design section of varying widths (depending on the design flow). Two channel excavation configurations were developed: shallow and deep.

The shallow excavation configuration was developed to minimize the excavation and land acquisition requirements for the bypass channel. The water surface of the shallow bypass channel configuration was placed near the existing land surface downstream of the railroad crossing at the Smoke Bend diversion facility location and then translated along the bypass alignment at the design slope. Excavation requirements for the channel were developed using the resulting topography along the alignment. Because the excavation was minimized, a drop structure will be required at the confluence to introduce the flows into the bayou.

The deep excavation would include greater excavation and land acquisition, but would eliminate the need for energy dissipation at the confluence (drop structure) with Bayou Lafourche near the Palo Alto Bridge.

Hydraulic Structures

The Donaldsonville or Smoke Bend bypass alternatives also have two key hydraulic features in the Bayou Lafourche reach upstream of the Palo Alto Bridge. For the Donaldsonville route alternatives, the existing railroad bridge near the levee would significantly restrict increased flow. For those alternatives, two optional features were included in the conveyance alternative: either the railroad bridge was to be replaced to lessen the hydraulic restriction, or the bridge would be left unmodified.

A small dam located just upstream of the confluence of the bypass channel and Bayou Lafourche was included as an alternative feature for some of the conveyance alternatives. The purpose of the dam (referred to as a check structure) is to eliminate backwater affects into Donaldsonville from higher downstream water levels.

HEC-RAS Analysis

Each alternative cross-sectional geometry, dredge templates, hydraulic structures, and overall conveyance route were input to the HEC-RAS model. Flow was varied to meet the not-to-exceed target water levels. Therefore, for each alternative, a maximum flow was derived to meet the controlling target water level. Dredging volumes based on the dredge templates were also calculated using the HEC-RAS model. This approach resulted in an efficient computational approach to formulating alternatives and an excellent method to draw comparisons between the alternatives.

The detailed hydraulic modeling evaluated 69 of the possible 144 alternatives derived from a combination of alignments, target water surfaces, dredging, and improvements (check structures and railroad bridge modifications) used to determine the allowable flows that would meet target water levels. The 69 alternatives were the remainder after the application of the first set of filter criteria (discussed further below).

A diagram presenting the methodology of combining the project features to formulate the various conveyance alternatives is presented on Figure ES-2. Combining the flowchart options suggests that 144 alternatives could be considered when using all seven dredge templates, plus the no-dredge option.

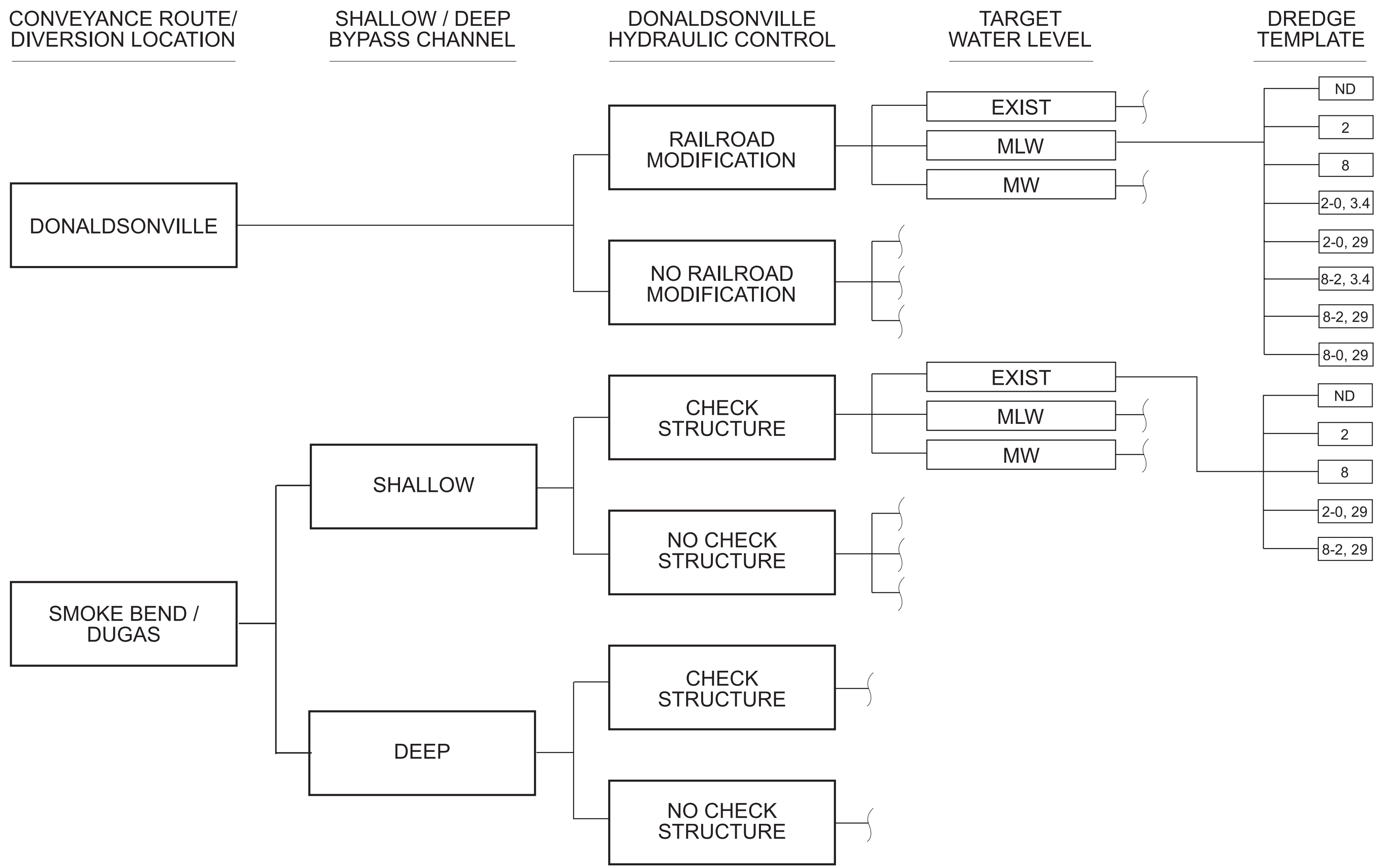

FIGURE ES-2
CONVEYANCE ALTERNATIVES CHARACTERIZATION DIAGRAM
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Comparison of Alternatives

Qualitative Screening

Alternatives were compared in a step-wise fashion using eight qualitative and quantitative screening criteria. Figure ES-3 illustrates this generalized comparison process and subdivides the screening approach into three main groups of criteria. Comparison Criteria 1 through 3 and Criteria 4 through 6 focus on a more qualitative evaluation where specific limitations or criteria were used to screen alternatives. Reasons for screening included not being cost effective (e.g., alternatives with an extremely high ratio of dredge quantity to diversion flow), restrictive to flow, or did not make sense (e.g., dredging in Donaldsonville for Smoke Bend alignments). Costs were not specifically needed to make these determinations.

Figure ES-4 outlines the screening criteria basis and illustrates how the 144 alternatives were screened down to 19 for quantitative screening. Comparison Criteria 7 and 8 on Figure ES-3 evaluate the quantitative cost effectiveness of the remaining alternatives. The number of alternatives screened out at each step of the process is shown on Figure ES-4.

A key consideration in the screening process was the expected impacts from increased water levels. Detailed photographic surveys of structures coupled with Geographic Information System-based water level contouring were used to assess impacts. These studies indicate that the increase in water level from mean low water (MLW) to mean water (MW) would cause a significant increase in impacted property and structures.

The MLW level rise is less than 1.5 feet throughout the Donaldsonville area and about 5 feet in the Thibodaux area. The MW level rise was approximately 1 to 2 feet higher than the MLW through both cities.

Detailed structures and property inventory in the local Donaldsonville and Thibodaux areas led to the conclusion that a water level rise in Bayou Lafourche should be limited 1.5 feet in Donaldsonville (downstream of the railroad bridge) and 3.0 feet in Thibodaux. These increased water levels are less than the MLW elevation in Thibodaux and about equal to MLW in Donaldsonville. Table ES-1 shows a sample structure impact inventory of the local areas near Donaldsonville and Thibodaux.

TABLE ES-1
Local Structure Impacts and Inundated Property
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

	Donaldsonville[a]		Thibodaux[b]		
	MLW	**MW**	**3-foot Rise**	**MLW**	**MW**
Structures	7	17	20	36	47
Property (acres)	6	20	11	19	25

[a]Upstream of the Palo Alto Bridge.
[b]Within 4 miles downstream of weir.

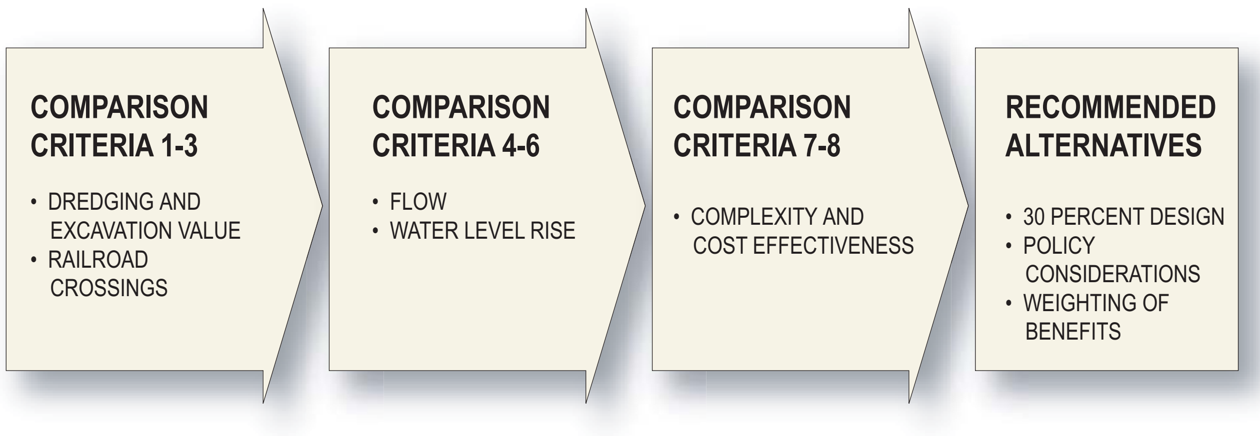

FIGURE ES-3
PROCESS FOR COMPARING ALTERNATIVES
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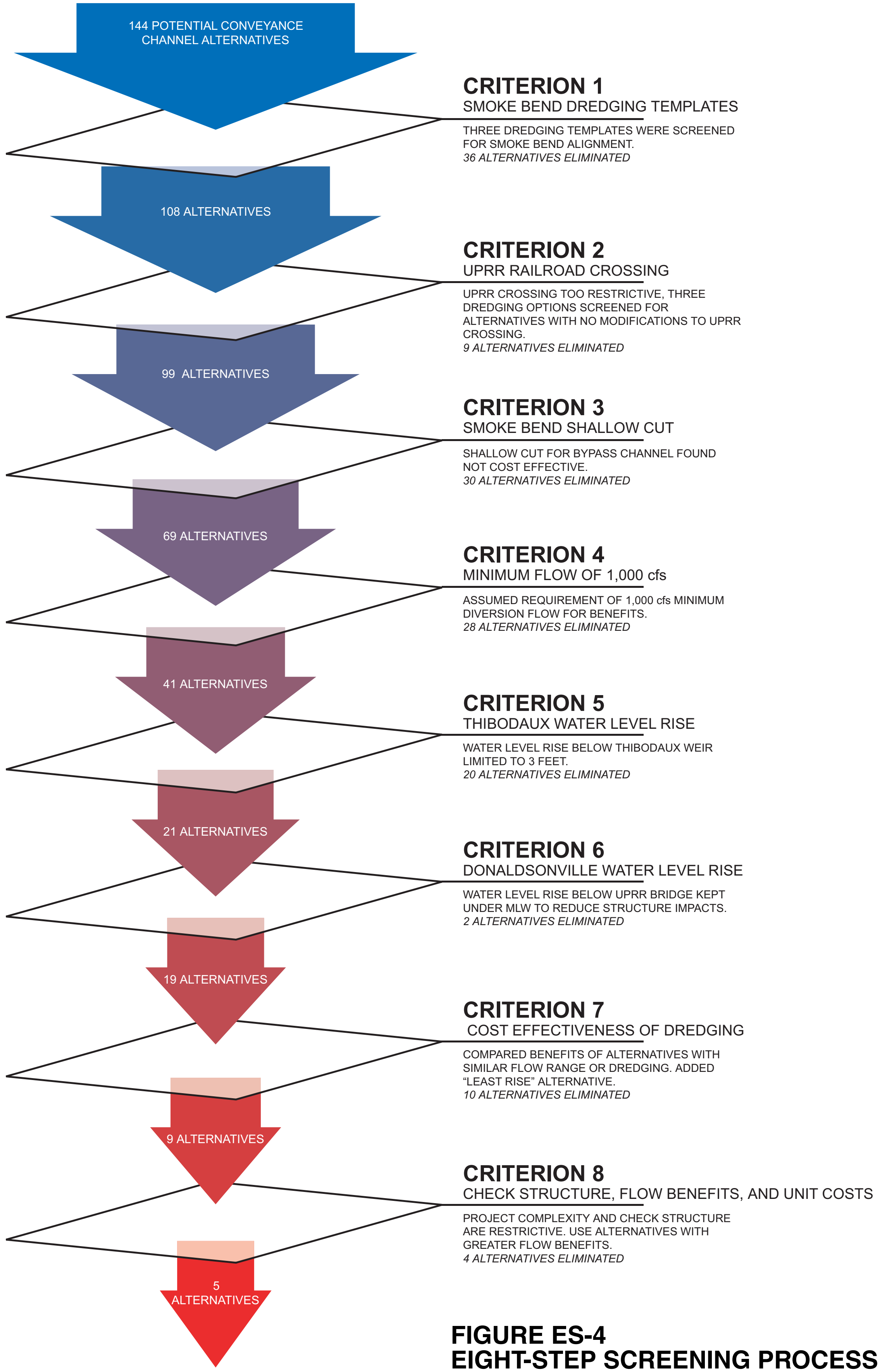

FIGURE ES-4
EIGHT-STEP SCREENING PROCESS
CONVEYANCE CHANNEL ALTERNATIVES
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Quantitative Screening

The development of cost estimates, as a quantitative screening step at the Phase 1 design stage of the project, was completed to compare cost differences among alternatives in Criteria 7 and 8 on Figure ES-4. The costs presented do not represent total construction, land acquisition, or capital costs. Therefore, they are not suitable for use in developing funding projections or total cost budget requirements. The costs developed were planning-level cost estimates prepared in accordance with the guidelines of the Association for the Advancement of Cost Engineering International for Class 4 estimates.

Costs were developed for the following alternative features:

- Dredging of Bayou Lafourche
- Constructing new bypass channel
- Bypass channel siphons
- Highway 1 crossing and drop structure at Bayou Lafourche
- Union Pacific Railroad crossing in Donaldsonville
- Deployable weirs in bayou
- Bulkheads
- Structure impacts
- Check structure with pump station at confluence
- Utilities relocation
- New diversion facility at Smoke Bend
- Modifying the Donaldsonville facility

Pump station costs for the diversion facility were based on a similar configuration in operation at Donaldsonville (riverside pump station with discharge over the levee). Costs were adjusted depending on flow capacity requirements of the specific alternative. The diversion structures and other components will be refined in the 30 percent evaluation, after the overall conveyance alternatives (e.g., route, target water level, dredge volume, and flow capacity) are screened to a reasonable number.

After completing cost estimates for the range of alternatives remaining after screening Criterion 6, the quantitative screening analysis was performed. The further reduction in alternatives to carry forward into the 30 percent design was based on cost comparisons of alternatives relative to the features described in the following subsections.

Comparison of Alternatives with Similar Dredging Requirements

For this level of analysis, alternatives with similar dredging requirements but different flow were screened to select the more efficient alternatives. Because the amount of dredging translated directly into higher costs, the advantage to the project was to carry forward those projects with the greatest flow at a similar dredging volume. Unit costs were developed for each of the 19 remaining alternatives and plotted versus flow. The more cost-effective alternatives in each dredging range were carried forward.

Least Rise (Water Level Rise) Alternative

The impacts of water level rise led to the development and analysis of a least rise alternative consisting of a 1,000-cubic foot per second (cfs) diversion and an 8-foot dredge template from Donaldsonville to Lockport. The hydraulic analysis of this alternative showed the lowest water level rise at 1,000 cfs, and, therefore, the least impact on structures.

The unit cost for this alternative was the largest of all the remaining alternatives because of the dredging required, and was, therefore, eliminated from further consideration. However, presenting the alternative had the value of showing the cost of reducing water level impacts as much as possible at the low flow threshold of 1,000 cfs.

Comparison of Alternatives by Complexity and Flow

The last step in the quantitative screening process for the remaining alternatives was to review the alternatives against project features and cost effectiveness. This approach was used because certain alternatives required additional complex features but benefited a small segment of the bayou. For example, protecting the residents in Donaldsonville from a rise in water level with a check structure and pump station added costs and only benefited the Donaldsonville residents.

When the unit cost of alternatives was similar, the relative benefit of additional flow was used to separate alternatives. The expectation of the project was that more flow would translate into greater downstream benefits. The alternatives with the greatest flow for similar unit costs were carried forward.

Analysis of Remaining Alternatives

The remaining five alternatives were summarized on a common unit cost versus flow diagram to delineate trends. As shown on Figure ES-5, the remaining alternatives follow a clear trend line of increasing unit cost with increasing flow. Each of these remaining alternatives has a measure of structure impacts that have been incorporated into the total project cost.

Of the remaining five alternatives, three are for the Donaldsonville alignment and two are for the Smoke Bend alignment. The largest flow considered for the project was 2,000 cfs and is only associated with a Smoke Bend alignment.

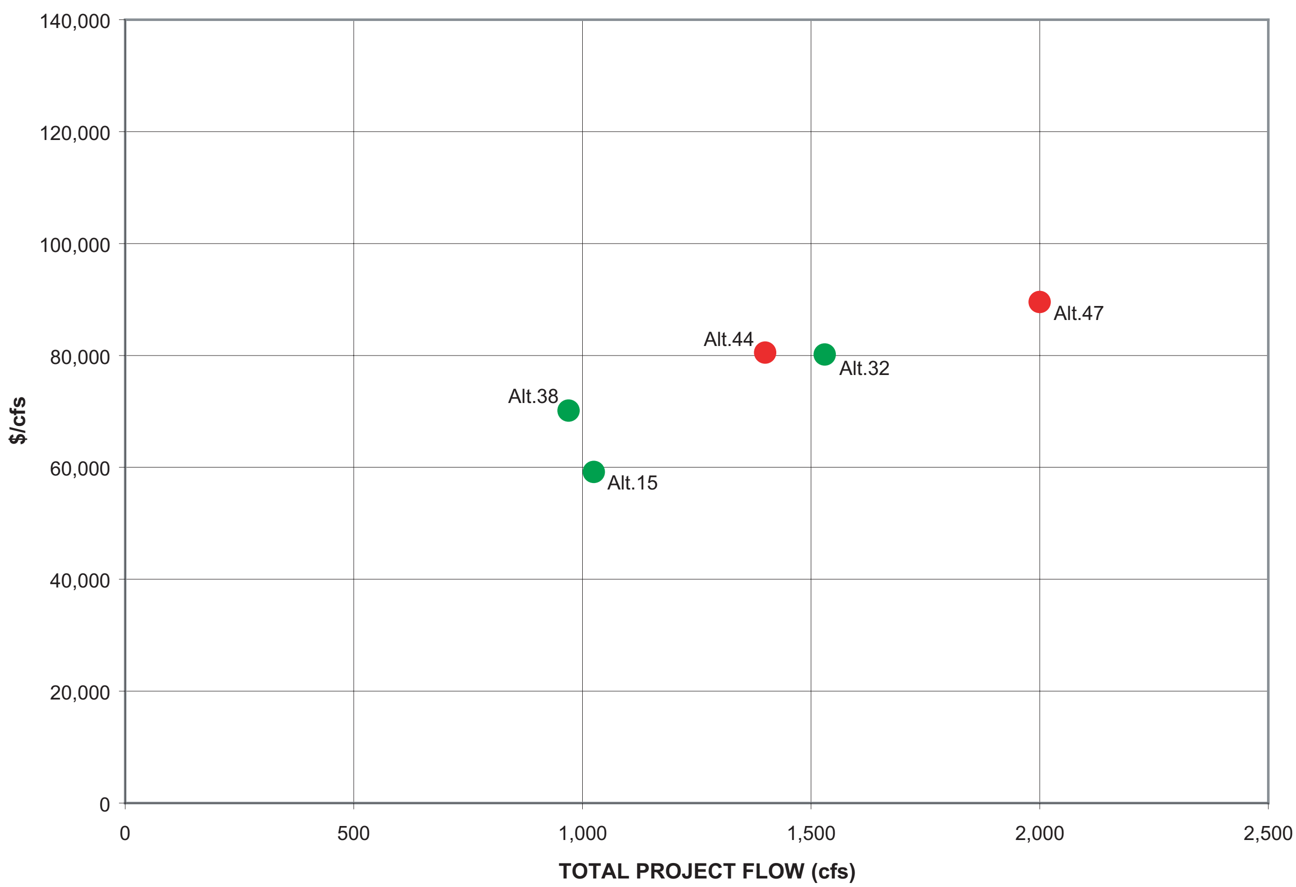
Selection of Recommended Alternatives

Selection of Short-list Alternatives for Further Design Analysis

The alternatives shown on Figure ES-5 were those that remained following the eight-step screening process and evaluation for cost efficiency (cost per cfs). These five alternatives combine to provide flows ranging from 1,000 to 2,000 cfs. None of the remaining alternatives include the use of a check structure, and two of the alternatives require the replacement of the Union Pacific Railroad Bridge.

Two of the alternatives require dredging to 8 feet for all or a portion of Bayou Lafourche and, therefore, might have additional bridge stability impacts. Bridge stability impacts will be evaluated in the 30 percent design phase. A similar situation exists for bulkhead costs.

Although some bulkhead costs have been included in the 8-foot dredging alternatives for bank stability, the full extent of bulkhead areas cannot be shown until the additional geotechnical work for the 30 percent design report is completed.



LEGEND
- DONALDSONVILLE ALTERNATIVES
- SMOKE BEND ALTERNATIVES

FIGURE ES-5
COST-EFFICIENCY PLOT OF REMANING ALTERNATIVES

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Following are the key decisions that will allow the remaining five alternatives to be reduced to one:

1. Should the design flow rate be 1,000, 1,500, or 2,000 cfs?
2. Should the Smoke Bend Bypass be used, or should the original channel through Donaldsonville be used? If the selected flow is greater than 1,500 cfs, Smoke Bend must be used.
3. Should the Union Pacific Railroad crossing be modified? If the higher water level (MWL) upstream of the bridge is acceptable and the 1,000-cfs flow is selected, the bridge would not require modification. If the Donaldsonville alignment is selected and a flow greater than 1,000 cfs is selected, a new bridge would be required.

