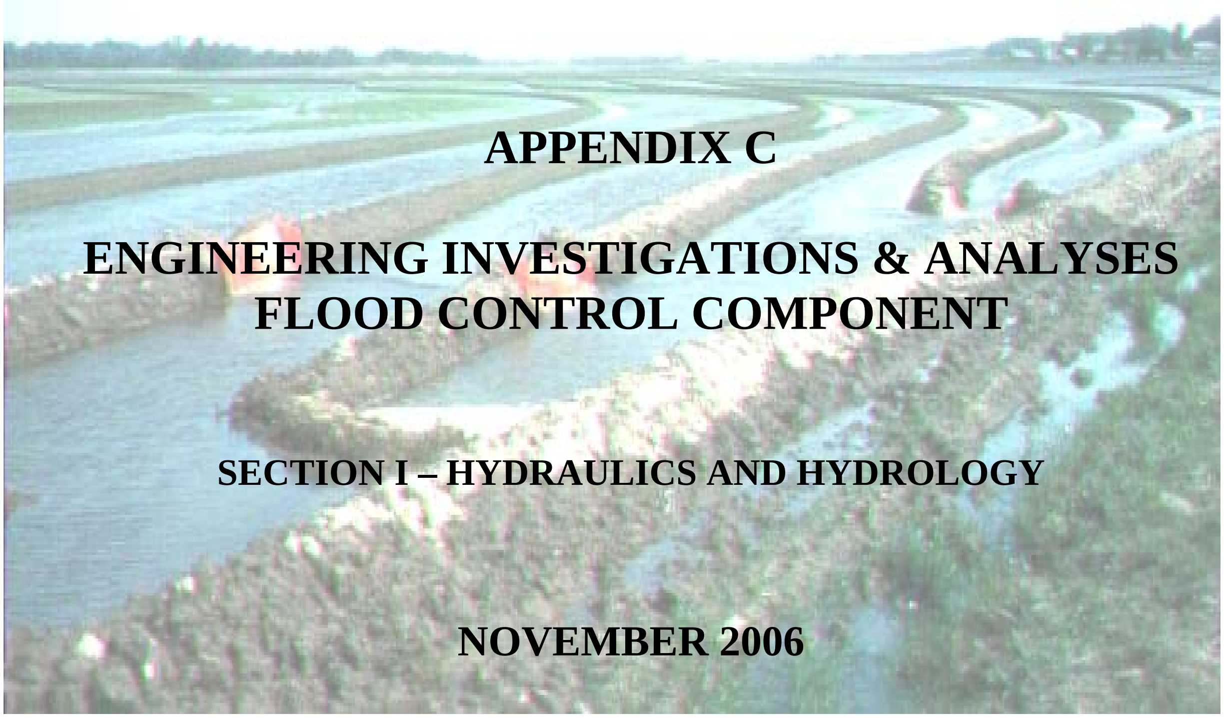
US Army Corps of Engineers®
Memphis District

GRAND PRAIRIE REGION AND BAYOU METO BASIN, ARKANSAS PROJECT

BAYOU METO BASIN, ARKANSAS

GENERAL REEVALUATION REPORT

VOLUME 8



APPENDIX C

ENGINEERING INVESTIGATIONS & ANALYSES FLOOD CONTROL COMPONENT

SECTION I – HYDRAULICS AND HYDROLOGY

NOVEMBER 2006

US Army Corps of Engineers®
Memphis District

GRAND PRAIRIE REGION AND BAYOU METO BASIN, ARKANSAS PROJECT

BAYOU METO BASIN, ARKANSAS

GENERAL REEVALUATION REPORT

VOLUME 8

APPENDIX C

ENGINEERING INVESTIGATIONS & ANALYSES FLOOD CONTROL COMPONENT

SECTION I – HYDRAULICS AND HYDROLOGY

NOVEMBER 2006

BAYOU METO BASIN, ARKANSAS PROJECT
GENERAL REEVALUATION REPORT (GRR) INDEX

BAYOU METO COMPREHENSIVE STUDY
BAYOU METO BASIN, ARKANSAS

APPENDIX C

ENGINEERING INVESTIGATIONS & ANALYSES
FLOOD CONTROL COMPONENT

SECTION I

HYDROLOGY AND HYDRAULICS

Appendix C - Engineering Investigations & Analyses
Flood Control Component

Section I - Hydrology and Hydraulics

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

TABLE OF CONTENTS (cont'd)

TABLE OF CONTENTS (cont'd)

Appendix C - Engineering Investigations & Analyses
Flood Control Component

Section I - Hydrology and Hydraulics

LIST OF PLATES

Appendix C - Engineering Investigations & Analyses
Flood Control Component

Section I - Hydrology and Hydraulics

I-1. GENERAL.

I-1-a. Purpose. The purpose of these hydrologic analyses is to identify the base hydrologic conditions in the Bayou Meto Basin and to estimate the changes to those conditions resulting from various flood control alternatives. Subsequent economic and environmental analysis will be made using this hydrologic data in development of a recommended plan. This section of the Engineering Appendix presents the methodology used in the hydrologic analyses and explains the types of data used in the analysis, which supports the formulation of the recommended plan.

I-1-b. Description of Study Area. The Bayou Meto, Arkansas drainage basin covers approximately 1,241 square miles. The project area is identified on Plate I-01. The basin extends from just above Interstate 40 on the north, southward to the Arkansas River Levee and from Arkansas Highway 130 on the west, to Stuttgart, Arkansas on the east. The area is predominately agricultural with the major crops being rice, soybeans, corn and cotton. The area is home to thousands of acres of both natural and manmade waterfowl habitat.

The Bayou Meto basin is predominantly flat with numerous streams that form eastern and western subbasins. The streams of the western subbasin eventually empty into Little Bayou Meto and the streams of the eastern subbasin empty into Big Bayou Meto. The majority of these streams reach bank full conditions during a 1-year event. Prior to the construction of the locks and dams on the Arkansas River, Little Bayou Meto flowed into the Arkansas River through the Little Bayou Meto drainage structure located where Little Bayou Meto meets the Arkansas River Levee. Big Bayou Meto also flowed into the Arkansas River through the Big Bayou Meto drainage structure located where Big Bayou Meto meets the Arkansas River Levee.

After the Arkansas River locks and dams came on line in the late 1960's, Little Bayou Meto could not drain effectively through its gravity structure due to high tailwater from Arkansas River pool stages. A diversion channel was constructed from Little

Bayou Meto, mile 10.0 to Big Bayou Meto, mile 24.0, which forced basically all of the drainage from the basin through the Big Bayou Meto structure. This structure itself is 75% full at pool stage causing outflow restrictions.

I-2. DESCRIPTION OF DRAINAGE AREA STREAMS AND FLOODING PROBLEMS.

I-2-a. Big Bayou Meto. This stream originates in Pulaski County, north of Jacksonville, Arkansas, and runs approximately 100 miles in a southeasterly direction, where it empties into the Arkansas River through the Big Bayou Meto Structure. Its drainage area is comprised of predominantly agricultural lands and scattered bottomland hardwood areas. Big Bayou Meto is the predominant stream in its basin and practically all of the runoff from the basin exits through the Big Bayou Meto Structure. Major flooding problems occur in various reaches beginning as far north as Jacksonville, Arkansas. Significant losses in the aquaculture and agriculture industries have been documented due to flooding from Big Bayou Meto.

I-2-b. Little Bayou Meto. This steam is approximately 15 miles long and serves as a collecting stream for flows from Salt Bayou and Wabaseka Bayou/Boggy Slough. It drains the western portion of the basin and has a total drainage area of approximately 400 square miles. Flows from Indian Bayou, Bakers Bayou, Salt Bayou, Caney Creek and Wabaseka Bayou all travel through Little Bayou Meto. The majority of this flow is then diverted into Big Bayou Meto via the Little Bayou Meto Diversion. A small portion, under certain Arkansas River conditions, will pass through the Little Bayou Meto Structure directly into the Arkansas River. Flooding problems in its drainage basin occur, in part, because the Little Bayou Meto has an ineffective outlet, causing a backwater effect. This backwater effect creates major problems in the Bayou Meto Wildlife Management Area. Thousands of acres of bottomland hardwoods within the management area have been adversely affected due to the extended duration of spring flooding caused by the lack of a sufficient outlet.

I-2-c. Wabaseka Bayou/Boggy Slough. Wabaseka Bayou/Boggy Slough is approximately 20 miles long and carries flows from the lower end of Indian Bayou to Little Bayou Meto. Floodwaters from this stream create damages to agricultural lands along its banks and, when combined with other flows, contribute to problems in Little Bayou Meto.

I-2-d. Indian Bayou. This stream is approximately 20 miles long above the split where Indian Bayou Ditch and Indian Bayou proper separate. Indian Bayou Ditch is relatively straight, approximately nine miles long, and serves as a cutoff. Indian Bayou proper is about 16 miles long and has silted in greatly since Indian Bayou Ditch was constructed and has virtually no low flow capabilities. Indian Bayou Ditch also has reduced capacity due to silt deposits. Predominately agricultural flooding in the past has led to some excavation projects, such as the ditch itself, by local entities in an attempt to reduce damages. The upper portion of Indian Bayou, above the split, has recently been cleaned out/enlarged by the local drainage district. The increased capacity on the upper end of the system further increases the need to create a more efficient outlet for the western side of the basin.

I-2-e. Salt Bayou/Salt Bayou Ditch. This stream is approximately 25 miles long and carries flows from the lower end of Bakers Bayou to the upper end of Little Bayou Meto. Salt Bayou has had extensive channel work in the past by local entities in an attempt to reduce flooding along the stream. Salt Bayou/Salt Bayou Ditch is also a source of the water management problems for the Bayou Meto Wildlife Management Area. Flows must pass through the management area and, because of the problems described above on Little Bayou Meto, the existing conditions create prolonged inundation which is negatively impacting the bottomland hardwoods within the management area. One reach has twin manmade channels that cover about 9.5 miles of its length. It is also connected to Big Bayou Meto through a small channel named Dry Bayou.

I-2-f. Bakers Bayou. This stream is about 40 miles long and carries flow into Salt Bayou. It has had extensive sedimentation in the past and is not even visible as a stream in parts of the upper end.

I-2-g. Caney Creek. This stream, originating near Pettus, Arkansas, is approximately 12 miles long and carries flow into Salt Bayou.

I-2-h. Bayou Two Prairie. This stream is approximately 40 miles long and carries flows from the Lonoke, Arkansas area downstream to Big Bayou Meto. Flooding problems are not as widespread along this stream as on others in the basin and are predominately in wooded areas and of shorter duration than those in the Bayou Meto Wildlife Management Area.

I-2-i. Crooked Creek. Crooked Creek is about ten miles long above the split where Crooked Creek Ditch and Crooked Creek separate. Crooked Creek Ditch is a relatively straight, 15-mile long ditch that serves as a cutoff. Crooked Creek is approximately 20 miles long and carries flows downstream to Big Bayou Meto. Predominately agricultural flooding in the past has led to excavation projects, such as the ditch itself, by local entities in an attempt to reduce damages.

I-3. CLIMATE. The climate for Bayou Meto drainage basin is primarily humid and subtropical with abundant precipitation. The summers are long and hot; the winters are short and mild. The average annual temperature is about 62 degrees Fahrenheit (F). Average monthly temperatures for Little Rock, Arkansas range from 27.5 degrees F in January to 89.4 degrees F in August and extremes range from about -15 degrees F to 120 degrees F.

I-4. PRECIPITATION. The average annual rainfall over the Bayou Meto drainage basin is about 50 inches. Normal monthly rainfall varies from 5.4 inches in March to 2.9 inches in October. Snowfall occurs more than once a year but is sporadic.

I-5. INFILTRATION AND RUNOFF. Runoff factors vary from 25 percent in the summer months to 75 percent in the spring and winter months, depending upon antecedent conditions, rainfall distribution and rainfall intensity. Seasonal variations in runoff factors are shown by the monthly-generalized values in the table below.

Monthly Percent Runoff

Month	Percent runoff
January	75
February	75
March	75
April	75
May	75
June	60
July	30
August	25
September	25
October	30
November	50
December	75

I-6. LAND-USE IN BAYOU METO BASIN.

I-6-a. Land-use Determination. Remote sensing techniques were used to determine the land-use for the Bayou Meto Basin. Four Landsat satellite images from 1999 were used to make the determination of land-use/land-cover. Those scenes were 17 June, 12 August, 15 October and 11 November. Each scene has eight bands of data. Bands 1, 2, 3, 4, 5 and 7 have pixel sizes of 28.5 meters. Band 8 is a panchromatic band with a pixel size of 14.25 meters. Band 6 is reflected thermal IR with a pixel size of 57 meters. Bands 1 through 3 are from the visible spectrum. A multi-temporal classification scheme was utilized to determine the land-use. One visible and one infrared band from three of the satellite scenes were combined and an unsupervised (MAPIX, canonical) classification was performed on the resulting data. The unsupervised classification produced 75 classes. These classes were resolved to their land-use by field verification of the land-cover. The NRCS provided crop cover for the agricultural lands in the basin. Their information also provided data on some forested lands in private ownership. The Vicksburg District's Regulatory Branch provided forest type information, which was collected during wetland determinations within the Project area. The 75 classes were resolved down into 25 land-cover land-cover classes.

Cleared lands were separated into nine classes: cotton, soybeans, rice, corn, other crop, pasture, bare soil, herbaceous and pond levee. There were four classes of developed lands: urban, roads, railroads and airports. The forests were divided into seven classes: three classes for upland forests and four for bottomland forests. The bottomland forests were classed based upon the frequency and duration of flooding. BLH1 was the driest and BLH4 was the wettest. Areas with permanent or semi-permanent water were divided into five classes: general, river, lake, pond and seasonal. These land-cover classes were used to make the stage area curves and to determine the cover for the aquatic, waterfowl, wetland and terrestrial appendices.

I-6-b. Land-Use. Plates I-4 through I-14 present the land-use in the Bayou Meto Basin for reaches 1 through 11.

I-7. ANALYSES.