Summary of Recommendations

A recommended group of alternatives is presented that was used to define a range of potential diversion flows and project costs. This short list of selected alternatives represents the perspectives of the design team with regards to possible alternatives that could proceed into the 30 percent design.

The screening process resulted in alternative costs ranging from approximately $70,000,000 to $179,000,000. The unit costs varied from about $60,000 per cfs to $90,000 per cfs.

Table ES-2 shows the specific attributes of the five remaining alternatives and the potential flow expected to be achieved through development of the project. Figure ES-6 shows the range of water levels for the Donaldsonville and Thibodaux areas.

The results in this report provide a basis to Louisiana Department of Natural Resources, U.S. Environmental Protection Agency (EPA), and the rest of the project team to proceed with discussions regarding project flow, benefits, and budget.

Integration of Design Activities with Environmental Documentation

As the design activities on the project proceed in the 30 percent design stage, it is important to closely coordinate the design and environmental documentation work. The EPA has selected a consultant for the environmental documentation activities. The design team should meet with the consultant, Louisiana Department of Natural Resources, and EPA regularly to review the various activities of each team and coordinate information exchange.

Incorporation of Policy-level Decisions

Assumptions were made by the design team to develop the recommended short list of alternatives for the project. Figure ES-5 illustrates that the short list falls on a continuously increasing trend in costs versus flow of potential alternatives for the project. Budgetary and project impacts must be integrated with the environmental benefits as the project proceeds. Refinements to the remaining alternatives are possible in the 30 percent design and selection of a single alternative should be made before starting the final design.

TABLE ES-2
Recommended Alternatives for Further Study in the 30 Percent Design
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Alternative No.	Alignment Alternative	Donaldsonville Railroad Crossing	Dredge Template	Maximum Target Water Level	Potential Cost (nearest $ million)	Project Flow (cfs)	Cost per cfs ($)
15	BL	NM	2-0@RM29	MW	61	1,025	59,150
32	BL	M, NB	8-2@RM29	MLW	123	1,530	80,150
38	BL	M, NB	2-0@RM29	MLW	68	970	70,100
44	SB	NM	2-ALL	MLW	113	1,400	80,500
47	SB	NM	8-ALL	MLW	179	2,000	89,500

Notes:

BL = Bayou Lafourche
M = Modified
NB = New Bridge
NM = Not Modified
RM = River Mile
SB = Smoke Bend

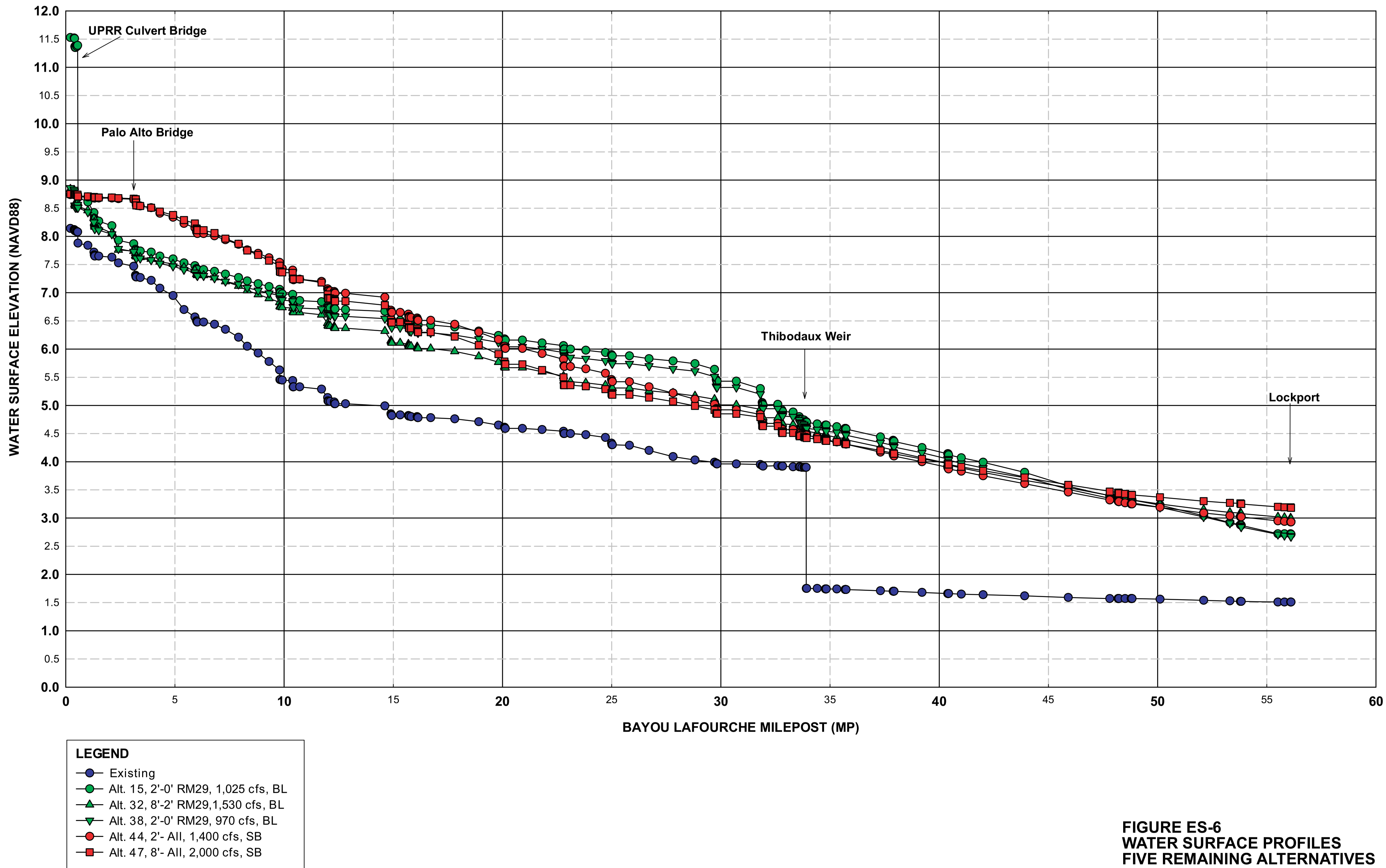

FIGURE ES-6
WATER SURFACE PROFILES
FIVE REMAINING ALTERNATIVES
BAYOU LAFOURCHE CHANNEL
MISSISSIPPI RIVER REINTRODUTION INTO BAYOU LAFOURCHE
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
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Subsequent to the development of the five final alternatives and during the review of the Draft Final Phase 1 Report, the Louisiana Department of Natural Resources and EPA requested that Alternative 20 and the least rise alternative be included in the set of remaining alternatives. The incorporation of these two alternatives was a policy-level decision to include additional alternatives with reduced water level rise, compared with the five recommended alternatives previously discussed.

Each of the two alternatives, 20 and least rise, has a diversion flow of about 1,000 cfs. Figure ES-7 shows the comparison of the water level rise for all seven of the alternatives. Both Alternative 20 and the least rise alternative reduce the projected rise in water level (resulting from the five final alternatives) by between 0.5 and 1.5 feet. The least rise alternative results in a water surface that is up to 2 feet lower than existing upstream of the Thibodaux weir, but this could be managed with check structures.

Table ES-3 shows the major attributes of the seven alternatives recommended by Louisiana Department of Natural Resources and EPA to be carried into the 30 percent design.

TABLE ES-3
Recommended Alternatives for Further Study in the 30 Percent Design
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Alternative No.	Alignment Alternative	Donaldsonville Railroad Crossing	Dredge Template	Maximum Target Water Level	Potential Cost (nearest million $)	Project Flow (cfs)	Cost per cfs ($)
15	BL	NM	2-0@RM29	MW	61	1,025	59,150
32	BL	M, NB	8-2@RM29	MLW	123	1,530	80,150
38	BL	M, NB	2-0@RM29	MLW	68	970	70,100
44	SB	NM	2-ALL	MLW	113	1,400	80,500
20	BL	M, NB	2-ALL	MLW	89	1,020	87,300
47	SB	NM	8-ALL	MLW	179	2,000	89,500
Least Rise	BL	M, NB	8-ALL	E	121	1,000	120,600

Note:
E = Existing Water Level

The unit costs range from $59,000/cfs to $121,000/cfs. Figure ES-8 shows a graphical representation of the alternatives unit cost compared with diversion flow. The trend of the five recommended alternatives from the detailed screening process is up-and-to-the-right showing slightly increasing unit costs for the added flow. With the addition of Alternatives 20 and the least rise, four alternatives have about 1,000 cfs with unit costs between $59,000/cfs and $121,000/cfs.

Each of the seven alternatives will be evaluated in the 30 percent design for engineering and costs. A final recommended alternative will be prepared as part of the 30 percent design report.

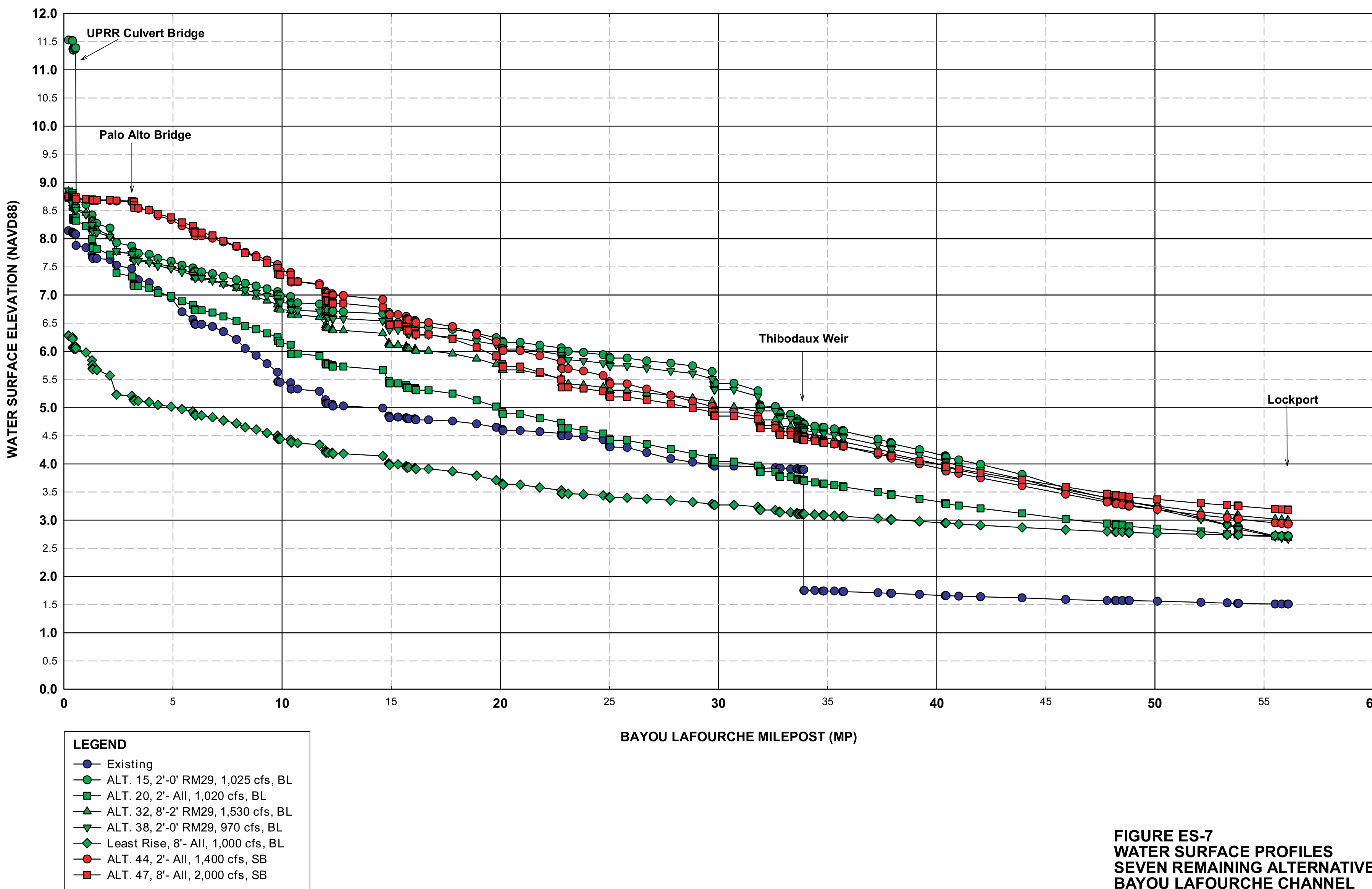

FIGURE ES-7
WATER SURFACE PROFILES
SEVEN REMAINING ALTERNATIVES
BAYOU LAFOURCHE CHANNEL
MISSISSIPPI RIVER REINTRODUTION INTO BAYOU LAFOURCHE
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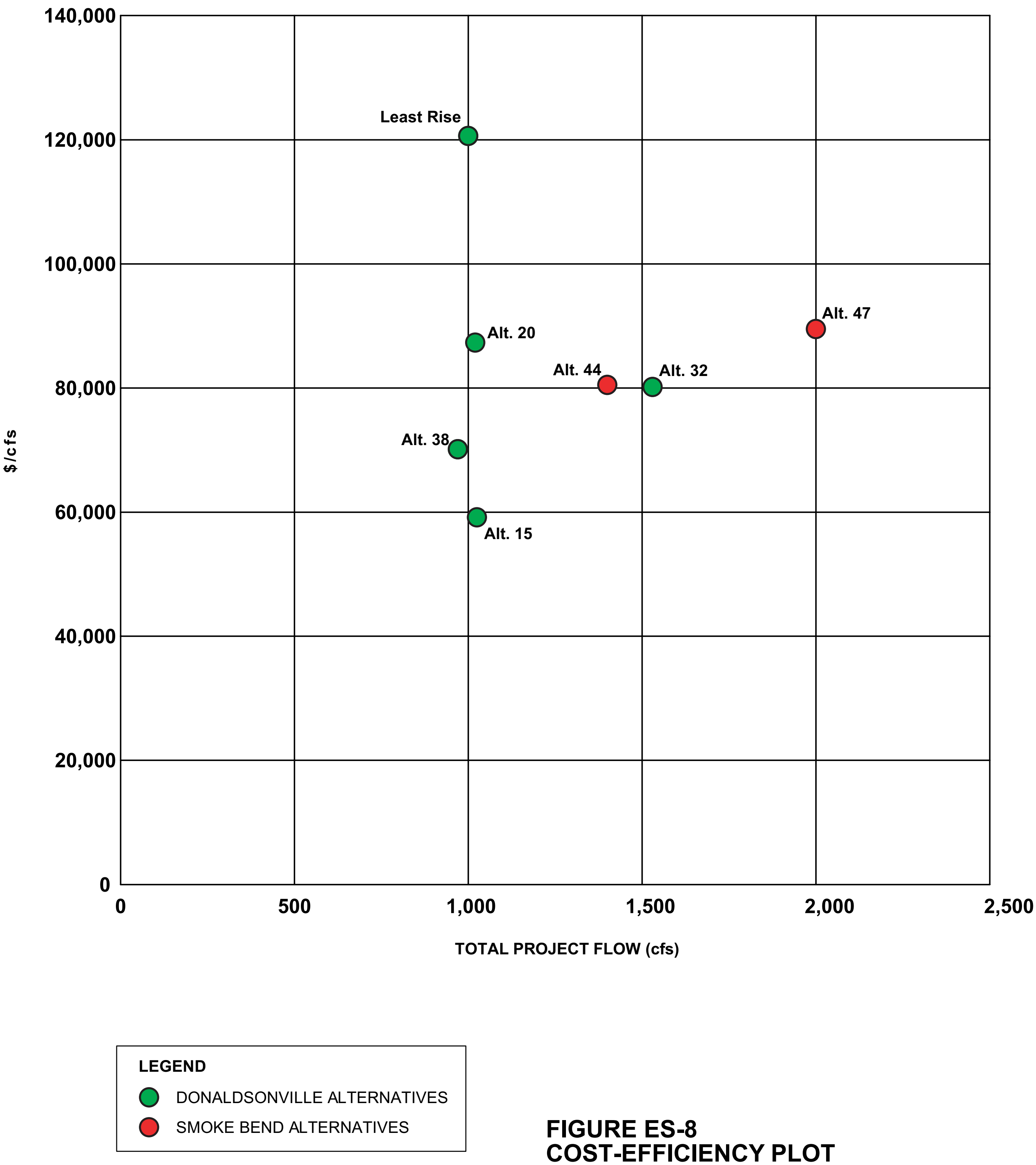

FIGURE ES-8
COST-EFFICIENCY PLOT
SEVEN REMAINING ALTERNATIVES
BAYOU LAFOURCHE CHANNEL

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Coordination of Project Activities with Other Stakeholders

Numerous key activities were defined for the project going forward into 30 percent design. Many of these activities involve coordination of the various aspects of the project with other stakeholders. A partial list of these activities and stakeholders is as follows:

- Refine the availability and suitability of dredged material for use in agricultural operations and beneficial reuse applications (marsh creation/nourishment) near the bayou.
- Refine the design criteria for crossing the levee along the Mississippi River with the U.S. Army Corps of Engineers and the Mississippi River Commission.
- Meet with representatives of the Louisiana Department of Transportation and Union Pacific Railroad to refine railroad crossing criteria for the project facilities.
- Gain concurrence on assumptions and parameters to be incorporated into the Wetlands Value Assessment with CWPPRA technical experts.
- Continue discussions with the Lafourche Freshwater District regarding operation and maintenance requirements and design configuration of the diversion pump stations.
- Continue drainage impacts research along the bayou, and refine the information currently available through ongoing contacts with appropriate city and parish officials.

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Acronyms and Abbreviations

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1D	one dimensional
2D	two dimensional
BL	Bayou Lafourche
CDF	confined disposal facility
CEC	cation exchange capacity
cfs	cubic feet per second
CWPPRA	Coastal Wetlands Planning, Protection, and Restoration Act
cy	cubic yard
cy/ft	cubic yards per foot
DCP	data collection platform
E	existing water level
E&D	Engineering and Design
EPA	U.S. Environmental Protection Agency
fps	feet per second
ft/ft	foot per foot
GIS	Geographic Information System
H:V	horizontal:vertical
HEC-RAS	Hydrologic Engineering Center-River Analysis System
LDNR	Louisiana Department of Natural Resources
LFWD	Lafourche Freshwater District
M	modified
mcy	million cubic yards
MHW	mean high water
MLW	mean low water
MRRBL	Mississippi River Reintroduction into Bayou Lafourche

MW	mean water
NAVD88	North American Vertical Datum 1988
NB	new bridge
NEPA	National Environmental Policy Act
NM	not modified
RM	River Mile
SB	Smoke Bend
SCADA	supervisory control and data acquisition
Sediment Study	*The Bayou Lafourche Sediment Study*
TM	technical memorandum
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WES	Waterways Experiment Station
WSE	water surface elevation

SECTION 1

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 Reintroduction into Bayou Lafourche (MRRBL) project in 2001. The project area is shown on Figure 1-1. This report is the first major evaluation of new and refined alternatives being conducted as part of the Phase 1 E&D.

This effort was funded equally by CWPPRA and the State of Louisiana. The U.S. Environmental Protection Agency (EPA) is the lead Task Force agency, and the Louisiana Department of Natural Resources (LDNR) is leading the initial design phase for the state. A decision to proceed beyond the 30 percent design review will be made by the Task Force and the state. Their decision will depend, in part, on willing cost-share partners and on available CWPPRA funding. This report represents the conclusion of the Phase 1 design effort.

1.1 Background

Bayou Lafourche was cut off from Mississippi River at Donaldsonville, Louisiana, in 1903 by a dam and subsequent levee improvements. The bayou was partially reconnected to the river in the 1950s, with the installation of a pump/siphon station that supplies approximately 200 cubic feet per second (cfs) for consumption and water quality maintenance. Historically, the river served to counteract subsidence in the area by introducing fresh water, sediments, and nutrients. In addition, numerous oil field canals, the Gulf Intracoastal Waterway, and the Houma Navigation Canal have altered the natural hydrology of the area. These alterations reduced the freshwater flows to area marshes, and saltwater intrusion impaired drinking water quality.

A conceptual project was identified in the *Louisiana Coastal Wetlands Restoration Plan* (CWPPRA, 1993) to divert fresh water down Bayou Lafourche to benefit the marshes of the Terrebonne and Barataria Basins. In 1995, EPA and the Bayou Lafourche Freshwater District (LFWD) 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 by means of siphons, and only operated during periods when the difference between river and bayou stage was adequate to accomplish siphon function (January to June in normal water years). Outside of the siphon operations period, diversions would be reduced to those quantities that could be supplied using the existing pump station.