I-7-a. General. The Bayou Meto Basin was divided into 11 hydrologic reaches as shown on Plate I-02. The reaches were defined by hydrologic boundary conditions and related to either existing stream gages or synthetic gages produced by stage relation of existing gage data. All data derived for economic and environmental analyses were calculated and tabulated on a reach-by-reach basis.

I-7-b. Existing Conditions. Existing conditions, as defined for this report, are those that existed throughout the basin since the completion of the locks and dams on the Arkansas River in the late 1960's. All completed channel work, done by private and local entities, was also included in existing conditions.

I-7-c. Post Project. Post Project conditions are defined as those conditions that would exist after completion of the recommended plan.

I-7-d. Channel Cross-Sections and Manning's "n" Values. Surveyed cross-sections were used to develop the HEC-RAS backwater model. Manning's "n" values for existing conditions ranged from composites values of .045 to .09 for the channel and .055 to .12 in the overbanks. Post project values ranged from composites values of .035 to .06 for the channel and .055 to .12 in the overbanks.

I-7-e. Flow Development and Routings. Flows and routings were developed using a HEC-HMS model calibrated to available flow data.

I-7-f. Water Surface Profile Development. Water surface profiles were developed by a calibrated HEC-RAS backwater model and are shown for existing conditions and the project alternatives on Plate Nos. I-15 through I-34.

I-7-g. Elevation-Area and Storage Curves. Elevation-area curves were developed for the economic and hydrologic reaches using a Geographic Information System (GIS). This system uses a satellite aerial flood scene as input data to determine the elevation-area curves and land use data for each reach. The flood scenes that were used in developing the elevation-area curves are as follows:

OOD SCENE DATE	ELEV AT GAGE REACHES 1 & 7	ELEV AT GAGE REACH 2	ELEV AT GAGE REACH 3	ELEV AT GAGE REACH 4 & 5	ELEV AT GAGE REACH 6	ELEV AT GAGE REACH 8	ELEV AT GAGE REACHES 9 & 11	ELEV AT GAGE REACH 10
1-Mar-89	176.08	190.24	218.21	188.6	194.9		212.5	199.9
23-Mar-97	173.38	188.5	214.01	191	193.5	179.59	209.8	198.97
15-Mar-94	171.58	187.04	214.81	184.9	192.5	174.3	209.9	198.7
8-Feb-93	167.08	181.94	206.01	184.6	190.7	173.36	209	197.6
10-Mar-98	167	186.94	218	190	192.9	181.23	210.4	199.1
18-Mar-95	168.28	185.04	210.21	183.3	192.2	175.32	209.2	197.9
7-Mar-97	176.58	190.5	221.71	195	195.5	182.68	211.4	200.4

The satellite scenes were classified with an unsupervised classifier. The classes were then grouped into basic categories: flooded and un-flooded. The flooded category was subdivided into three classes: cleared, forested and aquatic. The un-flooded category was subdivided as cleared agricultural, forested and herbaceous. In addition to the flood scenes, two other satellite images were utilized to classify the landuse/landcover in the project area. An unsupervised classifier classed the scenes into 60 classes. Landuse information was used to determine the correct landuse category. Crop data was obtained from the USDA. Other classes were determined by field verification. The landuse/landcover scenes were broken down into the following classes: cotton, soybeans, corn, rice, herbaceous, pasture, ponds, bottomland hardwoods, swamp, rivers, lakes and sandbar/clouds. The classes were divided into three categories: cleared, forested and water. The elevation-area curves were developed for the cleared, forested and total catagories. The elevation-area curves were developed by plotting the GIS flood scene elevations versus the area flooded on that date. The elevation-area curves showing Forested, Cleared and Total acres for Reaches 1 - 11 are shown in figures 1 - 11 below.

REACH 1

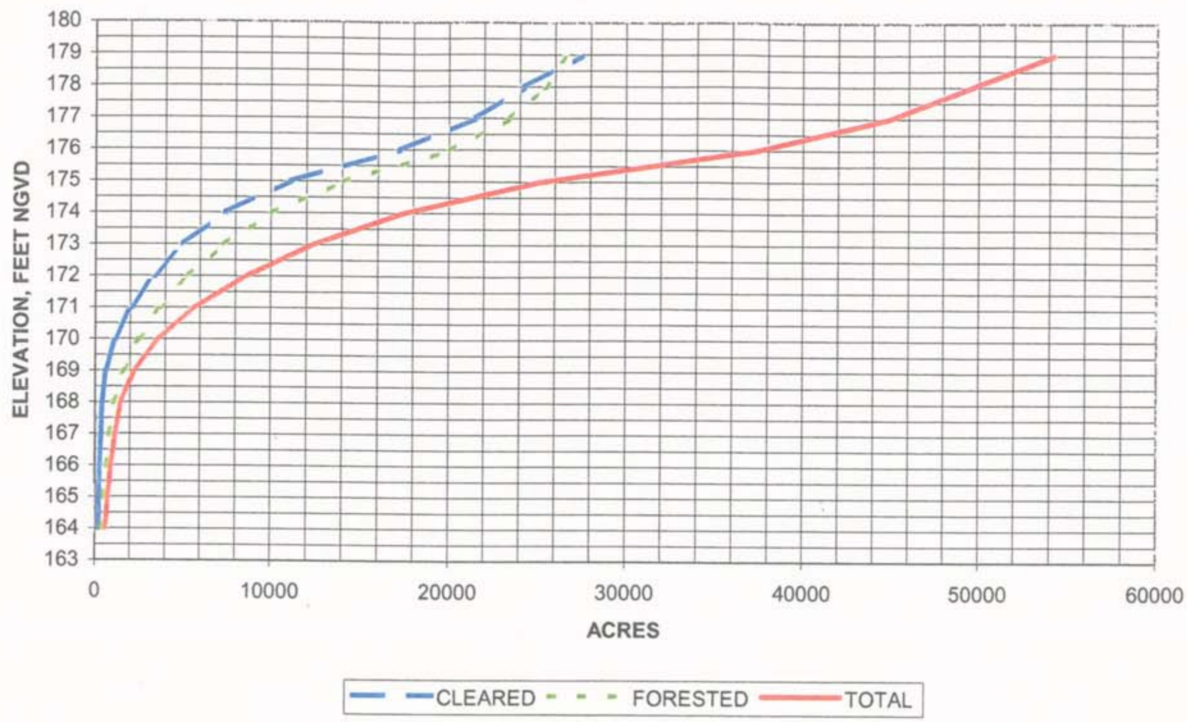


FIGURE NO 1

REACH 2

FIGURE NO 2

REACH 3

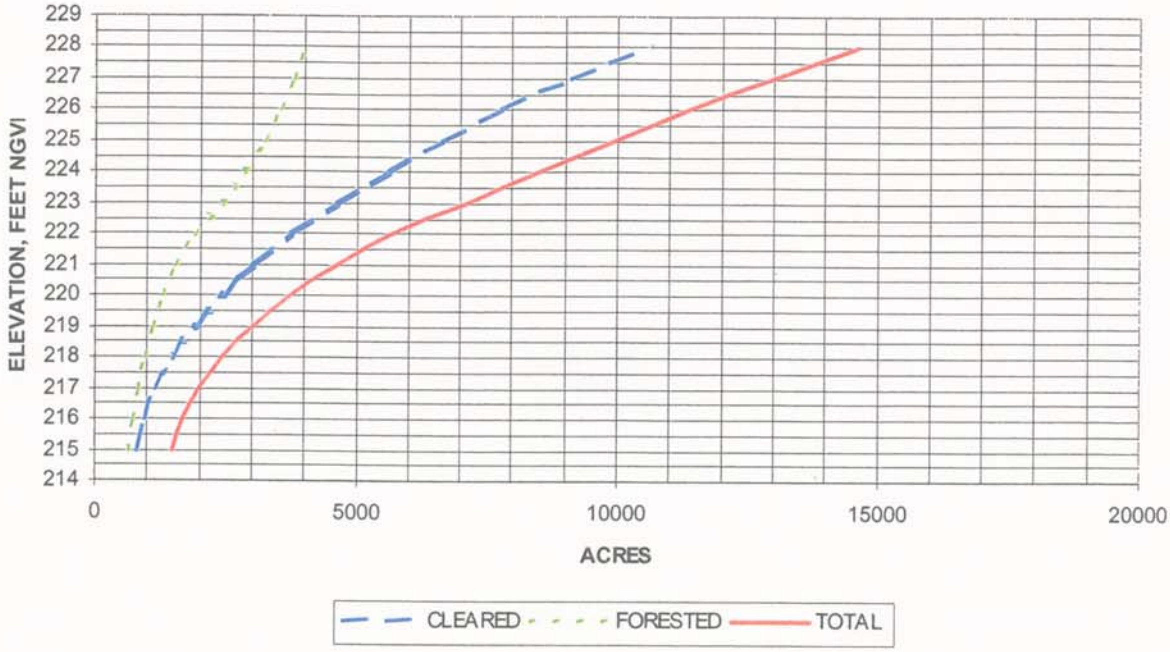


FIGURE NO 3

REACH 4

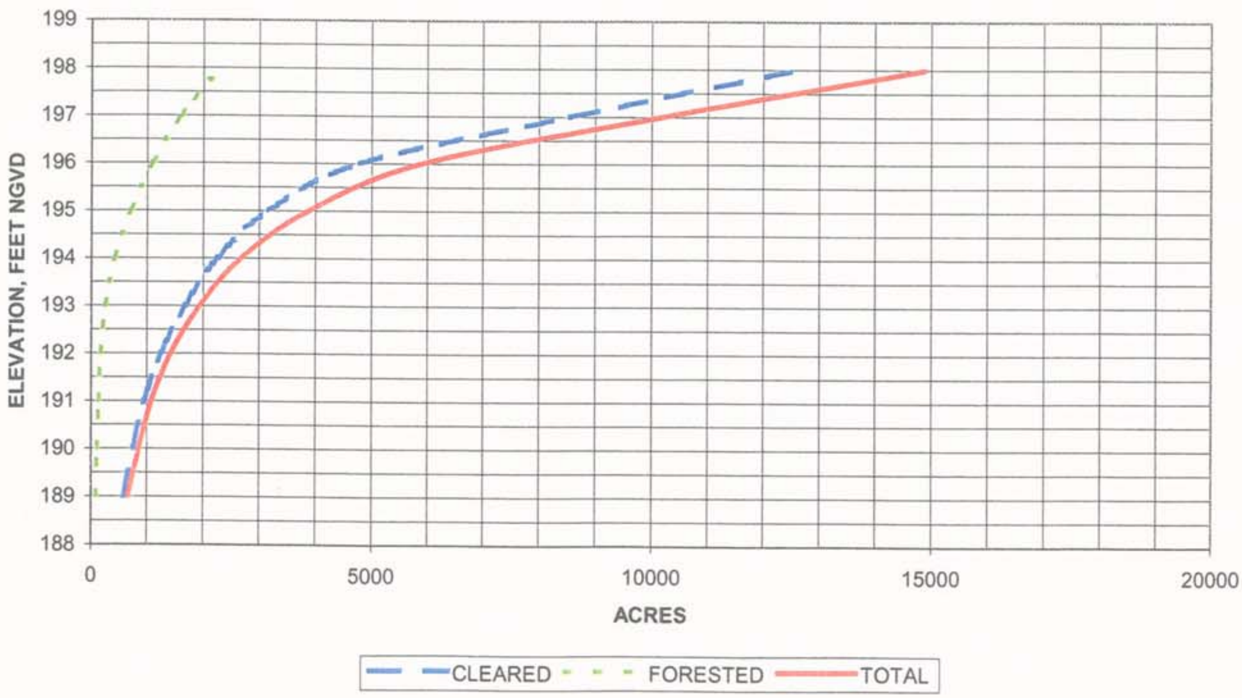


FIGURE NO 4

REACH 5

FIGURE NO 5

REACH 6