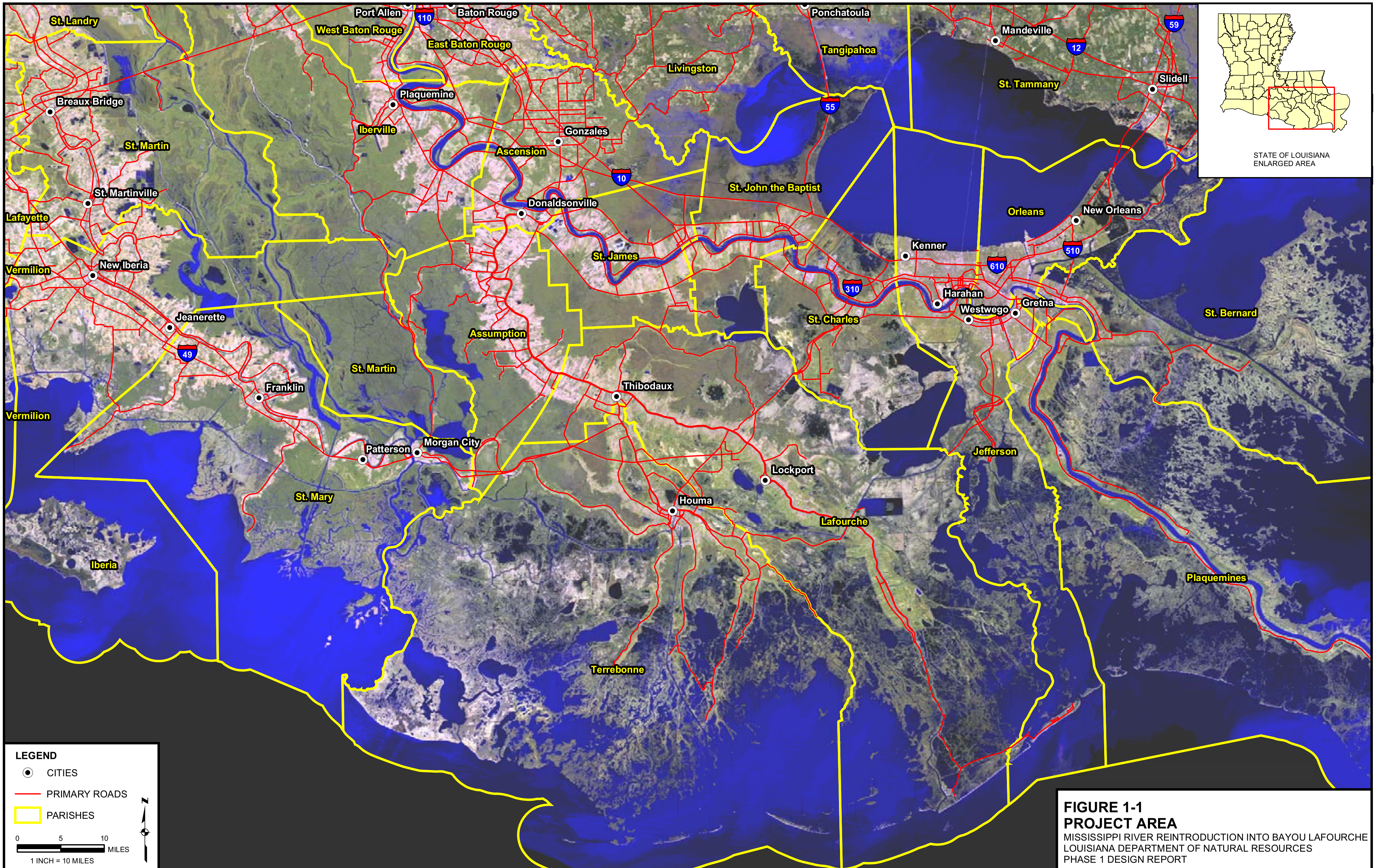

FIGURE 1-1
PROJECT AREA
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
PHASE 1 DESIGN REPORT

CH2MHILL

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The original project met with substantial public resistance, primarily because of concerns over the negative impacts of increased water levels on residential properties adjacent to the bayou, existing flood control measures, and bank stability. No provision was included in the original project to address property inundation or flood control 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., conducted an alternatives analysis to increase the conveyance capacity of Bayou Lafourche to accommodate the 2,000 cfs that was proposed in the original project without raising water levels above a reference water surface profile. Coastal Engineering and Environmental Consultants, Inc., 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 fresh water to 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, which was 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 and several other alternatives. In contrast to the original project, the following three features were consistently identified in the additional alternatives considered:

- Pumping capacity was added to provide consistent flows year-round and to maximize freshwater supplies, particularly in the fall when salinity problems are greatest.
- 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 bayou water levels 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 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 cost share 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 wetlands conservation goal of the Bayou Lafourche project via additional Mississippi River flows.
- The design report will include the following updated cost and benefit estimates and alternative designs and approaches for accomplishing the project's conservation goals:
  - An evaluation 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 April 2004, the project purpose was refined as follows:

> Maximize the Mississippi River connection to Barataria-Terrebonne Basins to nourish and protect the marsh through the reintroduction of fresh water, sediments, and nutrients. The proposed project has added purposes of ensuring long-term freshwater supply to communities and industries served by the LFWD by limiting saltwater intrusion and enhancing water quality.

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 expected area for marsh enhancement is located south of Thibodaux in the Lake Fields and Lake Long (both fed by Company Canal), Grand Bayou, Bayou Terrebonne, Houma Navigation Canal, Delta Farms, and Bayou Perot and Bayou Rigolets areas.

This Phase 1 Design Report presents analyses for an array of project alternatives. These alternatives were systematically screened, qualitatively and quantitatively, to result in only a proposed few for the state and Task Force agencies to review. Following their guidance, and incorporating the environmental review process (National Environmental Policy Act [NEPA]), the range of project alternatives will be evaluated in more detail in the 30 percent effort to result in three to five project alternatives that will be carried into the 30 percent design phase. At the conclusion of the 30 percent design effort, one project alternative will be recommended for detailed design and construction.

1.2 Purpose of Phase 1 Design Report

This report presents analyses, findings, and a summary of recommendations concerning project alternatives that will be evaluated during the next stage of the project. During this phase, an array of project alternatives that accomplished project objectives were developed to the Phase 1 level for comparison and screening purposes. The initial steps of this effort required assimilating project data gathered to date and detailing a logical methodology to define, characterize, group, analyze, and compare project alternatives.

1.3 Scope

This report documents the Phase 1-level evaluation of alternatives for the MRRBL project. The project, which was awarded to CH2M HILL in July 2003, was separated 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: Alternatives Analysis

Task 3 developed the following technical memoranda (TM):

- Task 3.1: Verify Existing Alternatives
- Task 3.2: Identify New Alternatives

Task 3.1 reviewed and summarized prior studies' project alternatives. TM 3.1 identified those alternatives and components of alternatives that were considered viable and consistent with the overall project goals and that could be brought forward as concepts for further development. The subsequent TM developed in Task 3.2 provided a description of new potential project alternatives/components and summarized the methodology proposed for evaluating alternatives in the Phase 1 design effort.

Task 4 of the scope includes the engineering analyses for both the Phase 1 and 30 percent efforts. This Phase 1 Design Report provides an evaluation of the updated list of viable alternatives and engineering issues that will require further development as the analysis and design efforts progress. The recommended alternatives include design and policy issues that the Task Force and state will need to consider before finalizing the alternatives that will proceed into the 30 percent design phase.

As part of the Task 4 efforts, a two-dimensional (2D) hydrodynamic and water quality model is under development and will be used to help assess wetlands benefits for a refined set of alternatives in the 30 percent effort. A Phase 1 modeling report is included in Appendix A of this report. Support for the modeling effort has included gathering significant new surveying information and data.

A preliminary hydraulic model of the upstream portion of the project was developed and used to facilitate the Phase 1 design. At the conclusion of the Phase 1 design effort, additional surveying and data collection will be conducted to refine and address issues specific to the limited number of project alternatives.

Task 5 consists primarily of conducting a Wetlands Value Assessment further cost and benefit analyses, and a proposed allocation of costs for the 30 percent design alternatives. This information will be prepared for use in determining which project alternative will proceed to final design.

1.4 Report Organization

This Phase 1 Design Report provides a planning-level analysis of the alternatives under consideration. The report is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Overview of Alternatives Development
- Section 3 – Conveyance Evaluation
- Section 4 – Diversion Structures
- Section 5 – Infrastructure, Utility, and Site Modifications
- Section 6 – Dredging, Disposal, and Beneficial Reuse Analysis
- Section 7 – Comparison of Alternatives
- Section 8 – Summary of Recommended Alternatives and Considerations for the 30 Percent Design Evaluation
- Section 9 – Louisiana Department of Natural Resources and U.S. Environmental Protection Agency Review
- Section 10 – References
- Appendix A – Phase 1 Modeling Preliminary Results
- Appendix B – Historical Water Users along Bayou Lafourche
- Appendix C – Historical Water Level Investigation
- Appendix D – Smoke Bend Canal Sizing and Dredging Volumes
- Appendix E – Bayou Lafourche Alignment Conveyance Alternative Matrix/Water Level Profiles
- Appendix F – Mississippi River Stage Elevation 1951 to 2004
- Appendix G – Pump Curve and Sizing Data
- Appendix H – Existing Utility Owners and Pipe Elevations
- Appendix I – Review of the Wetlands Value Assessment Process and Role in Coastal Wetlands Planning, Protection, and Restoration Act
- Appendix J – Phase 1 Geotechnical Report
- Appendix K – Comparing Dredging Requirements with Target Water Levels and Diversion Flows

SECTION 2

Overview of Alternatives Development

2.1 General Approach

This section provides an overview of how project alternatives were developed and evaluated. A methodology was developed to characterize, group, define, and evaluate a large range of possible alternatives to meet project objectives. A goal of this evaluation was to review a combination of previously and newly proposed potential alternatives. The alternatives were then logically screened to narrow the range of potential alternatives to a short list that reflected the overall objectives of the project. The short-listed alternatives will be more closely analyzed and screened in the 30 percent evaluation so that a preferred alternative can be recommended.

The initial list of potential alternatives is large because of the possible combinations of the following physical variables:

- Diversion location and flow rates
- Dredged channel cross section
- Allowable water elevation

Although numerous components will need to be individually analyzed in detail during the 30 percent and final design efforts, this initial Phase 1 effort focused on refining the general conveyance route and hydraulic capacity of the system. During the Phase 1 evaluation, the following prominent issues became apparent early in the process:

1. The number of possible alternatives associated solely with channel geometry is great, and requires a systematic evaluation to efficiently reduce the number of potential options.

2. Costs attributed to dredging the bayou dominate the overall costs of the alternatives.

3. Demonstrating the relationship between raised water levels in Bayou Lafourche, property impacts, and project alternative conveyance capacity and costs is vital to environmental and policy-level decisionmakers for subsequent phases of the project.

In light of the broad range of project alternatives, it was necessary to formulate an approach to characterize a potential channel system (depth and cross section along the channel profile, plus other key hydraulic features) and identify the diversion capacity of that system. Using characterization of the alternatives, planning-level cost estimates were developed to allow comparisons among project alternatives. To define the alternatives to evaluate, components of the alternatives were characterized. The following four main categories of project features were combined to create the alternatives for evaluation:

- **Conveyance System** – The conveyance system is composed of Bayou Lafourche and other major new channels constructed as part of the overall system. Existing major channels that already intersect Bayou Lafourche, such as the Gulf Intracoastal Waterway or Company Canal, are not assumed to be part of the primary conveyance system for this evaluation. Conveyance system project components that are part of the Phase 1 design effort include the bayou's cross section (including potential dredging) and water-depth profile along each reach; alternative bypass channel routes around Donaldsonville; major hydraulic structures that influence capacity and water levels of the system; and additional project features constructed, modified, or demolished along the conveyance route that are not included in the other categories.

- **Diversion Structures** – The diversion structures include the facilities necessary to convey fresh water from the Mississippi River into Bayou Lafourche or a bypass channel. These include pump stations located along the river, intake piping, discharge piping, and sediment control facilities. Past projects only considered upgrading the existing pump station at Donaldsonville. Depending on the selected alternative, these facilities could be either upstream or adjacent to the existing pump station in Donaldsonville.
- **System Control and Monitoring** – Control and monitoring systems include all systems deployed to control or stabilize water levels during times of pump shutdown, hazardous spill containment, or storm events. These systems generally include deployable weirs, monitoring stations, and monitoring/control linkages to the pump station. These components were only briefly reviewed for the Phase 1 design, but will be developed in further detail as the conveyance and diversion component alternatives are refined in the 30 percent effort.
- **Infrastructure, Utility, and Site Modifications** – Increasing the discharge down Bayou Lafourche for the selected alternative will require some level of modification to the various constructed features depending on the alternative. Some alternatives require land to be acquired for a new bypass channel and associated improvements. Other impacts to existing infrastructure, such as roads, bridges, and utilities, vary depending on the particular features of the alternatives.

These overall categories of project components and how the project components were defined to apply to individual project alternatives are discussed below. More detail on development and evaluation of these components and the alternatives themselves can be found in Sections 3 through 8.

2.2 Conveyance Systems

The conveyance system features used to define alternatives revolve around the following factors: route or alignment, hydraulic structures, bayou water levels, and dredging requirements.

A diagram presenting the methodology of combining the various project features and components to formulate the various conveyance alternatives is presented on Figure 2-1. By combining the basic features (route, target water level, and dredge template) with the other alternative features (variations in bypass channel excavation criteria, modifications to the Union Pacific Railroad (UPRR) crossing, inclusion of a bayou check structure immediately upstream of Palo Alto Bridge), 144 alternatives were initially characterized for evaluation. The project features that were combined to develop these alternatives are briefly described in the following subsections.

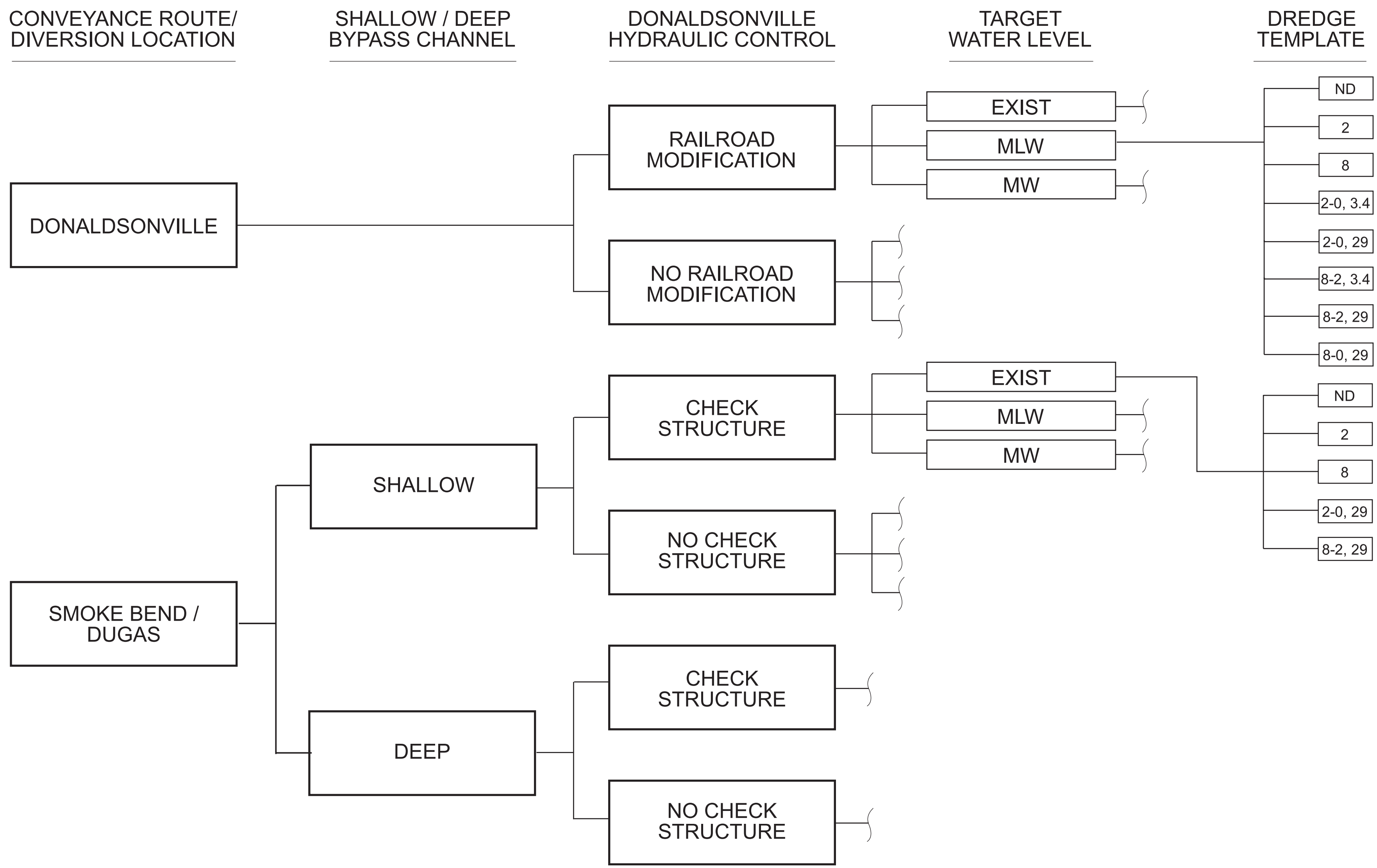

FIGURE 2-1
CONVEYANCE ALTERNATIVES CHARACTERIZATION DIAGRAM
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
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2.2.1 Route

Two basic conveyance system routes are in the upper reach of the bayou in or near Donaldsonville, each named after the approximate location of the Mississippi River diversion site (Smoke Bend and Donaldsonville). The Donaldsonville route uses the existing bayou as the main conveyance route, which is similar to past proposals (EPA, 1998).

The Smoke Bend alternative consists of a bypass channel around the upper reach of Bayou Lafourche, starting with a diversion upstream of Donaldsonville at Smoke Bend and ending just upstream of the Palo Alto Bridge. This alternative will route flow around the more densely populated reach of Bayou Lafourche. The advantages of using a bypass channel are the ability to minimize water level impacts in Donaldsonville and to eliminate the need for dredging in the upper reach of Bayou Lafourche (with associated construction impacts).

2.2.2 Hydraulic Structures

The Donaldsonville and Smoke Bend bypass alternatives each possess important hydraulic features in the Bayou Lafourche reach upstream of the Palo Alto Bridge. For the Donaldsonville route alternatives, the existing railroad bridge near the levee will significantly restrict increasing flow, because of the limited hydraulic capacity of the existing culverts under the bridge. For those alternatives, the following two conveyance features were included: either the existing railroad bridge and culverts were replaced with a new open-span railroad bridge to reduce the hydraulic restriction, or the bridge and its culverts were left unmodified.

A small dam located just upstream of the confluence of the bypass channels and Bayou Lafourche was included as an alternative feature for some of the conveyance alternatives. The purpose of the dam (referred to as a check structure) is to eliminate backwater effects into Donaldsonville from higher downstream water levels. Details of this structure are discussed in later sections of this report.

2.2.3 Target Water Levels

To evaluate hydraulic capacity of the bayou, assumptions were made about the project's effect on water surface levels throughout the bayou. As part of the alternative formulation process, the design team considered a wide range of potential flows for the project. Flows of up to 10,000 cfs were initially considered for the project. However, when viewed in the context of property development adjacent to the bayou and evaluations of the impacts of higher flows in previous studies, it was determined that lower flow limits were more appropriate. These lower flow limits were achieved by developing alternatives that varied by target water level. Three not-to-exceed water level profiles were developed and termed target water levels. The allowable diversions were developed by increasing flow until the modeled water surface met the average existing water surface elevations in Bayou Lafourche (termed existing target water level), and historical mean low and mean Mississippi River elevations at Donaldsonville (extrapolated linearly down to sea level at the Gulf of Mexico) as the two higher target water levels (termed mean low water [MLW] target level and mean water [MW] target level). Further discussion about the basis for these target levels is provided in Section 3 and a detailed description of how the target water level profiles were developed is presented in Appendix C. As described in Section 3, the establishment of target water levels allowed project alternatives to be formulated by "degree of impact" on properties adjacent to the bayou.

2.2.4 Dredge Template

Increasing the capacity of the bayou depends on two factors within the bayou channel: raising the water level and dredging. Past studies set a target capacity (e.g., 1,000 cfs) and then varied the dredging to match a given target water level (near the existing level). This approach requires effort and several iterations to alter the cross section geometry, by dredging, to meet the capacity (flow) targets.

For this Phase 1 design analysis, three different channel geometries were proposed: no dredge, 2-foot dredge, and 8-foot dredge (as measured by the depth from the bottom of the existing channel invert). The three geometries were applied in various combinations, resulting in several different dredge template scenarios. Dredging was limited to upstream of Lockport, based on previous study conclusions. For each defined cross-sectional geometry, flow was varied to meet the target water levels. This approach resulted in a more efficient computational methodology for formulating alternatives and a better way of drawing comparisons among the alternatives.

2.2.5 Bypass Channel Depth

Two options were considered for the geometry criteria of the bypass channels: a deep channel or a shallow channel. A deep channel could be excavated that would allow water surfaces to better match the water surface at the confluence with Bayou Lafourche. Alternately, a shallower channel could be constructed that would require less excavation. Alternatives were formulated to enhance the tradeoffs of channel excavation.

2.3 Diversion Structures

The diversion structures are the facilities used to divert water from the Mississippi River into Bayou Lafourche or the bypass channels. These facilities include the pipes, intake and discharge structures, and pumps that deliver the water into the bayou. These facilities require a site along the river that provides necessary access for the diversion works and has suitable geotechnical properties for foundation support. The diversion structure might also include sediment removal facilities to provide for better sediment control.

More detailed discussions with permitting agencies for levee penetrations and site-specific field investigations are needed to select a final diversion structure configuration. Therefore, a conservative approach has been taken at this stage of the project, where a diversion facility configuration based on existing conditions has been assumed. Opportunities will exist during the 30 percent design evaluations to optimize the diversion facilities for the recommended alternatives.

Following are the basic components of the diversion system that required characterization for the Phase 1 design:

- Diversion site location
- Pump station configuration

- Pump intake
- Pump discharge
- Sedimentation facilities

2.3.1 Diversion Site Locations

Two potential locations for reintroduction structures were identified through site reconnaissance, review of U.S. Geological Survey (USGS) topographic maps and aerial photographs, and discussions with the U.S. Army Corps of Engineers (USACE) and the LFWD. The site locations included in this Phase 1 evaluation are the existing Donaldsonville site and the Smoke Bend site (located at River Mile [RM] 177.5, on the outside of a large curve in the Mississippi River). A detailed discussion on the diversion site alternatives is presented in Section 4.

2.3.2 Pump Station Configuration

A pump station located on the river side of the levee is the most common configuration along the river because of the concern for maintaining the integrity of the levee. Previous studies have typically located a pumping facility on the river side. A pump station located on the land side of the levee would require that a series of intake pipes be installed under the levee by microtunneling to avoid removing and replacing the levee during construction. Intake pipes would be located sufficiently deep that they would be submerged for all river water elevations. It is not clear whether the USACE would allow such a facility because of concerns of reduced levee integrity. For the Phase 1 design, it was assumed that a pump station would be located on the river side using a configuration that is typical for the area.

2.3.3 Pump Intake

A piped intake for a pump station located on the river side of the levee would be similar to the existing Donaldsonville pump station. This type of inlet would include a piling-type structure in the river to protect the submerged inlet from river traffic and large debris damage. A forebay-channel intake was also evaluated. For the Phase 1 design, a piped intake was assumed for the diversion facilities.

2.3.4 Pump Discharge

Discharge piping from a pump station located on the river side of the levee could have two discharge pipe arrangements. To maintain the integrity of the levee and minimize the potential for flooding, the USACE might require that the discharge pipe invert be above a given high water elevation. Alternatively, through discussion and coordination with the agencies, the discharge pipes might be allowed to pass through the levee at a lower elevation. Lower discharge pipes would reduce the difficulty in creating a siphon over the levee. A siphon would reduce the operating costs when the water levels are favorable. For the Phase 1 design, it was assumed that discharge piping would not penetrate the levee below the 100-year flood elevation.

2.3.5 Sedimentation Facilities

Previous studies have investigated the possibility of constructing a sediment basin in the bayou immediately downstream of the railroad bridge in Donaldsonville. Heavier sediments that would settle out into the channel need to be removed as soon as possible after being pumped into the bayou to minimize downstream maintenance dredging. To create the basin, the existing channel could be widened to create a small pool with low velocities for coarse sand and silt particles to settle out. Access to the settling basin would be required to allow for frequent routine maintenance. Sediment would be removed by clamshell, dragline, or excavator. For the Phase 1 design, it was assumed that a sedimentation basin would be constructed downstream of the pump station for both Donaldsonville and any alternative that uses a bypass channel.

2.3.6 Existing Pump Station

Previous studies often included rehabilitating the existing pump station to 340 cfs (closer to its actual rating) and providing additional capacity by means of new and separate pumping facilities. For the Phase 1 design, it was assumed that a completely new pump station would be built for any alternatives using Donaldsonville as the primary reintroduction site. For any bypass alternative, it was assumed that the existing pump station would be maintained to run one pump at approximately 100 cfs for water supply and water quality requirements in Donaldsonville, upstream of the bypass channel confluence.

2.4 System Control and Monitoring

Control of water levels must be responsive enough to minimize water level fluctuations during severe storm events and during times when the diversion facilities are shut down. This section provides an overview of how weir systems, a check structure, and monitoring stations were addressed in the Phase 1 design. Cost allowances are included in later sections for some of these items. Control and monitoring systems generally include specialized structures and controls to ensure that water levels are maintained and flooding is controlled. Assumptions made for these systems are described in the following subsections.

2.4.1 Weir Systems

Currently, one primary weir exists along the main channel of Bayou Lafourche at Thibodaux. It has been proposed to remove this weir to provide adequate channel capacity for the increased flow rates being contemplated. Removing the weir will require more sophisticated control systems to maintain water levels within an acceptable range. For all project alternatives, it was assumed that the Thibodaux weir would be removed. This removal will allow maximum flow through the bayou and minimize water level rise upstream of Thibodaux. This assumption is consistent with past recommendations (EPA, 1998).

The previously proposed optimized project calls for the installation of two weirs, one at Thibodaux and another below Donaldsonville. For the Phase 1 design, it was assumed that two inflatable weirs would be installed for water level control. The Thibodaux weir would stabilize upstream water levels and help maintain bank stability during diversion facility shutdown. If the diversion facility were shut down in response to a chemical spill on the Mississippi River, the Donaldsonville weir would be deployed to prevent or minimize contaminants moving to downstream water supply intakes on the bayou. The need for these or additional water control structures will be studied in greater detail later in the design process.

2.4.2 Check Structure

A component of some of the alternatives that involve routing flows from the Mississippi River around Donaldsonville is a check structure (i.e., a small dam). This check structure would be located immediately upstream of the convergence of a proposed bypass channel with the existing bayou. This structure would isolate water levels in the upstream reaches of the bayou in Donaldsonville so the level in the most upstream reach of the bayou could be strictly managed. However, the main purpose of this check structure will be to allow higher reintroduction flow via the bypass channel and higher water levels downstream of Donaldsonville without affecting the water levels upstream in the bayou, within the main downtown portion of the city. A small amount of flow (100 cfs) would be conveyed from the Donaldsonville pump site into the newly isolated reach for small water supply and water quality purposes.

A pumping facility will also be needed at the check structure to convey flow (including excess stormwater runoff) from the newly formed Donaldsonville reach over the dam and into the downstream portion of the bayou. When isolated, Bayou Lafourche could drain across the check structure only by pumping. For the Phase 1 design, a 500-cfs pump station was assumed to handle both the 100-cfs dry flow plus some stormwater runoff.

2.4.3 Monitoring Stations

Five data collection platforms (DCP) were proposed by EPA (1998) at several locations between Donaldsonville and Larose. These DCPs would be equipped with instruments capable of providing real-time stage, rainfall, and flow data. In addition to monitoring flows and levels, it is possible to automate the pump discharge through a supervisory control and data acquisition (SCADA) system. SCADA information might be desired at the potential check structure, significant water intakes, and pump stations along the project alignment. Control of equipment from a remote location might also be a desired option. For the Phase 1 design, it was assumed that all alternatives would use the previously proposed five DCPs and have a basic SCADA system for automatic control of the diversion discharge. Details of this system will be developed more fully in the 30 percent design phase.

2.5 Infrastructure, Utility, and Site Modifications

The main infrastructure components that have been identified for the initial screening are the railroad, road, and utility crossings; and the water intakes and discharge structures along the bayou. Costs were assigned where anticipated modifications could be reasonably defined. Sections 5 and 7 provide details on identifiable impacts and assumptions used for the Phase 1 design.

2.6 Comparison of Alternatives

Project alternatives were reduced from an initial 144 to a short list of 5 to be evaluated in further detail in the 30 percent design. Development, evaluation, and screening of the alternatives are described in detail in Sections 3 through 8. As the alternative attributes were refined through further engineering and evaluation (e.g., flow capacity, water level rise and impacts, dredging quantities, and cost), several comparisons were made. Screening criteria were developed in steps using both qualitative and quantitative criteria. In all, eight basic criteria were used to screen the alternatives from the initial 144 to 5. Figure 2-2 presents a summary of these criteria. Different levels of analysis are represented by each set of criteria; Figure 2-3 presents the groups of screening criteria in the general sequence of the effort. Criteria 1 through 3 allowed a relatively quick screening from 144 to 69 alternatives by the following means:

1. Eliminating three Smoke Bend dredge templates (Screening Criterion 1): In the initial effort of the project, during the channel hydraulics analysis, it was apparent that for alternatives using the Smoke Bend route, there was no reason to dredge through Donaldsonville. This allowed elimination of two of the dredge templates (see Figure 2-1). Additionally, one dredge template was eliminated that closely matched another template in hydraulic capacity. By eliminating these three templates, the possible list of alternatives was reduced from 144 to 108.

2. Eliminating three Donaldsonville dredge templates because of railroad crossing constriction (Screening Criterion 2): A significant restriction to flow in Bayou Lafourche is the railroad crossing in Donaldsonville. The bayou conveyance capacity is restricted by the existing three culverts at this location. To pass flows exceeding 1,000 cfs under the railroad without raising water levels significantly, a new railroad bridge is required. Because diversion flows are restricted unless the UPRR bridge is replaced, three additional dredge templates for the Donaldsonville alignment were eliminated from further consideration. This reduced the number of alternatives from 108 to 99.

3. Eliminating the Smoke Bend shallow-cut option (Screening Criterion 3): The advantages and disadvantages of excavating a shallow Smoke Bend bypass channel versus a deeper bypass channel were compared. The shallow bypass channel takes advantage of reduced construction costs (less excavation), but requires a higher-head pumping system to match the hydraulic capacity requirements of the system. The opposite logic applies to a deeper bypass channel, which trades higher initial construction cost (more excavation) with lower-head pumping system requirements. A present-worth analysis of construction and pumping costs for the two options was performed over a 20-year term, and the deeper bypass channel was found to be more economical. With the shallow-cut bypass channel removed from further consideration, 30 alternatives were eliminated. This reduced the number of alternatives from 99 to 69. Of these 69 alternatives, 39 were for the Donaldsonville alignment and 30 for the Smoke Bend alignment.

A detailed description of the screening process, starting from 69 alternatives and concluding at the five short-listed alternatives, is presented in Section 7.

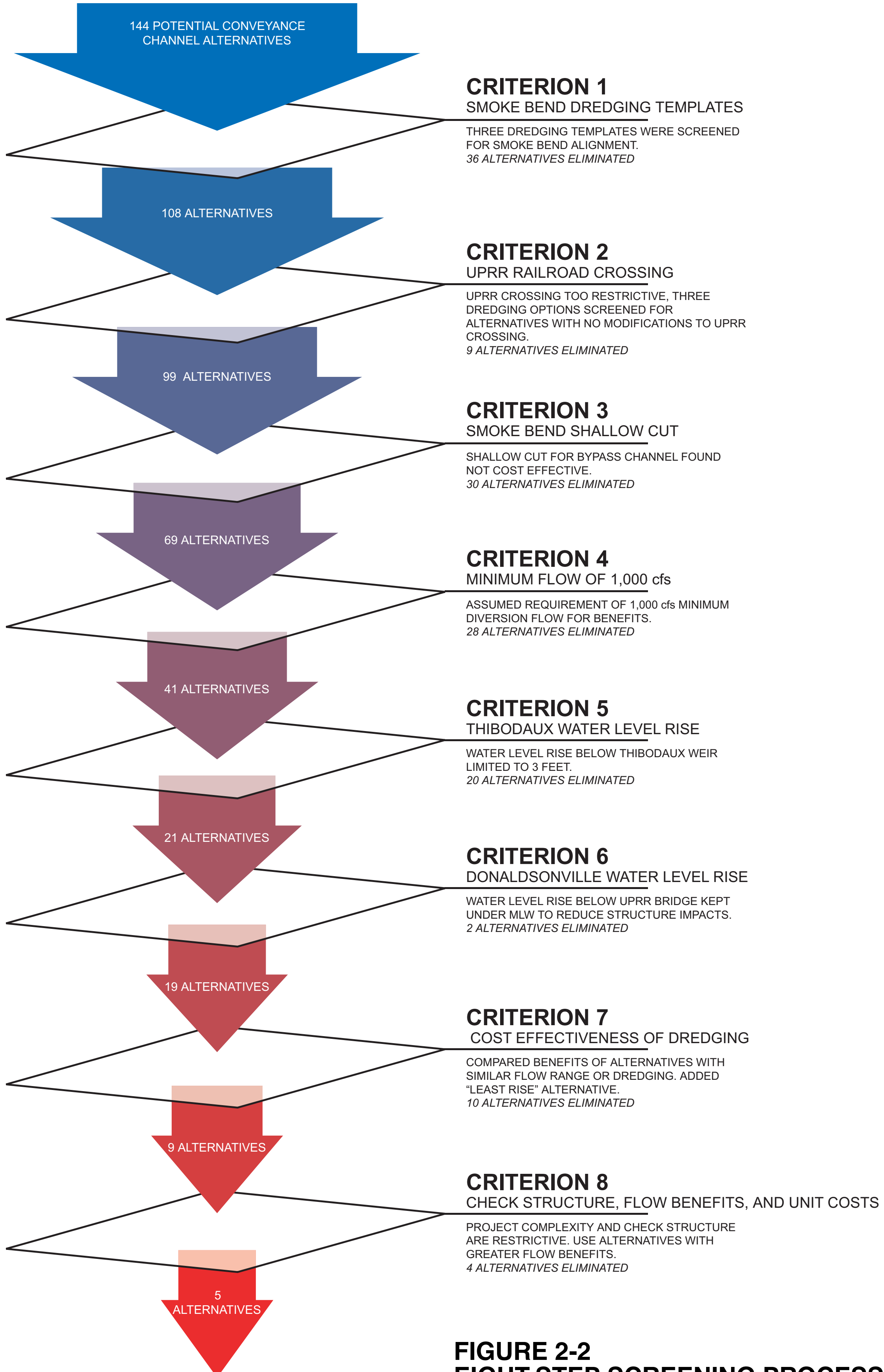

FIGURE 2-2
EIGHT-STEP SCREENING PROCESS
CONVEYANCE CHANNEL ALTERNATIVES
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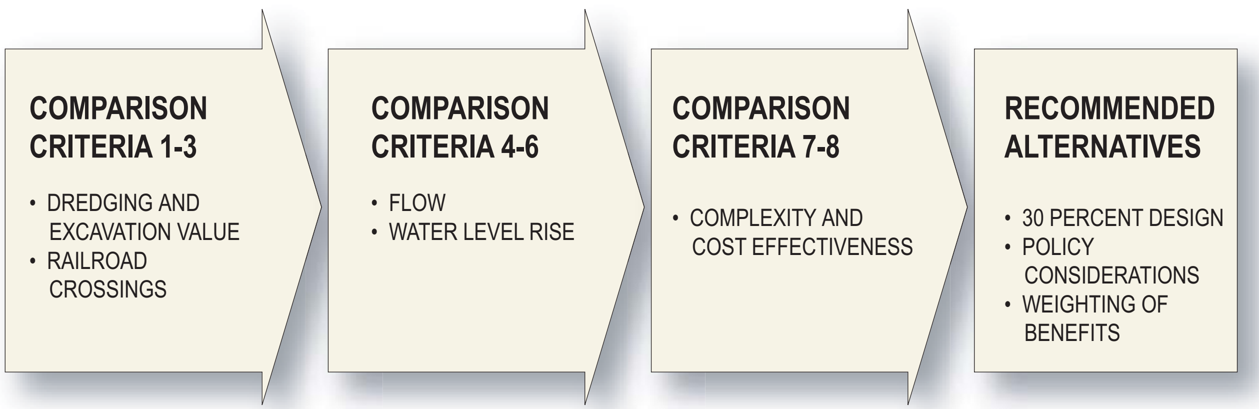

FIGURE 2-3
PROCESS FOR COMPARING ALTERNATIVES

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SECTION 3

Conveyance Evaluation

For the initial screening of alternative alignments in the Phase 1 design, the hydraulics of the upstream 56 miles of Bayou Lafourche, from the Mississippi River to Lockport, were evaluated. The conveyance capacity, channel size, the effect of different dredge templates, and alignment alternatives were evaluated with hydraulic models. Figure 3-1 shows the primary study area for the screening conveyance options in the Phase 1 design.

This initial evaluation was conducted using Hydrologic Engineering Center-River Analysis System (HEC-RAS), a one-dimensional (1D) backwater model developed by the USACE. The model was used for the initial evaluation because there were many alternatives to screen. The HEC-RAS model was applied only for steady-state analyses for the upstream portion of the bayou. All elevations referenced in this report are based on the North American Vertical Datum 1988 (NAVD88). Conveyance capacity for water supply and dilution will be balanced against channel size, dredging, and target water levels. Additional cost features, such as hydraulic structures, bridge rehabilitation or replacement, utility relocation or crossings, land easements, property purchases, pump station rehabilitation or new construction, and dredge disposal were included in cost estimates for the initial evaluation. These results were used to reduce the number of alternatives to only a few cost-effective recommendations.

The capacity evaluation of the subset of alternatives carried forward to the 30 percent design will be evaluated with a 2D hydrodynamic/water quality model called TABS-MD (RMA2 and RMA4). During the Phase 1 design, the TABS-MD model was specifically modified for this project by FTN Associates, Ltd., and their subconsultant, Dr. Ian King, to enhance the geometric description of the channels by incorporating an irregular cross-sectional shape in the 1D elements (see Appendix A). The hydrodynamic model (RMA2) will be used to examine the conveyance capacity, velocities, and channel size over the approximate 109-mile length of Bayou Lafourche, including the interconnections to more than 3,900 square miles of surrounding marsh areas for the 30 percent design.

During the 30 percent design, the 2D model (RMA4) will be used to evaluate the flushing and dilution (reduction of salinity concentrations) of the marsh areas. Initial decisions will be based on the available geometry of the 2D model and categorized by salinity concentrations. Additional surveying and model grid development might be conducted later to improve the ability to estimate the benefits of each alternative studied in Phase 2 modeling.

This section describes the hydraulic modeling that was conducted to support the Phase 1 design. This section provides an overview of the models, the source of the data used for model calibration, details on how the alternatives were implemented in the analysis, screening-level modeling results, and a brief discussion of results. These initial alternatives were screened down to a smaller number of alternatives using both qualitative and quantitative criteria (see Section 7).

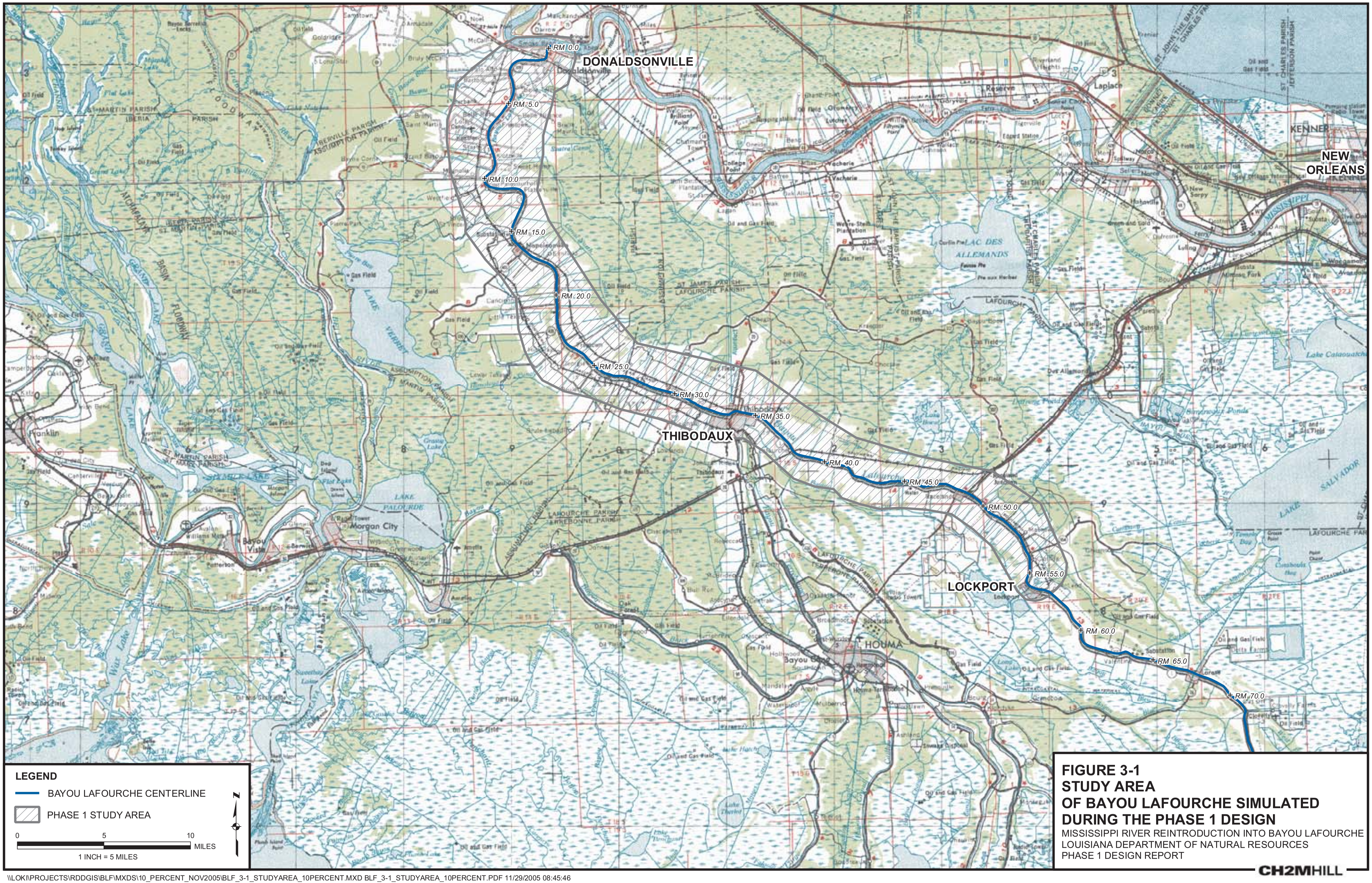

FIGURE 3-1
STUDY AREA
OF BAYOU LAFOURCHE SIMULATED
DURING THE PHASE 1 DESIGN
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3.1 Modeling Software

Using Bayou Lafourche as a conveyance channel for the reintroduction of Mississippi River water to the marshlands requires computer modeling tools to study both hydraulics and water quality. The overall project approach uses both a 1D, steady-state hydraulic (backwater) model called HEC-RAS for the initial alternative screening process at the Phase 1 design level, and a more sophisticated 2D (vertically averaged) model called TABS-MD for evaluating flushing in the marsh areas for the 30 percent design. Each of these models is described in this section.

3.1.1 HEC-RAS

For the Phase 1 design, the initial screening of alternatives was completed using HEC-RAS. This model, originally called HEC-2, was developed by the USACE in the 1970s. Since then, the model has been revised several times by the Hydrologic Engineering Center, and is now called HEC-RAS. In general, the HEC-RAS modeling effort was similar to earlier efforts conducted for the CWPPRA project definition (EPA, 1998), except that updated data and alternatives were studied.

For application in the Phase 1 alternative screening process, the Bayou Lafourche study reach was truncated at Lockport and was limited to the reach from the Mississippi River (RM 0.0) to Lockport (RM 56.0). Beyond Lockport, the ability of HEC-RAS to provide reasonable hydraulic information becomes uncertain because of the connecting waterways, significant interflows with the marsh areas, Gulf tidal influences, and the overall dynamic nature of the system.

A significant benefit of using HEC-RAS in the upper segment of Bayou Lafourche for the Phase 1 screening of alternatives is the added capability of the model to develop quantities from dredge templates, provide fast simulation times, and perform scour analysis at bridges deemed critically affected.

3.1.2 TABS-MD

The TABS-MD system is a collection of finite-element models that is sponsored by the USACE Waterways Experiment Station (USACE-WES) in Vicksburg, Mississippi. The main channels will be modeled using 1D elements in the modified TABS-MD program. The model that will be used to evaluate the flow in Bayou Lafourche and adjacent channels and marshes, RMA2, was initially developed by private consultants in the early 1970s, and has been enhanced over the past 3 decades through the efforts of Dr. Ian King, often in coordination with the USACE-WES. Figure 3-2 illustrates the area where the 2D model will be used for the interconnected waterways and marsh areas along Bayou Lafourche.

The 2D model, a vertically averaged hydrodynamic model, provides detailed velocity patterns and water surface elevations throughout the marshlands and channels in the study area. The 2D water quality component of the model (RMA4) will predict the salinity concentrations and changes over time from the additional diversion flows in Bayou Lafourche

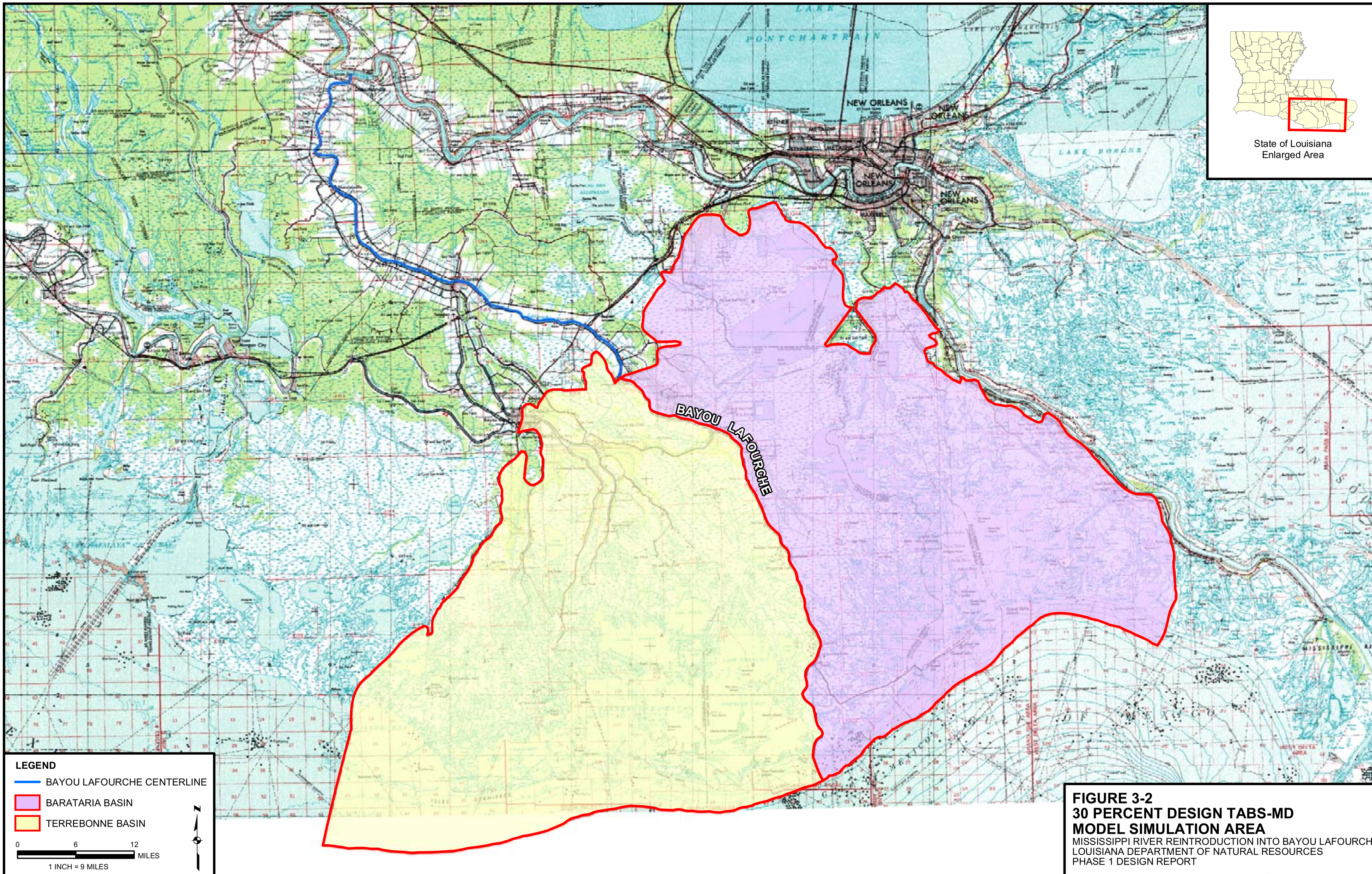

FIGURE 3-2
30 PERCENT DESIGN TABS-MD
MODEL SIMULATION AREA
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for each alternative. Because the models are computationally intensive and require significant solution time, the number of conveyance alternatives carried into the 30 percent design must be limited.