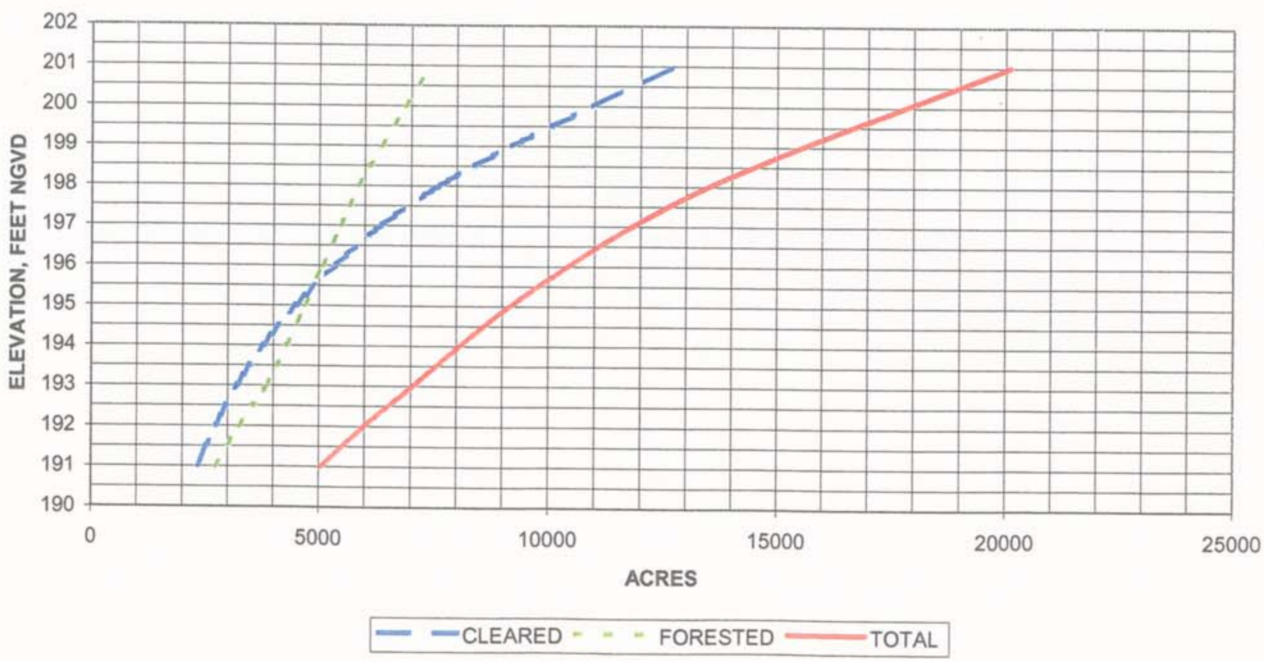


FIGURE NO 6

REACH 7

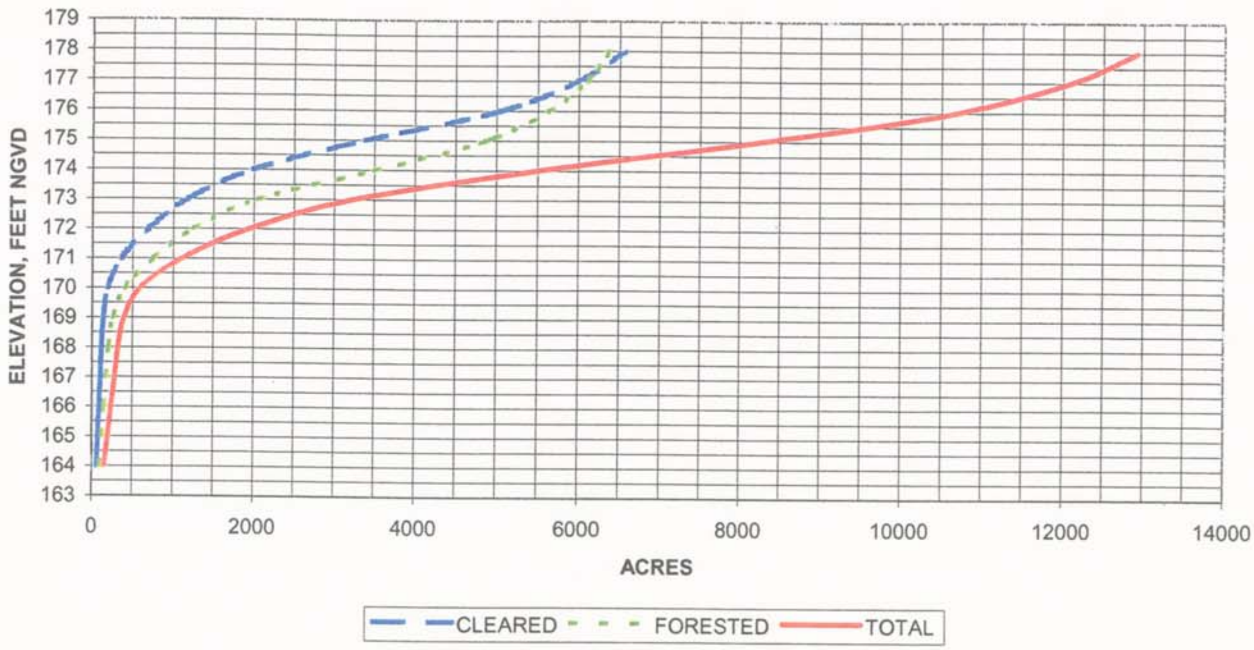


FIGURE NO 7

REACH 8

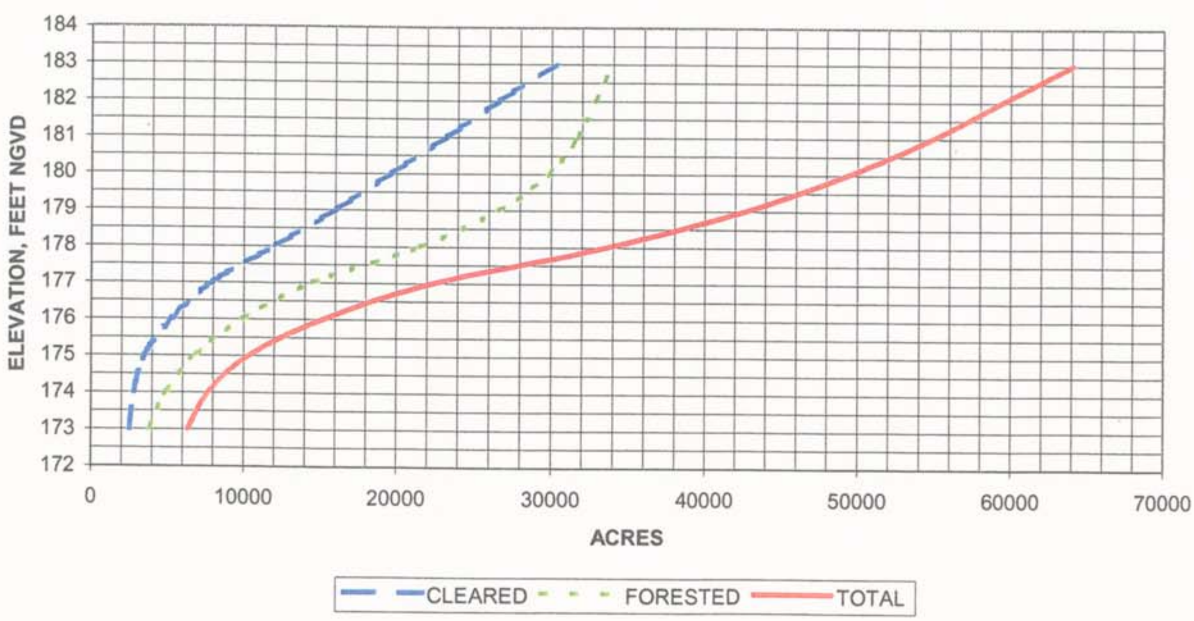


FIGURE NO 8

REACH 9

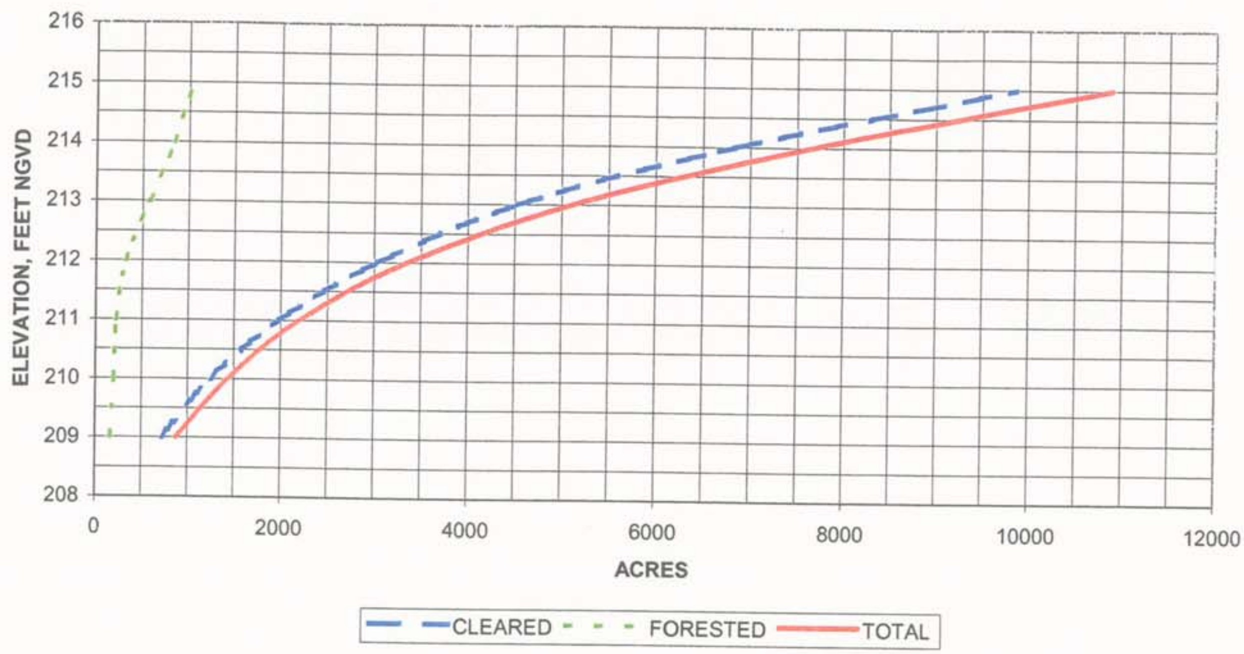


FIGURE NO 9

REACH 10

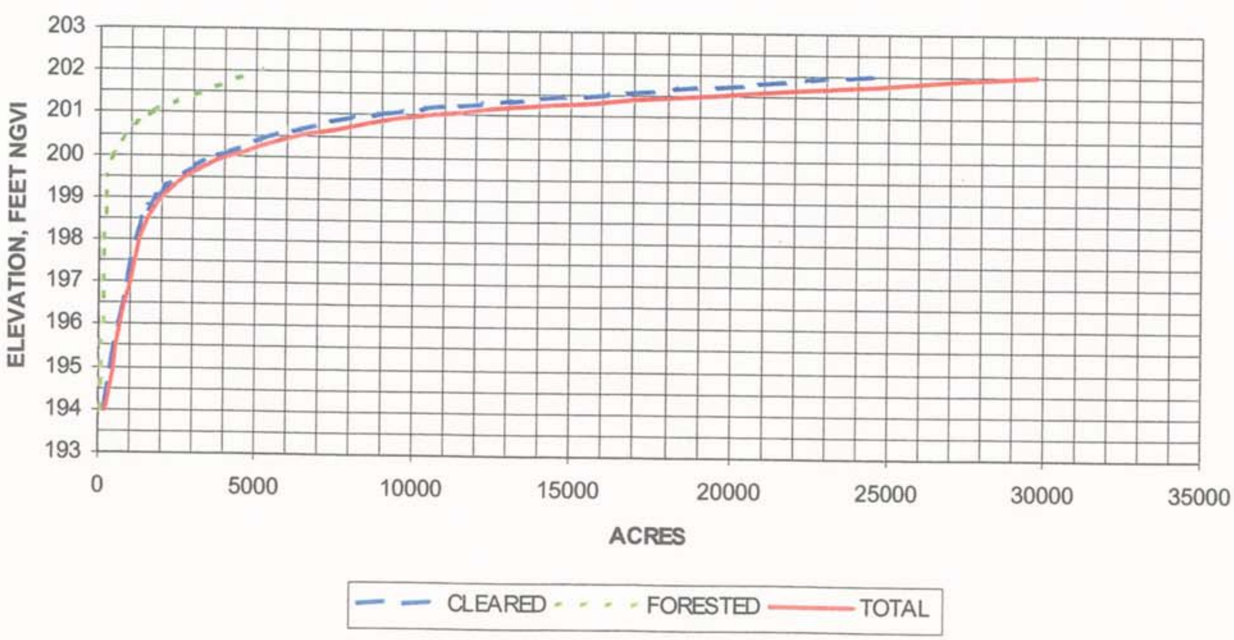


FIGURE NO 10

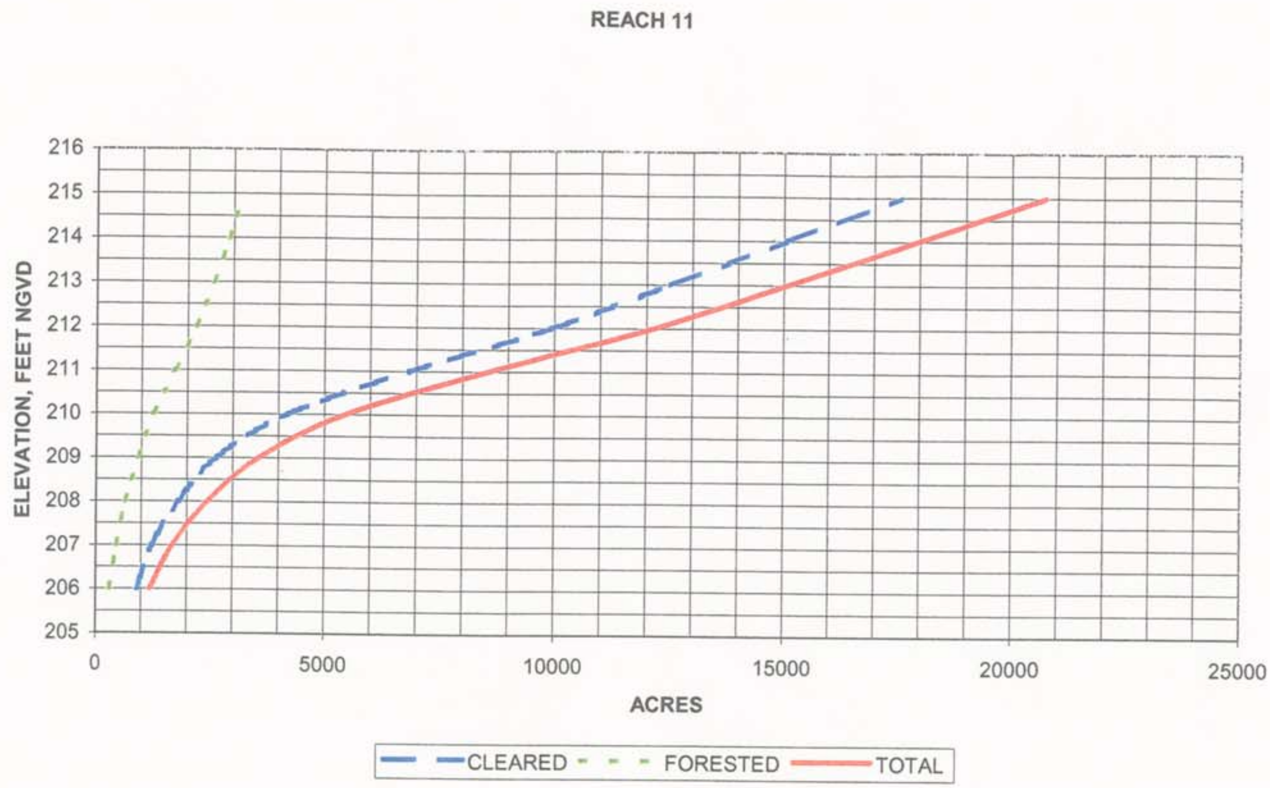

REACH 11
216
215
214
213
212
211
210
209
208
207
206
205
ELEVATION, FEET NGVD
0
5000
10000
15000
20000
25000
ACRES
CLEARED
FORESTED
TOTAL

FIGURE NO 11

I-8. FLOOD CONTROL ALTERNATIVES.