The screening process used for the Phase 1 design reduced the alternatives options to a more workable number for detailed flushing evaluations and benefited area analysis later in the design process. The physical characteristics of the alternatives carried into the 30 percent design, such as channel size, diversion location, and flows, will be incorporated into the TABS-MD model.

3.2 HEC-RAS Model Calibration

The HEC-RAS model was calibrated using historical flow and elevation data from the period March 12 through April 6, 2004. This section describes how the model data were obtained and presents the results of the calibration.

3.2.1 Data Sources for HEC-RAS Model

The UNET model that the USACE developed previously for Bayou Lafourche was used as a starting point to define the model geometry. Additional surveying was conducted to improve the accuracy of the model. Channel cross section and bridge surveys were completed between January and May 2004 by T. Baker-Smith & Son, Inc. More than 100 additional surveyed cross sections and 27 bridges were included in the initial TABS-MD 1D model. These cross sections were extracted from the TABS-MD model and used for the HEC-RAS model in the Phase 1 design. The final HEC-RAS model comprised 205 sections between the Mississippi River and Lockport, including bridges.

The HEC-RAS model used a labeling system that was consistent with the USACE UNET model. The outlet of the Donaldsonville pump station was labeled as RM 226.0, which is actually located about 0.3 mile downstream of the Mississippi River. For the Phase 1 design, RM 226.0 in the original model was used as the beginning of the HEC-RAS model (i.e., 0 miles from the river), and all references of distance downstream originate from this location. For example, Lockport is 56.3 miles downstream of the outlet of the pump station in Bayou Lafourche.

Existing Flow Rates

The USGS has a gage in Bayou Lafourche near the center of Donaldsonville. However, data from this gage are reported by the USGS and previous researchers (USACE, 1999) to be erratic. The USGS gage was established July 20, 1995, by M.L. Ross and C.L. Jones as a miscellaneous measurement site only. On December 17, 1996, it was 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 record velocity. On April 4, 2002, a SonTek Argonaut SL Doppler current meter was installed to eventually replace the magnetic flowmeter. The March 2004 data are labeled separately on Figure 3-3 to illustrate that the replacement meter still has scatter in the stage/discharge results.

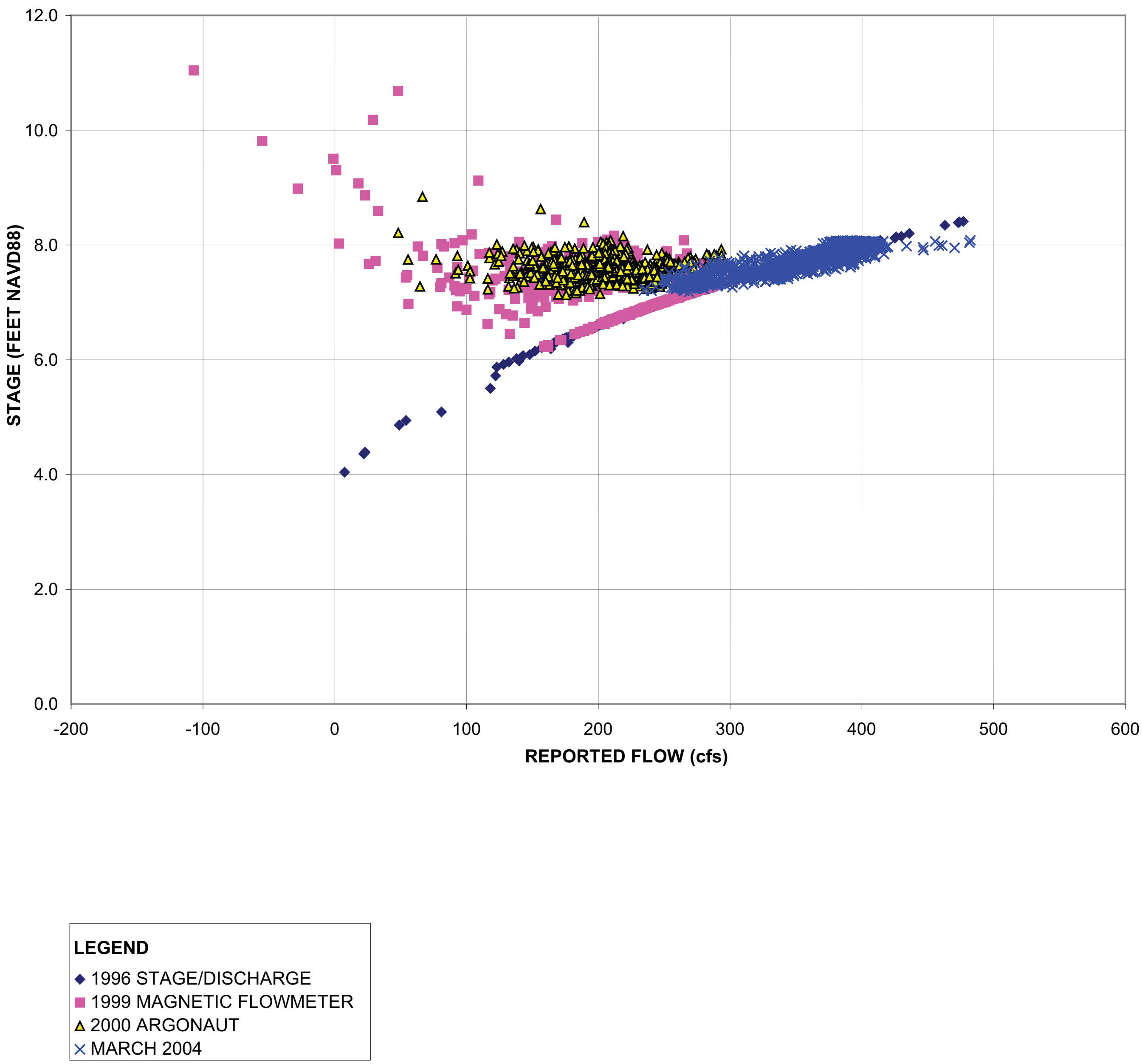

FIGURE 3-3
REPORTED FLOW VERSUS STAGE
FOR THE USGS DONALDSONVILLE GAGE
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Because there is only a small amount of non-pumped flow in the bayou, the Donaldsonville pump station flow data and USGS elevation (stage) data were used to calibrate the project model. According to the pump station data during the calibration period, the average daily diversion was 248 cfs.

A field data collection program began in mid-March 2004, and continues to compile velocities and depths for the project at several sites. Figure 3-4 shows the locations and data types (stage and/or velocity) for the hydraulic monitoring sites. The 15-minute data being collected downstream of Donaldsonville were used for those stations.

Lockport Rating Curve

The field data site labeled Station 1 on Figure 3-4 is at Lockport and was used to establish a stage-flow rating curve for the model calibration and alternative analysis. Measured water surface elevation data were correlated to field velocity data collected by a SonTek Argonaut SL current meter. The side-looking Argonaut meter was checked and calibrated for accuracy using a down-looking SonTek profiler on two separate occasions, May 17 and June 11, 2004. Eight individual velocity trials were taken between the 2 days using the profiler.

The data from the profiler were compared to the same period data from the side-looking meter and a velocity correction factor established. Over the range of flows measured during the calibration period, the correction factor varied from 0.99 to 1.13, with an average of 1.06.

Measured velocities from the Lockport instrument were then corrected during the calibration period and regressed against the stage record. The regression curve has an R^2 equal to 0.56, which indicates a marginal correlation with substantial variability. Figure 3-5 shows the high-tide rating curve for Station 1 that was used to fix the downstream stage boundary condition in HEC-RAS.

The marginal correlation between stage and flow at Lockport substantiates the limits of using HEC-RAS beyond this point. Downstream of Lockport, the tidal effects dominate the backwater elevations. The model’s sensitivity to the downstream starting water surface was examined, and differences in stage (for the same flow) do not affect the upstream reaches much beyond Thibodaux because of the size of the channel and slopes.

Water Withdrawals

Flows were incrementally lower within the downstream study reach because of withdrawals from the system. According to the records for the 3-week calibration period, the average withdrawal was about 65 cfs. Although this level of extraction is greater than the long-term average of 39 cfs (see Appendix B), the 65-cfs withdrawal was used in the model calibration.

3.2.2 Calibration Results

Table 3-1 summarizes the field data for flows and elevations and the model results during the calibration period. Differences between the model elevations and the field data at each of the two sites of primary interest (Donaldsonville and Thibodaux) are less than 0.2 foot. Channel velocities ranged from about 0.4 to 1.4 feet per second (fps), and depths varied from 4 to 10 feet deep. Although previous hydraulic studies of Bayou Lafourche by the

FIGURE 3-4
LOCATIONS OF STUDY AREA MONITORING STATIONS
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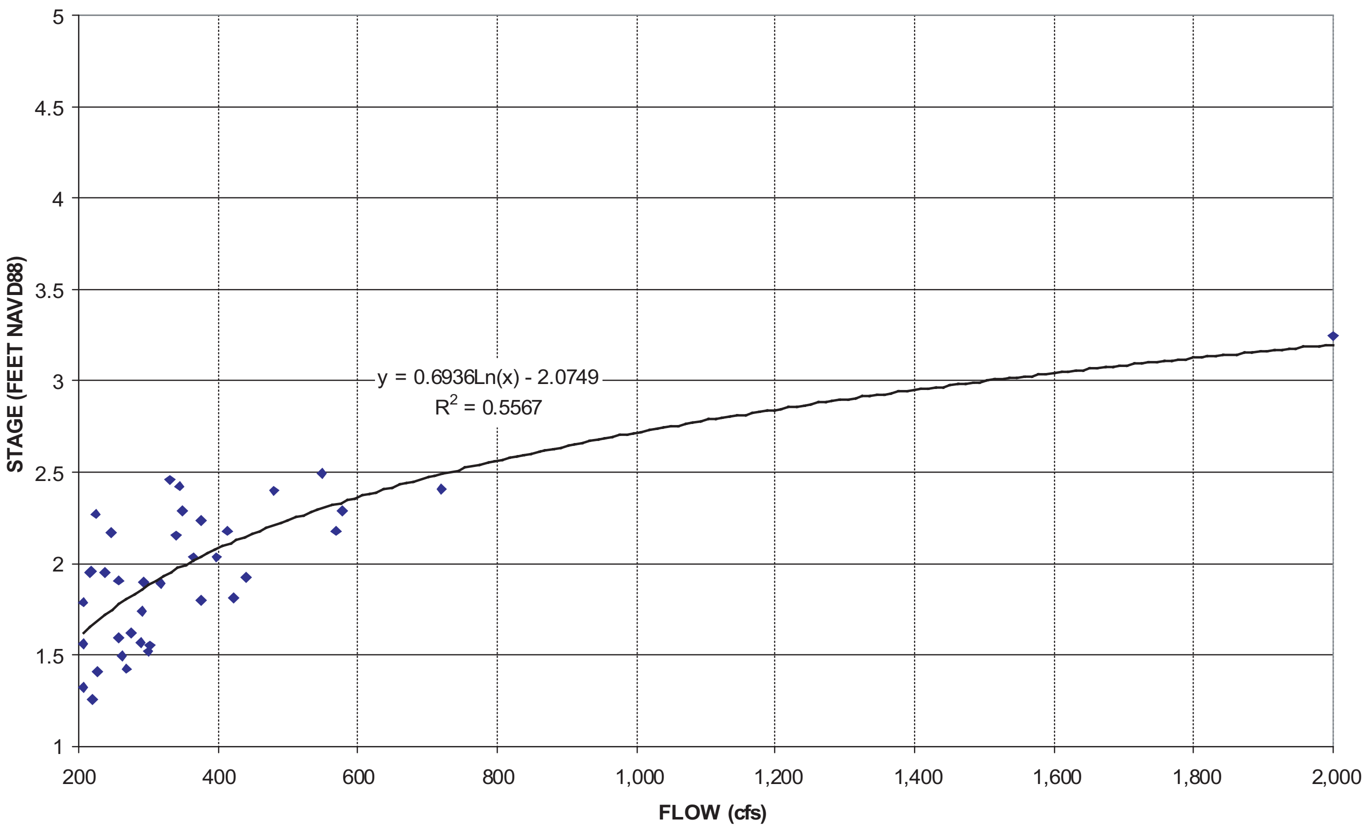

FIGURE 3-5
RATING CURVE AT LOCKPORT
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USACE and Louisiana State University have determined Manning's roughness to be between 0.020 and 0.025 (USACE, 1999), this model calibration used a roughness factor of 0.021 throughout the study reach.

TABLE 3-1
Summary of Calibration Results, HEC-RAS Model
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Site	Flow (cfs)	Stage (feet NAVD88)	Model Result (feet NAVD88)
Donaldsonville	248 (from pump data)	7.73 (from gage data)	7.92
Thibodaux (upstream)	232	4.09 (from gage data)	4.07
Thibodaux (downstream)	232	1.65 (from gage data)	1.57
Lockport	183	1.26 (from gage data)	1.26

The results in Table 3-1 indicate that the HEC-RAS model is a reasonable predictor of elevation in the reach of Bayou Lafourche from Donaldsonville to Lockport and can be used for the initial screening and comparison of conveyance alternatives.

An additional check of the HEC-RAS water surface elevations will be conducted as part of the 30 percent design phase. The TABS-MD predictions will be compared to the HEC-RAS predictions under similar flow and channel geometry configurations to provide final verification that the HEC-RAS assumptions were appropriate.

3.3 Model Implementation of Alternatives

Section 2 provided an overview of the project approach and the alternatives. This section describes how main features of the alternatives were implemented within the HEC-RAS model framework in greater detail. This section is organized as follows:

- Channel Route Alternatives
- Withdrawals for Alternative Evaluations
- Target Water Levels
- Channel Hydraulic Controls and Structures
- Channel Configuration and Dredge Templates

Results of the HEC-RAS modeling are presented in Section 3.4.

3.3.1 Channel Route Alternatives

Three channel alignments have been proposed near Donaldsonville for Phase 1, plus another possible diversion point downstream, as follows:

- Donaldsonville, with Bayou Lafourche as the sole conveyance channel
- Smoke Bend diversion, joining Bayou Lafourche near the Palo Alto Bridge (west side of Donaldsonville)

- Dugas Plantation diversion, joining Bayou Lafourche near the Palo Alto Bridge (east side of Donaldsonville)
- Terrebonne Diversion, near Thibodaux

Each Donaldsonville bypass route would require a piped conveyance segment across the Mississippi River levee, and under Highway 3089 and the railroad line to the open-channel segment that crosses the fields to Bayou Lafourche (see Section 4 for more information on diversion structures). Only the open-channel portions of the main conveyance are included in the HEC-RAS model.

Donaldsonville

The Donaldsonville alignment uses the existing bayou along the entire study area from the Mississippi River to the Gulf of Mexico (see Figure 3-1). The HEC-RAS portion of the model (upstream 56 miles) consists of the bayou channel, bridges, and the Thibodaux weir (when applicable). Water withdrawals were simulated as point losses (negative flow), and no other channel reaches were included.

Enlarging the bayou through the Donaldsonville area focused on deepening the channel and not widening the channel (EPA, 1998), which is a project assumption. The changes to available flow capacity were evaluated in the Phase 1 design using existing and increased water levels and channel size (dredge template).

The existing 50-year-old pump station at Donaldsonville would require rehabilitation and retrofitting of some of the pumps and motors to deliver the increased capacity. Replacing the entire pump station is also an option, based on required civil works, capacity, and cost. Alterations to the existing pump station are discussed in Section 4. For modeling purposes, the capacity of the channel was based solely on meeting the target water level for a given geometry (dredge template).

Smoke Bend – Westside Bypass

The Smoke Bend alignment includes a new pump station near Smoke Bend, about 1 mile west of Donaldsonville, and a bypass channel connecting with Bayou Lafourche just upstream of Palo Alto Bridge. Two alternative routes for the bypass channel are shown on Figure 3-6. The shorter route (Alternative 1) follows an existing drainage channel and cuts across agricultural fields to the south side of Palo Alto Plantation, then turns east to Bayou Lafourche (approximately 9,500 feet). The longer route (Alternative 2) follows a railroad spur line on the west boundary of the same fields until reaching just north of the road from Palo Alto Bridge, then turns east to Bayou Lafourche (approximately 13,500 feet).

The shorter route bisects more agricultural fields and parallels the historic Palo Alto Plantation property closely, which might create easement challenges. As a result, only the longer route shown on Figure 3-6 was included in the initial sizing and cost analysis. The shorter alignment for the Smoke Bend bypass is still considered a viable refinement if this alignment alternative is carried further into the design process.

In addition to the two alignment options (only one studied), there is an option to build this new channel either shallowly or deeply. There are cost ramifications for both the excavation and the pump station. A shallow channel would require less excavation, and the cut

FIGURE 3-6
SMOKE BEND BYPASS
ALIGNMENT ALTERNATIVES

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material could be balanced by being used as fill for levees along the channel to reduce the volume of material that would need to be hauled offsite. However, a shallow channel would require more pumping energy to lift water from the Mississippi River to an elevation roughly equivalent to the field elevation. Conversely, a deeper channel would require less energy, but more excavation. This is discussed further in Sections 4, 5, and 7. The bypass channel will be sized using engineering software, so this alternative (deep versus shallow channel) will not need to be explicitly included in the HEC-RAS model.

Dugas Plantation – Eastside Bypass

The eastside diversion alignment near the Dugas Plantation was not evaluated in detail because of its longer route from the Mississippi River to the junction with Bayou Lafourche at the Palo Alto Bridge (see Figure 3-7). The longer canal length needed to circumvent the developed area of Donaldsonville (approximately 23,000 feet) eliminated the eastside route from more detailed hydraulic evaluation. The Dugas bypass channel would be approximately 9,500 feet longer than the Smoke Bend bypass channel. This alternative route was proposed only as an alternative to the Smoke Bend Bypass and could still be a viable option if the Smoke Bend site is not available. The general effects on flow and downstream elevations computed for the westside bypass will still be valid for the eastside bypass alignment. Therefore, except for the cost and real estate differences, the hydraulic capacity of the Dugas Plantation bypass will be very similar to the Smoke Bend bypass. The Dugas diversion site and bypass, although discussed in this report, were not included as a viable alternative for the Phase 1 design, because of the expectation that land will be available for the more efficient Smoke Bend bypass alternative.

Bayou Terrebonne Diversion

A diversion from Bayou Lafourche into Bayou Terrebonne near Thibodaux has been proposed. Bayou Terrebonne is connected to Bayou Lafourche via a stormwater culvert under Canal Boulevard. This culvert has an existing capacity of approximately 25 cfs (preliminary estimate). The open-channel section of Bayou Terrebonne continues to increase in size in the downstream direction and appears to be of sufficient size to convey more than 25 cfs.

An evaluation of a diversion to Bayou Terrebonne would essentially require the same investigative steps and analyses performed for the Bayou Lafourche diversion. Extensive analyses would be required, including surveying, utility location or relocation, hydraulic capacity modeling, water level and property impacts, and wetlands benefits analysis.

3.3.2 Withdrawals for Alternative Evaluations

Withdrawal data from the bayou for public water supply were examined for the past several years to determine the extractions within the HEC-RAS study reach. In the 56-mile reach from Donaldsonville to Lockport, the average withdrawal was about 39 cfs. The table of water users in Appendix B shows the monthly average withdrawal data from 1998 through 2004. During the 3-month period from October through December, there are additional withdrawals for private industry, largely sugarcane refineries. The typical average use was 39 cfs along the Phase 1 design study reach.

FIGURE 3-7
DUGAS BYPASS
ALIGNMENT ALTERNATIVE
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3.3.3 Target Water Levels

The Phase 1 hydraulic evaluation was completed using the concept of target water levels within Bayou Lafourche (or profiles, which are the levels along the length of the bayou). The purpose of establishing the different reference water levels was to evaluate the conveyance benefits (increased capacity) for different assumptions about the channel geometry (i.e., dredge templates) or higher water levels.

The following three target water levels were used in the Phase 1 conveyance analysis (see Section 2):

- Existing, based on the 215-cfs pumped flow at Donaldsonville, and including the Thibodaux weir
- MLW, based on historical Mississippi River levels
- MW, based on historical Mississippi River levels

The MLW, MW (average), and mean high water (MHW) target levels in the Mississippi River were determined at Donaldsonville, then extrapolated linearly to Elevation 0.0 over the 109 miles to the Gulf (see Appendix C). Therefore, the target water levels would be higher upstream and linearly reduce to the Gulf. For the Phase 1 design, only the existing, MLW, and MW levels were used as target levels for defining available flow. The three target water level profiles used for this evaluation are shown on Figure 3-8, from the Mississippi River to Lockport. A summary of the water level analysis is provided below.

Existing Water Level Profile

The complete target profile for the existing condition flow rate is shown on Figure 3-8. Existing water levels were determined using HEC-RAS simulation results for the existing channel geometry, including the Thibodaux weir, at a flow rate of 215 cfs. The existing profile flow rate of 215 cfs was developed from 26 months (April 2002 through June 2004) of Donaldsonville pump station data using daily average flows. The 50^{th} percentile (median) flow was taken as a reliable description of the existing flow condition over a long period. Within any given day, the flows ranged between 180 and 345 cfs.

The calibrated HEC-RAS model was used to develop the existing profile, including the withdrawals and the Thibodaux weir. The model elevation at the USGS gage southwest of Donaldsonville (No. 07380401) was approximately 7.7 feet, with a flow of 215 cfs. Recorded gage elevation data vary widely with flow, but the statistical best-fit curve indicated that an elevation of 7.5 feet could be expected at the gage site for that flow rate (see Figure 3-3).