I-8-a. <u>Existing Conditions</u>. Existing conditions were determined by using observed hydrologic and climatological data along with the numeric models HEC-RAS and HEC-HMS. Existing flows for the one-year through the 100-year events were determined and, using HEC-RAS, flowlines were computed for all streams within the basin. Project flows for alternatives were computed using HEC-HMS and flowlines were computed using HEC-RAS.

I-8-b. <u>Alternative 1</u>. This alternative considered only selective clearing for each of the streams described in Alternative 2 in this section. The only exception would be a portion of Crooked Creek Ditch from mile 0.0 to mile 9.64, where a proposed 20-foot channel bottom width and one to three feet of material would be excavated. Hydraulic modeling of this alternative yielded no significant reduction in flooding. Therefore it was considered unfeasible and not submitted for economic analysis.

I-8-c. <u>Alternative 2</u>. This plan was developed to provide some flood relief for the more frequently flooded reaches while giving full consideration to environmental resources. The work would be accomplished from one side of the channel and would not require that bank lines be cut back since all material would be removed from the bottom of the channel. The work proposed under this alternative is outlined below.

I-8-c-1. <u>Reach 11 (Indian Bayou)</u>. Indian Bayou was cleaned out in year 2000 from about mile 17.0 to mile 29.0 and, for the purpose of this study, was not considered to need any further work.

I-8-c-2. <u>Reach 11 (Indian Bayou Ditch)</u>. Indian Bayou Ditch is a manmade channel that cuts off several miles of Indian Bayou. This ditch has 15 to 20-foot bottom width from mile 50.0 to mile 58.0. The amount of excavation planned for Indian Bayou Ditch is a 15-foot bottom width cut and removal of one to two feet of material. The work would affect the left descending top bank line of the ditch because it has fewer trees to remove. Also, most of the excavated material could be placed in the existing dredged material disposal bank for the Indian Bayou work previously accomplished by a local drainage district.

I-8-c-3. <u>Reach 09 (Indian Bayou)</u>. Indian Bayou from mile 0.0 to mile 16.6, would require two types of restoration work due to the growth of cypress in much of the streambed. From mile 0.0 to mile 13.4, the streambed is shallow and wide with a large amount of trees, including numerous cypress, in the stream. The work in this reach would consist of selective clearing over a 100-foot channel width. From mile 13.4 to mile 16.6, the channel has filled in and would require removal of two to three feet of material with an average bottom width of 25 feet. Bank lines would be left undisturbed with all work to be done from one bank. Due to the imbalance of low flow entering Indian Bayou Ditch and Indian Bayou at their upstream junction, low water weirs would be constructed in both channels just downstream of the junction to provide a more even split of low flow through the two streams.

I-8-c-4. Reach 09 (Wabbaseka Bayou). Flow enters Wabbaseka Bayou near mile 49.9, which is the junction with both Indian Bayou Ditch and Indian Bayou. Removal of one to two feet of material with a bottom width of 20 feet from mile 38.8 to mile 49.9 will be necessary to accommodate the channel work upstream without excessive ecosystem impacts.

I-8-c-5. Reaches 08 and 09 (Wabbaseka Bayou). From mile 20.6 to mile 38.8, the work will consist of selective clearing in order to prevent adverse flood effects from upstream work. Wabbaseka Bayou from mile 17.03 to mile 20.6 is a manmade channel that bypasses the old channel through the Bayou Meto Wildlife Management Area (WMA). The work proposed for this channel is one to two feet of channel cleanout with a bottom width of 20 feet.

I-8-c-6. Reach 08 (Boggy Slough). The proposed work on Boggy Slough consists of a 20-foot bottom width channel and one to two feet of excavation between miles 11.4 and 17.03.

I-8-c-7. Reach 08 (Little Bayou Meto). This portion of the work would be necessary to give flood relief for both the Boggy Slough and Salt Bayou areas. The work would consist of excavating about one to three feet of channel material between miles 7.5 and 11.4, with a 20-foot channel bottom width.

I-8-c-8. Reach 08 (Salt Bayou). Salt Bayou work would consist of channel cleanout on the twin channel portion and channel excavation on the lower part. Work from mile 0.0 to mile 5.0, would consist of excavating one to two feet of material with a channel bottom width of 20 feet. Work from mile 5.0 to mile 13.66, would consist of selective clearing on the west twin channel.

I-8-c-9. <u>Reach 04 (Crooked Creek Ditch)</u>. In order to provide some amount of flood relief in the Crooked Creek area and leave the channel banks in their natural state, the work proposed would consist of two to three feet of excavation with a 15-foot bottom width channel between miles 0.0 and 9.6.

I-8-c-10. <u>Reach 05 (Crooked Creek Channel)</u>. To accommodate the upstream work on Crooked Creek Ditch and provide some minor flood relief, channel work on Crooked Creek would consist of excavating one to three feet of channel material with a bottom width of 50 feet from mile 8.0 to mile 16.6. Additionally, the two low water weirs located at miles 4.3 and 13.3 would be modified to provide optimum flood relief.

I-8-c-11. <u>Reach 06 (Two Prairie Creek)</u>. Two Prairie Creek is wide and shallow with heavily wooded banks. In order to provide flood relief along this stream, considerable channel work would be required. Work on Two Prairie Creek would consist of excavating one to six feet of material with a 25-foot channel bottom width between miles 0.0 and 6.8. Work between miles 6.8 and 12.64, would consist of one to four feet of excavation with a 20-foot bottom width. The proposed work for this stream would also include one to four feet of excavation with a 20-foot channel bottom width between miles 12.64 and 19.1.

I-8-c-12. <u>Reach 02 (Big Bayou Meto)</u>. In order to accommodate the channel work upstream on Two Prairie Bayou, it will be necessary to clean out the Big Bayou Meto channel. Work proposed between miles 94.1 and 100.8, would consist of removing one to three feet of material with a 25-foot channel bottom width.

I-8-c-13. <u>Reach 03 (Big Bayou Meto Bypass Channel)</u>. A Big Bayou Meto bypass channel would lower flood stages in a reach of Big Bayou Meto from mile 132.8 to about mile 146.0, near Interstate 40. The proposed bypass channel would be five miles long and have a bottom width of ten feet. The depth of excavation would be 12 to 18 feet. Levees along both sides of the bypass channel would be necessary to prevent flooding of the areas adjacent to the channel. The existing levees around the fish ponds would serve as the left descending levee and a right descending levee would have to be constructed. A bridge would have to be provided where the new channel would breach Highway 70 and two low water weirs would be constructed in the channel near the lower end. One weir would be placed where the bypass channel enters Big Bayou Meto and the other at mile 2.5 of the bypass channel for maintenance.

I-8-d. Alternative 2A. This Alternative is the same as Alternative 2 with the exception of the Indian Bayou Ditch and Crooked Creek areas. Water supply and flood control channel work would overlap in these areas as discussed below.

I-8-d-1. Reach 11 (Indian Bayou Ditch). In order to accommodate the irrigation water that would flow through this channel along with floodwater, Indian Bayou Ditch was redesigned to pass the one-year frequency flow plus the design irrigation flow without increasing the flood stage. Work between miles 50.0 and 58.0, would consist of increasing the channel size by cutting the left descending bank to a one on three slope in addition to the excavation and 15-foot bottom width channel considered in Alternative 2.