Mean Low Water and Mean Water Level Profiles

To set target water levels above the existing water level, historical MLW, MW, and MHW levels were investigated for this project. Recent property determinations in the Donaldsonville area were based on the historical MLW levels within the Mississippi River. This assumed that the pre-levee water levels would be linear along Bayou Lafourche between the Mississippi River and the Gulf.

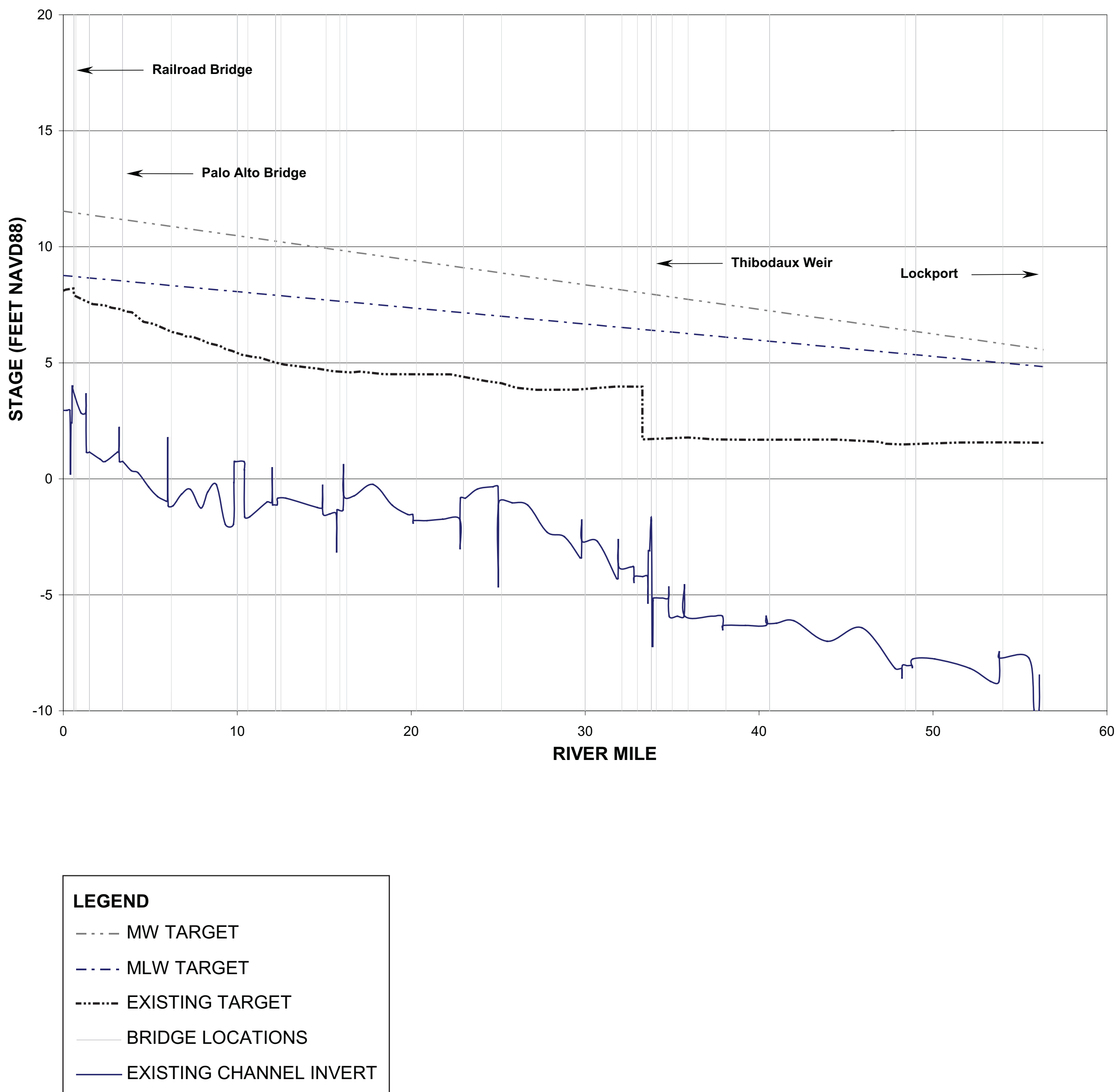

FIGURE 3-8
TARGET WATER LEVELS
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The MLW and MW profiles were developed from a statistical evaluation of the past 120 years of Mississippi River water level data (see Appendix C). These historical water levels provide a physical basis for setting higher target water levels and might have legal significance relative to existing state easements. The MLW elevation at Donaldsonville is approximately 8.8 feet, according to the historical data, and the MW elevation at Donaldsonville is approximately 11.5 feet.

Using the profiles shown on Figure 3-8, the change in the water levels will vary along the bayou depending on the station (i.e., RM). The existing water levels are generally flat upstream and downstream of the weir at Thibodaux. As the channel invert in Bayou Lafourche rises (moving from Thibodaux to Donaldsonville), the existing water levels rise while maintaining the water depths in the bayou at approximately 6 feet. The target water levels (MLW and MW) uniformly change from upstream to downstream. Within Donaldsonville (upper 3.4 miles), the MLW is only approximately 0.8 foot higher than the existing surface in the downtown area, and the MW is approximately 3.6 feet higher. This increases as it moves downstream. The MLW will rise by about 1.2 feet near the Palo Alto Bridge, then by approximately 2.9 feet more between Donaldsonville and Thibodaux (near Plattenville and Napoleonville). Figure 3-9 illustrates how the target water levels change, moving downstream. The greatest change in target levels is in Thibodaux, immediately downstream of the weir. However, Figure 3-9 illustrates only the potential maximum change in the water levels, not the actual flow simulations, which are discussed below. This figure only illustrates the potential allowable rise in water levels possible by selecting these target levels. Each computed profile only approaches the target water level in certain locations.

3.3.4 Channel Hydraulics Controls and Structures

The calibrated HEC-RAS model includes every existing bridge structure that crosses Bayou Lafourche to Lockport in the geometry file. This subsection discusses how several specific structural features were addressed in the Phase 1 design.

Existing Thibodaux Weir Removal

The Thibodaux weir will be removed to improve the capacity of Bayou Lafourche in the upstream reach from Donaldsonville to Thibodaux. This is consistent with previously proposed CWPPRA alternatives (EPA, 1998). The water surface over the weir is about 2.5 feet deep during normal operations. By eliminating the weir, the upstream conveyance capacity will have an immediate 2.5-foot equivalent increase without elevating the water surface above what is normally experienced. However, as the water levels are tracked upstream, the effect of the weir becomes less noticeable, until there is really no backwater effect from the weir in the Donaldsonville area. This is a function of the existing channel's shape and slope.

Past proposals have noted that because removing the weir will decrease the water surface elevation upstream of Thibodaux, one or more hydraulic structures might be required for proper operation of water intakes. However, by increasing the diversion flows from the

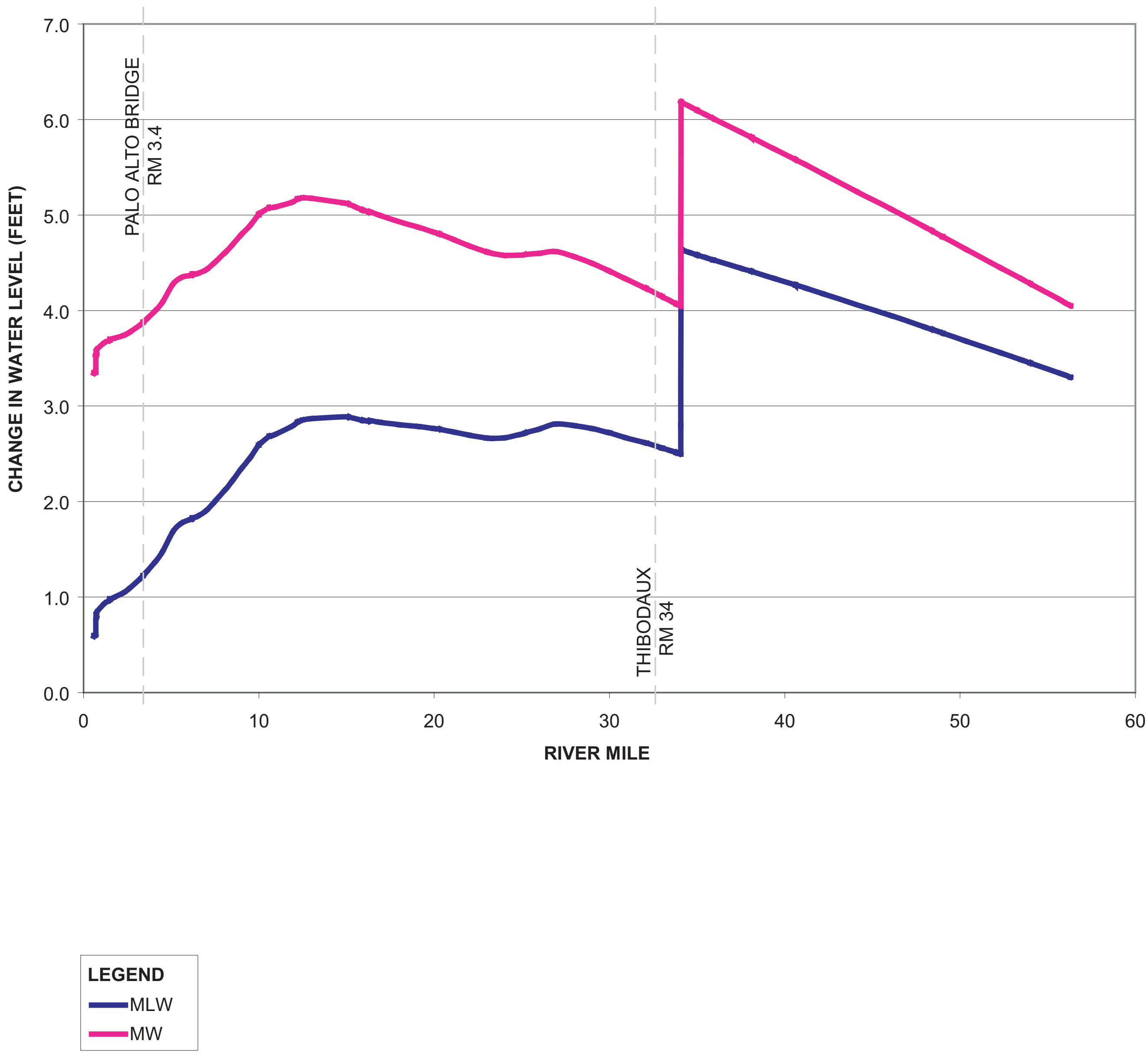

FIGURE 3-9
DIFFERENCE BETWEEN ESTIMATED EXISTING WATER LEVEL AND THE HISTORICAL MEAN LOW AND MEAN WATER LEVELS
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Mississippi River, the water levels will also tend to increase, which will offset this need. Some alternatives evaluated in the Phase 1 design also allow increases to water levels in the upstream reaches. Until the number of alternatives is reduced, these impacts will not be evaluated.

New Control Weirs

Past proposals have also suggested that additional water control structures be considered to help regulate water levels in Bayou Lafourche and provide isolation capability during spill events in the Mississippi River or the bayou (EPA, 1998). The optimized project included two control structures, one in Donaldsonville and one at Thibodaux. These gated structures would pass the high project flows, but during emergency spill operations, the main pump station would be shut down and the upstream segments of the bayou could be closed off to prevent conveying contaminated water down the system. The structures could also be used to regulate water levels and protect against rapid water level reductions (bank stability) after a high-runoff event, when the pumps would be cut back or shut down, and before they could be restarted.

The type of structures currently considered applicable are inflatable bladders (weirs) that can be raised and lowered depending on conditions. The crest elevation would likely be controlled through a telemetry system that measures water levels and connects to the main pump station at the Mississippi River.

The Phase 1 design hydraulic analysis of Bayou Lafourche does not include new control weirs because the new structures would be designed to pass the entire project flow with minimal elevation effects.

New Check Structure

A check structure located just upstream of the Palo Alto Bridge will be used for some of the alternatives that include a bypass channel around Donaldsonville. The purpose of the check structure is to maintain a stable water surface through Donaldsonville while allowing the levels downstream to rise to the target levels. This allows higher inflow from the Smoke Bend pump station, which enters Bayou Lafourche upstream of the bridge.

The Donaldsonville segment of Bayou Lafourche between the Mississippi River and the check structure would be maintained fresh with about 100 cfs from the existing Donaldsonville pump station. According to surveyed channel sections, the travel time and exchange rate in this reach would be significantly less than 24 hours. The check structure would act as a small dam, and upstream flows would have to be pumped past the structure into the downstream channel. Additional pumping capacity for stormwater runoff, redundancy, and emergency spill capability would be provided to protect the upstream reach during high-rainfall-runoff events (Section 4). For modeling purposes, on Smoke Bend alternatives with a check structure, the 100 cfs was added as a point source from Donaldsonville at the location of the confluence of the bypass channel.

Existing Union Pacific Railroad Crossing

An existing railroad crossing over Bayou Lafourche lies approximately 2,700 feet from the outlet of the existing Donaldsonville pump station and 600 feet north of Highway 3089. The crossing has three openings that convey water downstream. The openings consist of two

8.33-foot-diameter circular culverts and one 5-foot by 6-foot box culvert. These openings are insufficient to pass large flows; therefore, this crossing is a significant obstacle to using the bayou as the sole conveyance.

Past studies have noted that this railroad crossing would be modified, but the cost and implications have not always been clearly indicated. The railroad crossing's hydraulic capacity is restricted without causing significant headloss to the system and, thus, significantly raising the upstream water surface when flow is increased. According to the Phase 1 hydraulic analysis, dredging can only increase the capacity of the system by approximately 160 cfs (i.e., from 215 to 385 cfs total) while maintaining the existing water levels, without increasing the capacity of the railroad crossing. This conveyance limitation was evaluated in the HEC-RAS model to determine the need to improve capacity for cost estimating purposes.

New Drop Structure

Depending on the proposed design of the bypass channel (i.e., invert elevation), a hydraulic drop structure might be needed to compensate for the difference in elevation between the bypass channel and the bayou. This would be required for the shallow bypass channel alternative. A new shallow channel would terminate at a drop structure located in the cane field adjacent to Highway 1.

The drop structure will be a concrete inlet with a vertical drop to the elevation of the bayou channel. For the various options, the drop will be approximately 10 to 15 feet. The drop structure will have a discharge box culvert angled toward the bayou to minimize turbulence at the junction area. Riprap will be used to prevent erosion. Construction of the drop structure will be accomplished by either tunneling under the roadway or by open cut with a temporary detour. For the Phase 1 design, it was assumed that the shallow bypass channel alternatives would have a drop structure and the deep-channel alternative would not.

3.3.5 Channel Configuration and Dredge Templates

The surveyed cross sections and invert profile within the study reach from Donaldsonville to Lockport were examined for trends and consistency to aid in subdividing the 56 miles into shorter subreaches. The purpose of the examination was to find logical breakpoints in bottom slope or channel geometry to simplify implementation of the two dredge templates within the model framework. Two dredging depths, 2 and 8 feet (plus a no dredging option), were selected to evaluate the influence of dredging on project flows.

Design Reaches

After reviewing the existing bottom invert profile, there appeared to be four reasonably uniform slope segments and additional subreaches within these segments with similar bottom widths and geometry along the bayou. The study area in the model was divided into subreaches, called design reaches, for the alternative analysis, for purposes of modifying the channel cross sections by dredging. Figures 3-10 and 3-11 present schematics of the lengths of the design reaches for the 2- and 8-foot dredge templates, respectively, within each HEC-RAS model. Each HEC-RAS dredge alternative had these different reaches within the model geometry framework.

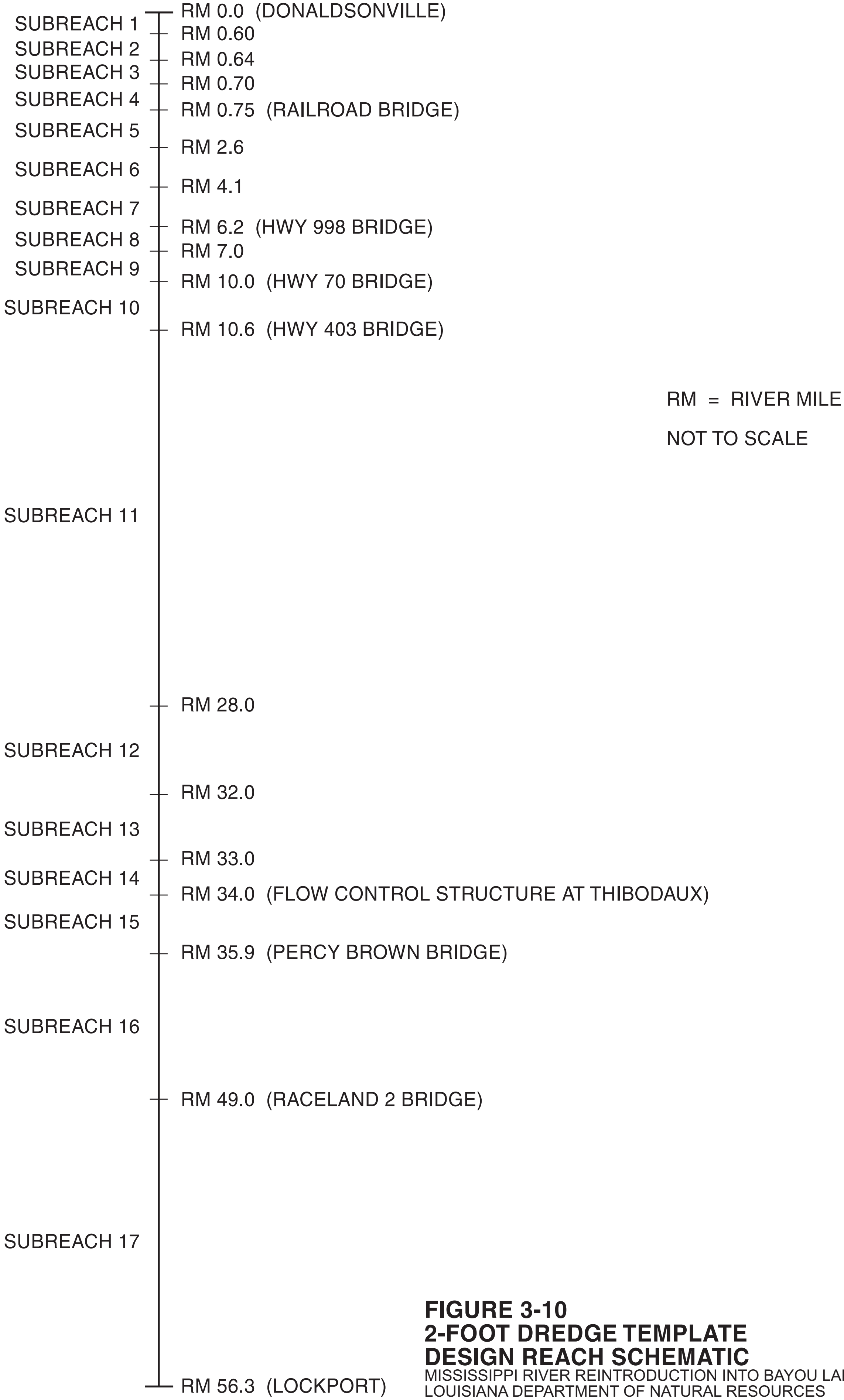

FIGURE 3-10
2-FOOT DREDGE TEMPLATE
DESIGN REACH SCHEMATIC
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
PHASE 1 DESIGN REPORT

W082005005RDD_20 (11/01/04)

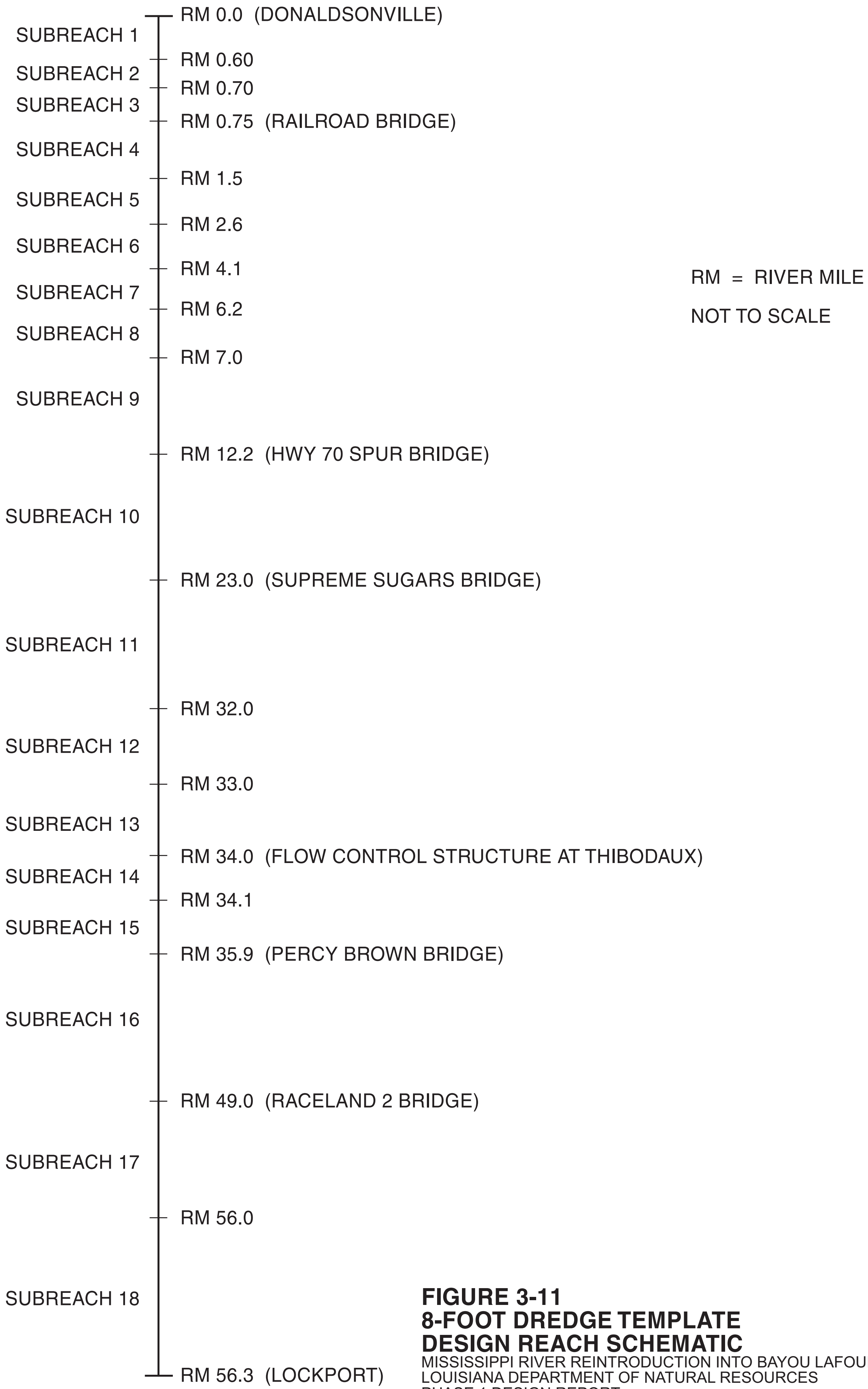

FIGURE 3-11
8-FOOT DREDGE TEMPLATE
DESIGN REACH SCHEMATIC
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
PHASE 1 DESIGN REPORT

W082005005RDD_18 (11/01/05)

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Dredge Templates

Figures 3-12 and 3-13 provide examples of how the two dredge templates would modify a typical cross section geometry. The dredge template modified each existing cross section; therefore, the resulting dredged channel was nearly uniform within the design reach. The dredge templates consist of a trapezoidal channel section with 2.5:1 (horizontal:vertical [H:V]) side slopes, an average bottom width for each subreach, and an approximate dredging depth. Table 3-2 lists the design reach bottom width, approximate bottom elevation, and invert slope for each template, by subreach.

TABLE 3-2
Description of Dredge Templates by Design Reach
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

	2-foot Dredge			8-foot Dredge		
Subreach No.	Bottom Width (feet)	Average Invert Elevation	Invert Slope	Bottom Width (feet)	Average Invert Elevation	Invert Slope
1	60	0.49	1.06E-04	30	-5.51	1.06E-04
2	5	0.21	1.06E-04	5	-5.67	1.06E-04
3	25	0.33	1.06E-04	75	-5.71	1.06E-04
4	100	0.30	1.06E-04	15	-5.94	1.06E-04
5	35	-0.13	1.06E-04	5	-6.24	1.06E-04
6	65	-0.97	1.06E-04	35	-6.97	1.06E-04
7	65	-2.06	1.25E-04	35	-7.72	1.25E-04
8	60	-2.63	1.25E-04	25	-8.23	1.25E-04
9	60	-2.96	2.44E-05	25	-8.79	2.44E-05
10	40	-3.16	2.44E-05	35	-9.61	2.44E-05
11	70	-4.12	2.44E-05	55	-10.92	2.44E-05
12	80	-5.51	2.44E-05	30	-11.51	2.44E-05
13	65	-5.71	2.44E-05	50	-11.67	2.44E-05
14	85	-5.87	2.44E-05	50	-11.74	2.80E-05
15	85	-6.23	2.80E-05	65	-11.90	2.80E-05
16	80	-7.33	2.80E-05	50	-12.30	2.80E-05
17	95	-9.04	2.80E-05	75	-14.65	2.80E-05
18	-	-	-	60	-14.98	2.80E-05

Notes:
Subreach lengths are not the same between 2- and 8-foot dredge templates (see Figures 3-8 and 3-9).
A minimum 5-foot bottom width was used when the natural channel was narrow.

The length of the dredging over the study area varied as an option for the alternatives to investigate benefits of reducing the extent of dredging, or using different dredging depths along the bayou. Table 3-3 shows the various dredging identification codes and descriptions used to identify alternatives. The identification code indicates the depth and extent of dredging captured by the numbering scheme and RM designation. As an example, the identification code 8–2@RM29 means an average of 8 feet of dredging upstream of RM 29.0, and an average of 2 feet of dredging downstream to RM 56.0. The identification code of 2 simply means 2 feet of dredging over the entire study reach (56 miles).

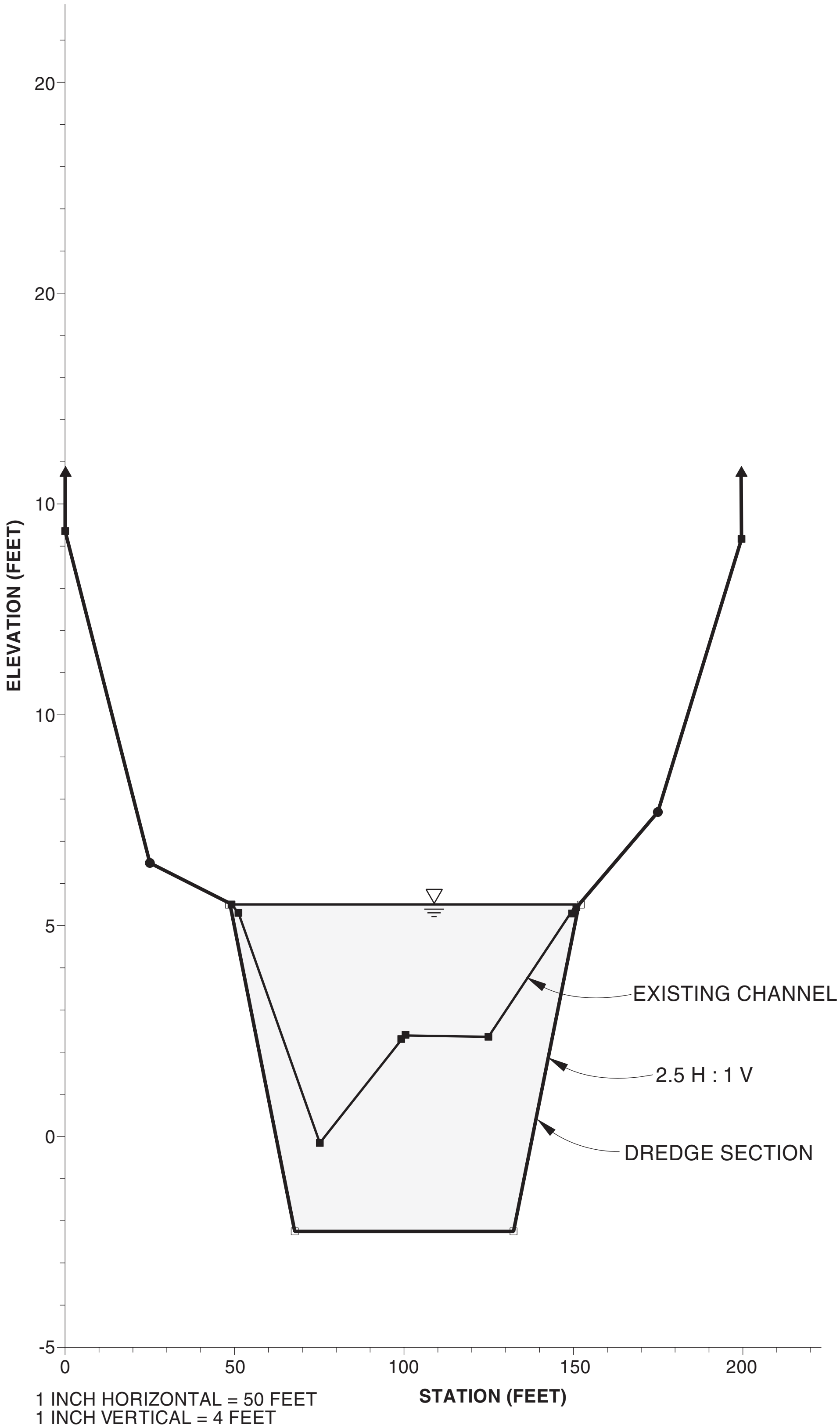

FIGURE 3-12
2-FOOT DREDGE TEMPLATE
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
PHASE 1 DESIGN REPORT

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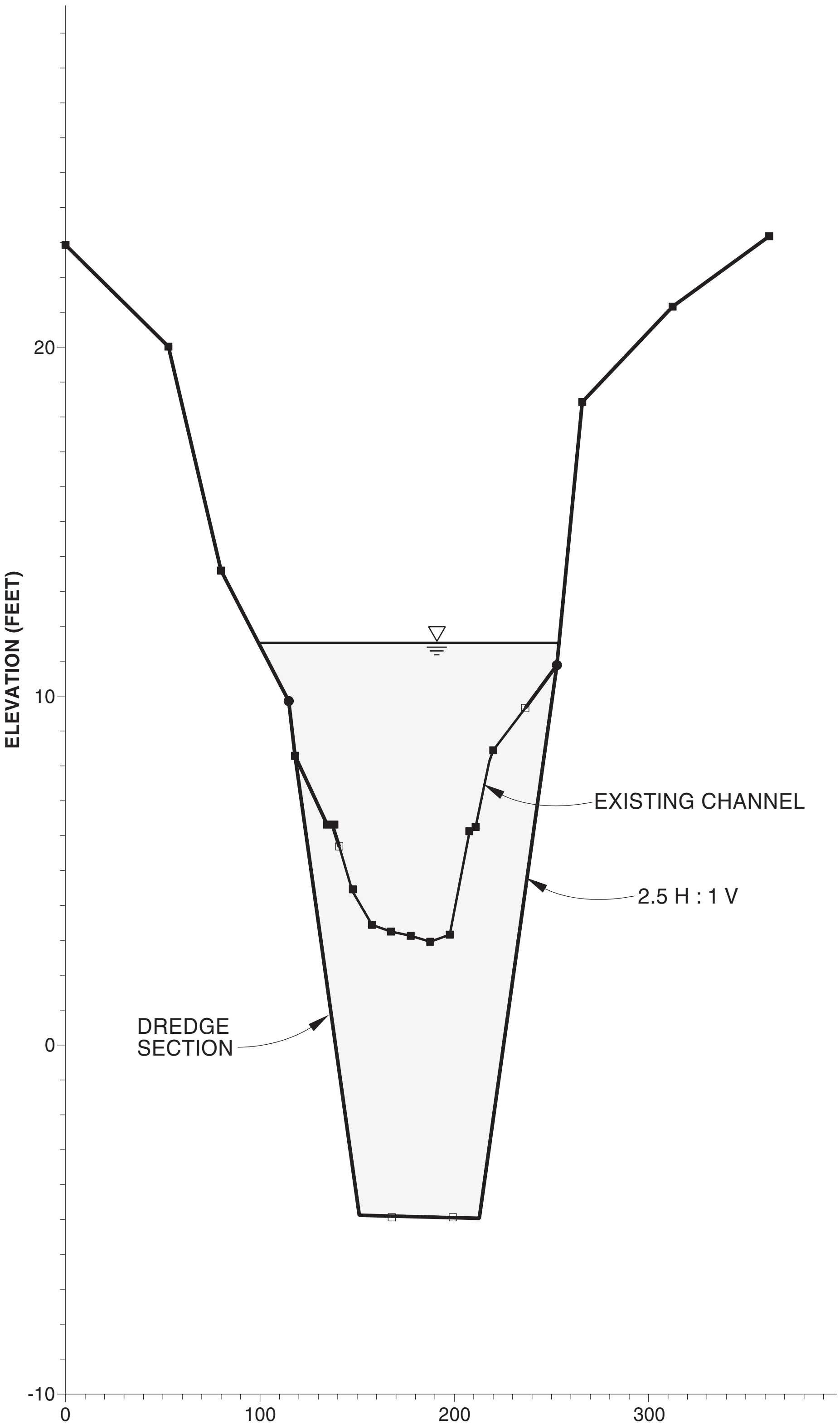

1 INCH HORIZONTAL = 90 FEET
1 INCH VERTICAL = 5 FEET

FIGURE 3-13
8-FOOT DREDGE TEMPLATE
MISSISSIPPI RIVER REINTRODUCTION INTO BAYOU LAFOURCHE
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
PHASE 1 DESIGN REPORT

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TABLE 3-3
Identification Scheme of Dredge Templates in HEC-RAS Model
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Code	Description
ND	No dredging
2-ALL	2-foot dredge, complete
8-ALL	8-foot dredge, complete
2-0@RM3.4	2-foot dredge upstream of RM 3.4, none downstream
2-0@RM29	2-foot dredge upstream of RM 29.0, none downstream
8-2@RM3.4	8-foot dredge upstream of RM 3.4, 2-foot dredge downstream
8-2@RM29	8-foot dredge upstream of RM 29.0, 2-foot dredge downstream
8-0@RM29	8-foot dredge upstream of RM 29.0, none downstream

Notes:

RM 3.4 is approximately the Palo Alto Bridge.
RM 29.0 is approximately 5 miles upstream of Thibodaux.
For Smoke Bend alternatives, dredging begins at RM 3.4.

Bank Stability

The dredging of the bayou and shape of the cross section have been assumed for the Phase 1 evaluation to be stable at 2.5:1 (H:V) side slopes based on the USACE analysis (USACE, 1999). Silt and sediment deposition have made the original designed channel irregular in shape, and made it difficult to establish the slope using native materials. According to the literature and geotechnical reconnaissance, this cross section is sufficient. During the 30 percent design, there will be additional geotechnical investigations to determine a final slope for the dredging cut.

Should additional bank stabilization be necessary in and around sensitive structures because of potential scour, localized slope protection methods will be used to stabilize the structure. Initial simulations indicate that velocities will be relatively low. Scour computations would be completed as part of the 30 percent design for the reduced number of alternatives.

3.3.6 Smoke Bend Bypass Channel Configuration

The alternatives that include the Smoke Bend bypass to Bayou Lafourche would require new channel excavation sufficient to convey the estimated flow at a velocity of less than 2 fps. The total length of the longest bypass route is about 13,500 feet. For the Phase 1 design, the bypass channel was engineered to convey the total downstream flow minus the 100 cfs to be sent through Donaldsonville, with 18 inches of freeboard. To match the target elevations, each alternative had a different flow, which subsequently required a different channel size to meet the velocity and flow requirements.

For the Phase 1 design, two types of channel excavation, shallow cut and deep cut, were proposed using the Smoke Bend pump station design and energy requirements, and facilities at the confluence for certain alternatives (check structure and confluence pump station). In the shallow-cut bypass option, 1.5 feet of freeboard were assumed to estimate excavation quantities for the shallow-cut channel. In the deep-cut channel, the freeboard was included in the depth of the channel excavation.

Appendix D provides hydraulic parameters and excavation tables with and without freeboard, showing the different combinations of bottom width and depth needed to convey flows from 400 to 3,000 cfs in the bypass canal.

3.4 Results of Conveyance Analysis

3.4.1 Methodology

The HEC-RAS model was used to evaluate a combination of 69 alternative alignments (corresponding to the number remaining after Screening Criterion 3), target water surfaces, dredging, and improvements (check structures and railroad bridge modifications) to determine the approximate allowable flows that would meet the target water levels. Table 3-4 contains descriptions of the 69 modeled alternative combinations.

Each alternative incorporated the 39-cfs withdrawal representing the public utility diversions and an elevation at Lockport based on the approximated rating curve. Reduction of flows in the most downstream segment of the study reach, between Thibodaux and Lockport for the Bayou Terrebonne diversion, was not included in the Phase 1 design.

The alternatives and options were subdivided into two groups: Bayou Lafourche alignment or Smoke Bend bypass alignment. These two groups were then partitioned into alternatives and options for the three target water levels, improvements to the railroad crossing, and several types of dredge templates. The total flow was increased until the target water surface was achieved within the study reach for any given section between Donaldsonville and Thibodaux.

The results of the allowable flow determination are listed in Table 3-5. The flow listed for the bypass alternative was the total project flow downstream of the Palo Alto Bridge. This total flow included the 100 cfs from the existing Donaldsonville pump station; therefore, the Smoke Bend pump station would be sized to handle the total project flow, less 100 cfs. For the Phase 1 design, only round numbers were used to select the pump station size and cost (e.g., total flow = 980 cfs; therefore, a 1,000-cfs pump station cost would be used).

Often, there was a common controlling section (i.e., a location where proposed water levels met the reference target level) in the upstream portion of the bayou that determined the capacity of the alternative. This section varied depending on whether the bypass channel was included. For the Bayou Lafourche alignment, the elevation control section was usually upstream of the railroad crossing. For the Smoke Bend alignment, the control section was typically at the confluence of the bypass channel and Bayou Lafourche. For some combinations of dredge templates, the control sections were farther downstream, but always upstream of Thibodaux.

TABLE 3-4
Combinations of Alignments, Dredge Templates, and Target Water Levels that Form the Phase 1 Design Alternatives
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Alternative Nos.	Short Title	Geometry Description	Water Surface Control Location	Flow Description
NA	Calibration	Existing geometry with weir from Donaldsonville to Lockport.	Donaldsonville gage location	248 cfs (average November 2003 flow rate) – flow change locations based on average daily with-drawals for water supply and irrigation.
1-3	Existing Condition with Weir-BL	Existing geometry with weir from Donaldsonville to Lockport.	Not applicable	Existing flow rate based on flow duration analysis of 3 years of data. 215 cfs is the 50^{th} percentile.
4-6	2 Dredging-NM RR-BL	2-foot dredged geometry from Donaldsonville to Lockport. No modifications to the railroad culvert.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
7-9	8 Dredging-NM RR-BL	8-foot dredged geometry from Donaldsonville to Lockport. No modifications to the railroad culvert.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
10-12	8-2 (RM 29.0) Dredging-NM RR-BL	8-foot dredged geometry from Donaldsonville to RM 29.0 and 2-foot dredged geometry from RM 29.0 to Lockport. No modifications to the railroad culvert.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
13-15	2-0 (RM 29.0) Dredging-NM RR-BL	2-foot dredged geometry from Donaldsonville to RM 29.0 and no dredging from RM 29.0 to Lockport. No modifications to the railroad culvert.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
16-18	No Dredging-M RR-BL	No dredging from Donaldsonville to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
19-21	2 Dredging-M RR-BL	2-foot dredged geometry from Donaldsonville to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
22-24	8 Dredging-M RR-BL	8-foot dredged geometry from Donaldsonville to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
25-27	8-2 (RM 3.4) Dredging-M RR-BL	8-foot dredged geometry from Donaldsonville to RM 3.4 and 2-foot dredged geometry from RM 3.4 to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
28-30	2-0 (RM 3.4) Dredging-M RR-BL	2-foot dredged geometry from Donaldsonville to RM 3.4 and no dredging from RM 3.4 to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
31-33	8-2 (RM 29.0) Dredging-M RR-BL	8-foot dredged geometry from Donaldsonville to RM 29.0 and 2-foot dredged geometry from RM 29.0 to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.

TABLE 3-4
Combinations of Alignments, Dredge Templates, and Target Water Levels that Form the Phase 1 Design Alternatives
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Alternative Nos.	Short Title	Geometry Description	Water Surface Control Location	Flow Description
34-36	8-0 (RM 29.0) Dredging-M RR-BL	8-foot dredged geometry from Donaldsonville to RM 29.0 and no dredging from RM 29.0 to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
37-39	2-0 (RM 29.0) Dredging-M RR-BL	2-foot dredged geometry from Donaldsonville to RM 29.0 and no dredging from RM 29.0 to Lockport. Railroad culvert modified.	Donaldsonville (RS 226)	Flow rates to match target water surface elevations.
40-42	BL & SB No Dredge No Control	Includes Smoke Bend Canal and existing Bayou Lafourche canal. No check structure or modifica-tions to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Does not include a set water surface elevation upstream of confluence. This allows backwater up to Donaldsonville. Flow rates to match target water surface elevations.
43-45	BL & SB 2' Dredge No Control	Includes Smoke Bend Canal and 2-foot dredged Bayou Lafourche. Dredging extends upstream of confluence of Bayou Lafourche and Smoke Bend. No check structure or modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Does not include a set water surface elevation upstream of confluence. This allows backwater up to Donaldsonville. Flow rates to match target water surface.
46-48	BL & SB 8' Dredge No Control	Includes Smoke Bend Canal and 8-foot dredged Bayou Lafourche. Dredging extends upstream of confluence of Bayou Lafourche and Smoke Bend. No check structure or modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Does not include a set water surface elevation upstream of confluence. This allows backwater up to Donaldsonville. Flow rates to match target water surface elevations.
49-51	BL & SB 8' - 2' Dredge No Control (RM 29.0)	Includes Smoke Bend Canal and 8- to 2-foot combination dredging. Dredging (8-foot) begins downstream of check structure (upstream of confluence). Dredging changes to 2 feet at RM 29.0.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Does not include a set water surface elevation upstream of confluence. This allows backwater up to Donaldsonville. Flow rates to match target water surface elevations.
52-54	BL & SB 2'-0' Dredge No Control (RM 29.0)	Includes Smoke Bend Canal and 2- to 0-foot combination dredging. Dredging (2-foot) begins downstream of check structure (upstream of confluence). Dredging changes to 0 feet at RM 29.0.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Does not include a set water surface elevation upstream of confluence. This allows backwater up to Donaldsonville. Flow rates to match target water surface elevations.

TABLE 3-4
Combinations of Alignments, Dredge Templates, and Target Water Levels that Form the Phase 1 Design Alternatives
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

Alternative Nos.	Short Title	Geometry Description	Water Surface Control Location	Flow Description
55-57	BL & SB No Dredge with Control	Includes Smoke Bend Canal and existing Bayou Lafourche Canal. Includes a check structure to prevent backwater. No modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Includes a set water surface elevation upstream of check structure to model the 100-cfs baseline in the reach upstream of the check structure. Flow rates to match target water surface elevations.
58-60	BL & SB 2' Dredge with Control	Includes Smoke Bend Canal and 2-foot dredge of Bayou Lafourche Canal. Dredging extends to downstream face of Palo Alto Bridge. Includes a check structure to prevent backwater. No modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Includes a set water surface elevation upstream of check structure to model the 100-cfs baseline in the reach upstream of the check structure. Flow rates to match target water surface elevations.
61-63	BL & SB 8' Dredge with Control	Includes Smoke Bend Canal and 8-foot dredge of Bayou Lafourche Canal. Dredging extends to downstream face of Palo Alto Bridge. Includes a check structure to prevent backwater. No modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Includes a set water surface elevation upstream of check structure to model the 100-cfs baseline in the reach upstream of the check structure. Flow rates to match target water surface elevations.
64-66	BL & SB 8'-2' Dredge with Control	Includes Smoke Bend Canal and 8- to 2-foot combination dredging. Dredging (8-foot) extends from check structure (upstream confluence). Dredging changes to 2 feet at RM 29.0. Includes a check structure to prevent backwater. No modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Includes a set water surface elevation upstream of check structure to model the 100-cfs baseline in the reach upstream of the check structure. Flow rates to match target water surface elevations.
67-69	BL & SB 2'-0' Dredge with Control	Includes Smoke Bend Canal and 2- to 0-foot combination dredging. Dredging (2-foot) extends from check structure (upstream of confluence to RM 29.0), where dredging changes to 0 feet. Includes a check structure to prevent backwater. No modifications to the railroad culvert.	Palo Alto Bridge (RS 211)	Range of flows to establish rating curve at target water surface locations. Includes a set water surface elevation upstream of check structure to model the 100-cfs baseline in the reach upstream of the check structure. Flow rates to match target water surface elevations.

Notes:

The water surface control location is the typical point where the target is met. The whole profile upstream of Lockport will be checked.

BL = Bayou Lafourche

B = Smoke Bend

TABLE 3-5
Summary of Estimated Allowable Flow for Each Alternative and Target Water Level
Mississippi River Reintroduction into Bayou Lafourche, Phase 1 Design Report

Alternative No.	Alternative Alignment[a]	Railroad[b]	Check Structure[c]	Dredging[d]	Maximum Water Surface Limit[e]	Donaldsonville Pump Station Flow (cfs) RS 226	Smoke Bend Pump Station Flow (cfs) RS 226	Palo Alto Bridge Combined Flow (cfs) RS 211
1	BL	NM	NA	ND	E	215	--	--
2	BL	NM	NA	ND	MLW	289	--	--
3	BL	NM	NA	ND	MW	688	--	--
4	BL	NM	NA	2-ALL	E	373	--	--
5	BL	NM	NA	2-ALL	MLW	480	--	--
6	BL	NM	NA	2-ALL	MW	1,030	--	--
7	BL	NM	NA	8-ALL	E	379	--	--
8	BL	NM	NA	8-ALL	MLW	487	--	--
9	BL	NM	NA	8-ALL	MW	1,040	--	--
10	BL	NM	NA	8-2@RM29	E	385	--	--
11	BL	NM	NA	8-2@RM29	MLW	485	--	--
12	BL	NM	NA	8-2@RM29	MW	1,040	--	--
13	BL	NM	NA	2-0@RM29	E	375	--	--
14	BL	NM	NA	2-0@RM29	MLW	480	--	--
15	BL	NM	NA	2-0@RM29	MW	1,025	--	--
16	BL	M	NA	ND	E	234	--	--
17	BL	M	NA	ND	MLW	315	--	--
18	BL	M	NA	ND	MW	833	--	--
19	BL	M	NA	2-ALL	E	850	--	--
20	BL	M	NA	2-ALL	MLW	1,020	--	--
21	BL	M	NA	2-ALL	MW	1,800	--	--
22	BL	M	NA	8-ALL	E	1,300	--	--
23	BL	M	NA	8-ALL	MLW	1,600	--	--
24	BL	M	NA	8-ALL	MW	2,470	--	--
25	BL	M	NA	8-2@RM3.4	E	850	--	--
26	BL	M	NA	8-2@RM3.4	MLW	1,250	--	--
27	BL	M	NA	8-2@RM3.4	MW	2,000	--	--
28	BL	M	NA	2-0@RM3.4	E	220	--	--
29	BL	M	NA	2-0@RM3.4	MLW	420	--	--
30	BL	M	NA	2-0@RM3.4	MW	970	--	--
31	BL	M	NA	8-2@RM29	E	1,100	--	--
32	BL	M	NA	8-2@RM29	MLW	1,530	--	--
33	BL	M	NA	8-2@RM29	MW	2,340	--	--
34	BL	M	NA	8-0@RM29	E	580	--	--
35	BL	M	NA	8-0@RM29	MLW	1,300	--	--
36	BL	M	NA	8-0@RM29	MW	2,100	--	--
37	BL	M	NA	2-0@RM29	E	580	--	--
38	BL	M	NA	2-0@RM29	MLW	970	--	--
39	BL	M	NA	2-0@RM29	MW	1,650	--	--
40	SB	NM	N	ND	E	100	115	215
41	SB	NM	N	ND	MLW	100	338	438
42	SB	NM	N	ND	MW	100	951	1,051
43	SB	NM	N	2-ALL	E	100	730	830
44	SB	NM	N	2-ALL	MLW	100	1,300	1,400
45	SB	NM	N	2-ALL	MW	100	2,200	2,300
46	SB	NM	N	8-ALL	E	100	1,220	1,320
47	SB	NM	N	8-ALL	MLW	100	1,900	2,000
48	SB	NM	N	8-ALL	MW	100	3,000	3,100
49	SB	NM	N	8-2@RM29	E	100	880	980
50	SB	NM	N	8-2@RM29	MLW	100	1,710	1,810
51	SB	NM	N	8-2@RM29	MW	100	2,680	2,780
52	SB	NM	N	2-0@RM29	E	100	460	560
53	SB	NM	N	2-0@RM29	MLW	100	1,130	1,230
54	SB	NM	N	2-0@RM29	MW	100	1,950	2,050
55	SB	NM	Y	ND	E	100	115	215
56	SB	NM	Y	ND	MLW	100	315	415
57	SB	NM	Y	ND	MW	100	1,020	1,120
58	SB	NM	Y	2-ALL	E	100	730	830

TABLE 3-5
Summary of Estimated Allowable Flow for Each Alternative and Target Water Level
Mississippi River Reintroduction into Bayou Lafourche, Phase 1 Design Report

Alternative No.	Alternative Alignment[a]	Railroad[b]	Check Structure[c]	Dredging[d]	Maximum Water Surface Limit[e]	Donaldsonville Pump Station Flow (cfs) RS 226	Smoke Bend Pump Station Flow (cfs) RS 226	Palo Alto Bridge Combined Flow (cfs) RS 211
59	SB	NM	Y	2-ALL	MLW	100	1,290	1,390
60	SB	NM	Y	2-ALL	MW	100	2,190	2,290
61	SB	NM	Y	8-ALL	E	100	1,220	1,320
62	SB	NM	Y	8-ALL	MLW	100	1,900	2,000
63	SB	NM	Y	8-ALL	MW	100	2,980	3,080
64	SB	NM	Y	8-2@RM29	E	100	880	980
65	SB	NM	Y	8-2@RM29	MLW	100	1,710	1,810
66	SB	NM	Y	8-2@RM29	MW	100	2,680	2,780
67	SB	NM	Y	2-0@RM29	E	100	460	560
68	SB	NM	Y	2-0@RM29	MLW	100	1,130	1,230
69	SB	NM	Y	2-0@RM29	MW	100	1,950	2,050

Notes:

[a]BL = Bayou Lafourche only
SB = Smoke Bend bypass and Bayou Lafourche

[b]NM = No modification to existing railroad bridge culverts
M = Modification to existing railroad bridge culverts

[c]Y = Check structure in place
N = No check structure
NA = Not applicable for Bayou Lafourche alignment
Check structure assumptions:
Location = Immediately upstream of confluence
Flow input upstream of check structure = 100 cfs

[d]ND = No dredging
2 = Dredge template characteristics:
Depth = 2 feet below existing bottom for 56 miles
Side slopes = 2.5:1 H:V
Channel bottom width = variable over 17 subreaches
8 = Dredge template characteristics:
Depth = 8 feet below existing bottom for 56 miles
Side slopes = 2.5:1 H:V
Channel bottom width = variable over 18 subreaches
8-2@RM3.4 = Combined dredging template characteristics:
8-foot dredge upstream of Palo Alto Bridge (RM 3.4) and 2-foot dredge downstream
2-0@+RM3.4 = Combined dredging template characteristics:
2-foot dredge upstream of Palo Alto Bridge (RM 3.4) and 0-foot dredge downstream
8-2@RM29 = Combined dredging template characteristics:
8-foot dredge upstream of RM 29.0 near Thibodaux and 2-foot dredge downstream
2-0@RM29 = Combined dredging template characteristics:
2-foot dredge upstream of RM 29.0 near Thibodaux and 0-foot dredge downstream
8-0@RM29 = Combined dredging template characteristics:
8-foot dredge upstream of RM 29.0 near Thibodaux and 0-foot dredge downstream

[e]E = Existing water level

The material-handling quantities were a major cost component for any alternative that includes dredging or the bypass channel. By using a fixed number of dredge templates for the bayou, the dredged sediment quantities from the main channel could be computed for a fixed number of combinations. For the bypass channel, the excavation quantities varied among alternatives depending on the computed flow. A uniform trapezoidal channel was computed for various flows and depths (deep or shallow) for each alternative. Regression equations were developed between depth and cross-sectional area. For each allowable flow in the bypass canal, the depth and resulting cross-sectional area were determined from Flowmaster® and the regression equations, respectively. Therefore, the estimated excavation quantities for the bypass alternatives (40 through 69) varied more than the others. Table 3-6 provides a list of the estimated dredge and excavation quantities for each alternative. The Smoke Bend bypass excavation subdivided alternatives 40 through 69 into a deep-cut and shallow-cut set of options. The shallow-cut option was eliminated during the initial stages of the screening process.

The complete set of alternative descriptions and resulting project flows is provided in Appendix E. This appendix also includes plots of the water profile results. Table 3-7 shows the resulting flows that meet the target water levels for a representative selection of dredge templates, improvement options, and alignments.

According to the Phase 1 design HEC-RAS modeling results, significant benefits (increased flow) are associated with dredging and/or allowing a rise in the target water level. The project flows ranged from approximately 300 cfs (allowing a water level rise to MLW, but no dredging) to more than 3,000 cfs (allowing a water level rise to MW and 8 feet of dredging). The maximum flows determined for the seven dredge templates and combinations of options were as follows:

- Existing Water Level: 1,320 cfs using 8-foot dredging for entire 56 miles
- MLW Level: 2,000 cfs using 8-foot dredging for entire 56 miles
- MW Level: 3,100 cfs using 8-foot dredging for entire 56 miles

3.4.2 Preliminary Results Discussion

In reviewing results, and as illustrated in Table 3-7 and Appendix E, several interesting preliminary observations are worth noting and are discussed in the following subsections.

Dredging Effects

There appears to be no significant advantage to dredging downstream of RM 29.0. The project flows are similar for dredging the full 56 miles and dredging only to RM 29.0, both for 2- and 8-foot dredging. The increase in flow is only about 200 cfs, but the dredging quantities are nearly double.

There is a substantial flow benefit for dredging downstream of Palo Alto Bridge (RM 3.4) to approximately RM 29.0. For the same set of conditions (i.e., target elevation, alignment, and railroad crossing improvement), the additional dredging provides an increased capacity of 200 to 500 cfs when only Bayou Lafourche is used, and 700 to 800 cfs with the Smoke Bend bypass canal. There is still a considerable amount of dredge material, but much less than what would result from dredging the full length. Additional dredging from 2 to 8 feet for any distance increases the allowable flow by 600 to 700 cfs.

TABLE 3-6
Summary of Estimated Dredging and Excavation Quantities for Each Alternative
Mississippi River Reintroduction into Bayou Lafourche, Phase 1 Design Report

							Smoke Bend Bypass	
Alternative No.	Alternative Alignment[a]	Railroad[b]	Check Structure[c]	Dredging[d]	Maximum Water Surface Limit[e]	Bayou Lafourche Dredging (cy)	Deep Channel Excavation Quantity	Shallow Channel Excavation Quantity (cy)
1	BL	NM	NA	ND	E	0	--	--
2	BL	NM	NA	ND	MLW	0	--	--
3	BL	NM	NA	ND	MW	0	--	--
4	BL	NM	NA	2-ALL	E	4,770,000	--	--
5	BL	NM	NA	2-ALL	MLW	4,770,000	--	--
6	BL	NM	NA	2-ALL	MW	4,770,000	--	--
7	BL	NM	NA	8-ALL	E	8,620,000	--	--
8	BL	NM	NA	8-ALL	MLW	8,620,000	--	--
9	BL	NM	NA	8-ALL	MW	8,620,000	--	--
10	BL	NM	NA	8-2@RM29	E	6,732,000	--	--
11	BL	NM	NA	8-2@RM29	MLW	6,732,000	--	--
12	BL	NM	NA	8-2@RM29	MW	6,732,000	--	--
13	BL	NM	NA	2-0@RM29	E	2,850,000	--	--
14	BL	NM	NA	2-0@RM29	MLW	2,850,000	--	--
15	BL	NM	NA	2-0@RM29	MW	2,850,000	--	--
16	BL	M	NA	ND	E	0	--	--
17	BL	M	NA	ND	MLW	0	--	--
18	BL	M	NA	ND	MW	0	--	--
19	BL	M	NA	2-ALL	E	4,770,000	--	--
20	BL	M	NA	2-ALL	MLW	4,770,000	--	--
21	BL	M	NA	2-ALL	MW	4,770,000	--	--
22	BL	M	NA	8-ALL	E	8,620,000	--	--
23	BL	M	NA	8-ALL	MLW	8,620,000	--	
24	BL	M	NA	8-ALL	MW	8,620,000	--	--
25	BL	M	NA	8-2@RM3.4	E	4,926,000	--	--
26	BL	M	NA	8-2@RM3.4	MLW	4,926,000	--	--
27	BL	M	NA	8-2@RM3.4	MW	4,926,000	--	--
28	BL	M	NA	2-0@RM3.4	E	225,800	--	--
29	BL	M	NA	2-0@RM3.4	MLW	225,800	--	--
30	BL	M	NA	2-0@RM3.4	MW	225,800	--	--
31	BL	M	NA	8-2@RM29	E	6,732,000	--	--
32	BL	M	NA	8-2@RM29	MLW	6,732,000	--	--
33	BL	M	NA	8-2@RM29	MW	6,732,000	--	--
34	BL	M	NA	8-0@RM29	E	4,341,000	--	--
35	BL	M	NA	8-0@RM29	MLW	4,341,000	--	--
36	BL	M	NA	8-0@RM29	MW	4,341,000	--	--
37	BL	M	NA	2-0@RM29	E	2,850,000	--	--
38	BL	M	NA	2-0@RM29	MLW	2,850,000	--	--
39	BL	M	NA	2-0@RM29	MW	2,850,000	--	--
40	SB	NM	N	ND	E	0	241,855	51,365
41	SB	NM	N	ND	MLW	0	398,396	118,943
42	SB	NM	N	ND	MW	0	592,119	292,338
43	SB	NM	N	2-ALL	E	4,545,000	765,916	230,649
44	SB	NM	N	2-ALL	MLW	4,545,000	901,505	388,926
45	SB	NM	N	2-ALL	MW	4,545,000	1,075,935	635,951
46	SB	NM	N	8-ALL	E	8,237,000	1,017,226	366,849
47	SB	NM	N	8-ALL	MLW	8,237,000	1,160,484	553,798
48	SB	NM	N	8-ALL	MW	8,237,000	1,355,812	852,193
49	SB	NM	N	8-2@RM29	E	6,351,000	896,802	272,578
50	SB	NM	N	8-2@RM29	MLW	6,351,000	1,077,743	501,691
51	SB	NM	N	8-2@RM29	MW	6,351,000	1,260,713	771,945
52	SB	NM	N	2-0@RM29	E	2,625,000	647,043	154,208
53	SB	NM	N	2-0@RM29	MLW	2,625,000	825,211	341,972
54	SB	NM	N	2-0@RM29	MW	2,625,000	983,960	567,499
55	SB	NM	Y	ND	E	0	239,423	51,365
56	SB	NM	Y	ND	MLW	0	383,886	112,228
57	SB	NM	Y	ND	MW	0	618,140	311,429
58	SB	NM	Y	2-ALL	E	4,545,000	765,916	230,649

TABLE 3-6
Summary of Estimated Dredging and Excavation Quantities for Each Alternative
Mississippi River Reintroduction into Bayou Lafourche, Phase 1 Design Report

Alternative No.	Alternative Alignment[a]	Railroad[b]	Check Structure[c]	Dredging[d]	Maximum Water Surface Limit[e]	Bayou Lafourche Dredging (cy)	Smoke Bend Bypass Deep Channel Excavation Quantity	Smoke Bend Bypass Shallow Channel Excavation Quantity (cy)
59	SB	NM	Y	2-ALL	MLW	4,545,000	897,048	386,168
60	SB	NM	Y	2-ALL	MW	4,545,000	1,072,259	633,215
61	SB	NM	Y	8-ALL	E	8,237,000	1,017,226	366,849
62	SB	NM	Y	8-ALL	MLW	8,237,000	1,160,484	553,798
63	SB	NM	Y	8-ALL	MW	8,237,000	1,352,949	846,724
64	SB	NM	Y	8-2@RM29	E	6,351,000	898,143	272,578
65	SB	NM	Y	8-2@RM29	MLW	6,351,000	1,077,743	501,691
66	SB	NM	Y	8-2@RM29	MW	6,351,000	1,260,713	771,945
67	SB	NM	Y	2-0@RM29	E	2,625,000	647,043	154,208
68	SB	NM	Y	2-0@RM29	MLW	2,625,000	825,211	341,972
69	SB	NM	Y	2-0@RM29	MW	2,625,000	983,960	567,499

Notes:

[a]BL = Bayou Lafourche only
SB = Smoke Bend bypass and Bayou Lafourche

[b]NM = No modification to existing railroad bridge culverts

M = Modification to existing railroad bridge culverts

[c]Y = Check structure in place
N = No check structure
NA = Not applicable for Bayou Lafourche alignment
Check structure assumptions:
Location = Immediately upstream of confluence
Flow input upstream of check structure = 100 cfs

[d]ND = No dredging

2 = Dredge template characteristics:
Depth = 2 feet below existing bottom for 56 miles
Side slopes = 2.5:1 H:V
Channel bottom width = variable over 17 subreaches
8 = Dredge template characteristics:
Depth = 8 feet below existing bottom for 56 miles
Side slopes = 2.5:1 H:V
Channel bottom width = variable over 18 subreaches
8-2@RM3.4 = Combined dredging template characteristics:
8-foot dredge upstream of Palo Alto Bridge (RM 3.4) and 2-foot dredge downstream
2-0@+RM3.4 = Combined dredging template characteristics:
2-foot dredge upstream of Palo Alto Bridge (RM 3.4) and 0-foot dredge downstream
8-2@RM29 = Combined dredging template characteristics:
8-foot dredge upstream of RM 29.0 near Thibodaux and 2-foot dredge downstream
2-0@RM29 = Combined dredging template characteristics:
2-foot dredge upstream of RM 29.0 near Thibodaux and 0-foot dredge downstream
8-0@RM29 = Combined dredging template characteristics:
8-foot dredge upstream of RM 29.0 near Thibodaux and 0-foot dredge downstream
[e]E = Existing water level

TABLE 3-7
Allowable Flow Rates and Dredge Quantities for Selected Alternatives
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

		Bayou Lafourche Only[b]				Smoke Bend and Bayou Lafourche[c]			Smoke Bend and Bayou Lafourche[d]		
	Dredging Quantity[a]	Flow (cfs)			Dredging Quantity	Flow (cfs)			Flow (cfs)		
Target Water Level:	(cy)	Existing	MLW	MW	(cy)	Existing	MLW	MW	Existing	MLW	MW
Dredging Option											
No Dredging	--	215	315	833	--	215	438	1,051	215	415	1,120
2-0@RM3.4	225,800	220	420	970	--	--	--	--	--	--	--
2-0@RM29	2,850,000	580	970	1,650	2,625,000	560	1,230	2,050	560	1,230	2,050
2-ALL	4,770,000	850	1,020	1,800	4,545,000	830	1,400	2,300	830	1,390	2,290
8-2@RM3.4	4,926,000	850	1,250	2,000	--	--	--	--	--	--	--
8-0@RM29	4,341,000	580	1,300	2,100	--	--	--	--	--	--	--
8-2@RM29	6,732,000	1,100	1,530	2,340	6,351,000	980	1,810	2,780	980	1,810	2,780
8-ALL	8,620,000	1,300	1,600	2,470	8,237,000	1,320	2,000	3,100	1,320	2,000	3,080

[a]Assumes the dredging quantity in the Bayou Lafourche channel. Does not include excavation quantity for the Smoke Bend bypass.

[b]Assumes that the railroad bridge in Donaldsonville is replaced with minimal-headloss structure.

[c]Assumes that the railroad bridge in Donaldsonville is not replaced, no check structure or confluence pump station.

[d]Assumes that the railroad bridge in Donaldsonville is not replaced, with check structure and confluence pump station.

Note:

cy = cubic yard

Allowing Higher Water Levels

Allowing a rise to the MLW level in Donaldsonville using only Bayou Lafourche as the main conveyance allows an increase of approximately 150 to 350 cfs in flow, depending on the amount of dredging and modification of the railroad bridges.

Allowing a rise to the MLW level for the Smoke Bend bypass alternative allows an increase of approximately 350 cfs in flow, depending on the amount of dredging.

Allowing a rise to the MW level using only Bayou Lafourche as the main conveyance allows an increase of approximately 600 to 1,500 cfs in flow, depending on the amount of dredging and modifications of the railroad bridge.

A rise to the MW level from the existing water level provides a similar flow benefit to 8-foot dredging of a segment of Bayou Lafourche (all 56 miles, to RM 29.0, or to RM 3.4).

Bypass Effects

Using the Smoke Bend alignment option instead of Bayou Lafourche alone appears to provide a limited increase in flow (less than 150 cfs), unless a concurrent rise in water surface is also considered. There is almost no flow benefit to including a check structure and pump station at the Smoke Bend confluence because the controlling water surface is located at or downstream of the confluence, not within Donaldsonville. The major benefit of a check structure and pump station near the confluence is to maintain stable water elevations upstream of Palo Alto Bridge in Bayou Lafourche.

The HEC-RAS results demonstrate the importance of dredging and the limits to capacity resulting from the existing channel size and railroad crossing. Improvements in cross section size and/or allowable increases in water levels over existing conditions will translate into several hundreds of cfs increase to the project total flow.

Donaldsonville Water Level, Dredging, and Flow Relationships

The relationship between dredging, target water levels, and diversion flows was critical to the Phase 1 design screening process and selection of alternatives to carry forward for the 30 percent design. During the hydraulic analysis for the Phase 1 design, three target water levels were used as boundary conditions – existing, MLW, and MW. The MLW target level represented a maximum rise of 1.2 feet, and the MW represented a maximum rise of about 42 inches (3.5 feet) in the Donaldsonville reach.

Target water levels were coupled with dredging depths to maximize flows in the bayou without exceeding the target water levels.

Each of the alternatives included an estimated dredging quantity (in millions of cubic yards [mcy]) defined by the dredge template applied. A series of regression methods, using the HEC-RAS model results, was developed to show continuous relationships between target water level, diversion flow, and dredge quantity. The HEC-RAS model dredge quantities were plotted along with the forecasting curves to provide information concerning intermediate water levels, dredge quantities, and diversion flows. This evaluation focused on diversion flows from 1,000 and 2,000 cfs for the suite of 69 alternatives in Table 3-5.

The result of the investigation was to show the relationship of dredge quantity with target water levels in Donaldsonville for five flows from 1,000 and 2,000 cfs (1,000 cfs, 1,250 cfs, 1,500 cfs, 1,750 cfs, and 2,000 cfs). This relationship showed how a change in water level would affect the dredging requirements for any flow from 1,000 to 2,000 cfs.

Table 3-8 shows the results of the regression analysis, and provides a matrix to compare the relationships between dredging, water level, and diversion flow. A TM is provided in Appendix K that explains the detailed steps and processes of using the HEC-RAS model to produce this result.

TABLE 3-8
Bayou Lafourche Evaluation Matrix – Dredging Quantity Projections
Mississippi River Reintroduction into Bayou Lafourche – Phase 1 Design Report

	Water Levels in Donaldsonville (feet, NAVD88)			
Flow (cfs)	**Existing**	**MLW**	**Existing + 24 inches**	**MW**
1,000	6.01	3.42	1.32	0.42
1,250	8.11	5.17	2.76	1.25
1,500	10.35	6.93	4.02	2.23
1,750	12.72	8.67	5.65	3.47
2,000	15.21	10.43	5.80	4.87

Note:

Only for alternatives that include railroad bridge modification.