I-8-d-2. Reach 04 (Crooked Creek Ditch). To accommodate the addition of irrigation water and the one-year frequency flow without increasing the flowline in the reach from mile 0.0 to mile 9.6, the channel would be altered as follows: The bottom of the channel would not be lowered as proposed under Alternate 2; however, banks would be cut back to one on three, with increases in channel bottom widths to 35, 45 and 55 feet between miles 0.0 to 5.0, 5.0 to 5.7 and 5.7 to 9.6, respectively.

I-8-d-3. Reach 05 (Crooked Creek). To accommodate the upstream flows, the following channel modification would be required: Increase channel bottom width from 50 to 60 feet between miles 8.0 and 16.6, and modify weirs as proposed for Alternative 2.

I-8-e. Alternative 3A (1000-cfs Pump). This plan adds a 1000-cfs pump, structural and channel features to Alternative 2A and is described below. The channel work described for Boggy Slough and Little Bayou Meto in Alternatives 2 and 2A would be replaced by that outlined below.

I-8-e-1. Reach 07. A 1000-cfs pump would be constructed adjacent to the Little Bayou Meto gravity floodgates at mile 0.0 of Little Bayou Meto.

I-8-e-2. Reach 07 (Lower Little Bayou Meto). Lower Little Bayou Meto is a 10-mile channel that connects the Cannon Brake structure to the Little Bayou Meto gravity structure and is undersized to deliver the flow required for the pump. This channel bottom grade would be lowered and enlarged to a 30-foot bottom width. The channel enlargement would require the replacement of three bridges that span the existing channel.

I-8-e-3. Reach 07 (Cannon Brake Structure Modification). This work would require the addition of a second structure adjacent to the existing Cannon Brake structure. It would have three, 10-foot by 10-foot gates and would divert flood flow down Lower Little Bayou Meto to the pump. A guide levee would be required downstream of the two structures to prevent flow from leaving Lower Little Bayou Meto and entering the present channel that carries flow from the Cannon Brake structure over to Big Bayou Meto channel.

I-8-e-4. Reach 08 (Lower Little Bayou Meto). This work would consist of one to two feet of excavation with a 40-foot bottom width between miles 9.8 and 11.5.

I-8-e-5. Reach 08 (Boggy Slough). This work would consist of one to two feet of excavation with a 40-foot bottom width between miles 11.5 and 12.7, downstream of the WMA.

I-8-e-6. Reach 08 (Boggy Slough Diversion). This work would consist of a five-mile channel with a 30-foot bottom width that would bypass the existing Boggy Slough reach (mile 12.7 to mile 17.7) that flows through the WMA.

I-8-e-7. Reach 08 (Boggy Slough Diversion Weirs and Grade Control Structures). The Boggy Slough diversion would cross Castor Bayou where a grade control structure would be placed to prevent head cutting in the channel. A low water weir would be constructed at the mouth of the diversion channel for maintenance purposes. In order to provide low flow into the existing Boggy Slough channel once the diversion channel is constructed and ensure a balanced flow between the two channels during higher flow conditions, a combination of weirs and gated culvert would be required. A low water weir would be constructed at the upper end of the Boggy Slough diversion and a weir with gated culvert would be constructed in the existing Boggy Slough channel immediately downstream of its juncture with the diversion channel. This would also allow control of ponded water in the WMA during waterfowl season.

I-8-f. Alternative 3B (3000-cfs Pump).

I-8-f-1. Reach 07. The bottom width for the connecting channel downstream of the Cannon Brake structure would be enlarged to a 60-foot bottom width, with the bottom grade the same as shown for Alternative 3A. The Cannon Brake structure would be increased in size to five, 10-foot by 10-foot gates to pass the flow to the pump.

I-8-f-2. Reach 08. The channel work upstream of the Cannon Brake structure would remain the same.

I-8-g. Alternative 3C (5000-cfs Pump). A 5000-cfs pump at the Little Bayou Meto location was also evaluated with the HEC-IFH interior flood hydrograph model. This pump station size would be too large to be practical due to the extensive channel work that would be necessary to supply the station.

I-8-h. Alternatives 4A, 4B, 4C & 4D (Big Bayou Meto Pumps). A pump station near the mouth of Big Bayou Meto was considered. Pump station capacities of 3000-cfs (Alternative 4A), 5000-cfs (Alternative 4B), 8000-cfs (Alternative 4C) and 10,000-cfs (Alternative 4D) were tested using the HEC-IFH interior flood hydrograph model. Extensive channel excavation would have to extend upstream from the station for 20 miles on Big Bayou Meto and ten miles on Little Bayou Meto. Although all of the scenarios yielded significant reductions in the water surface near the station, even the reductions in the water surface profiles produced by the 10,000-cfs station dissipated rapidly due to channel control as the HEC-RAS water surface profile model calculations progressed upstream. For this reason, the proposed pump station near the mouth of Big Bayou Meto was deemed hydraulically ineffective and was not submitted for economic analysis.

I-8-i. Alternative 5 (Reach 08). This plan proposes structures to divert flow from the Salt Bayou channel into Dry Bayou and then into a wildlife area located between Salt Bayou and Big Bayou Meto. The structures would have to be controlled since a fixed weir with enough height to divert flow would affect flood stages on Salt Bayou and Dry Bayou. The plan would consist of a 100-foot hinged crest gate that would be constructed immediately downstream from the junction of Salt Bayou and Dry Bayou (mile 13.65). The gate could be raised to divert flow and, in a lowered position, would pass flood flows down Salt Bayou without affecting stages. A smaller, 25-foot hinged crest gate would be constructed in Dry Bayou near mile 1.1 that would divert flow into the wildlife area.

I-9. ALTERNATIVE 3A FLOOD FREQUENCY AND STREAM PROFILES. This alternative yields reductions in the water surface elevations on various streams throughout the Bayou Meto basin through a combination of a 1000-cfs pump station, limited channel enlargement, bypass channels, channel cleanout and selective clearing. Detailed descriptions of the project features are given in the preceding paragraphs and are shown on Plate I-03. The pre/post project elevation frequency relationships used in the various economic and environmental analyses are given in Figures 12 - 19 below by reach. The reach number(s) and reference point river mile location are given in the title of each curve. Influences of the pump station and channel work required to get floodwaters to the station are reflected in the curves for Reaches 1, 7 and 8. The reductions shown in the other reaches are attributed to the channel cleanout, selective clearing and bypass channel work. Reaches 4, 5, 9 and 11 needed additional work to offset the effects of the water supply portion of the project. The Alternative 3A curves for these reaches show an inflection point between the one and two-year events. This is due to the fact that the analyses assumed that the water supply flows would still be present in the system up to and including the one-year event. The water supply flows were taken out at the two-year event due to the water managers' ability to shut down water supply features starting at the two-year event. Stream profiles showing existing conditions and post project conditions for Alternative 3A for the various basin streams where the flow lines were reduced, are shown in Plates I-15 through I-34. The 1, 2, 5, 25 and 100-year events are plotted for the affected stream reaches.

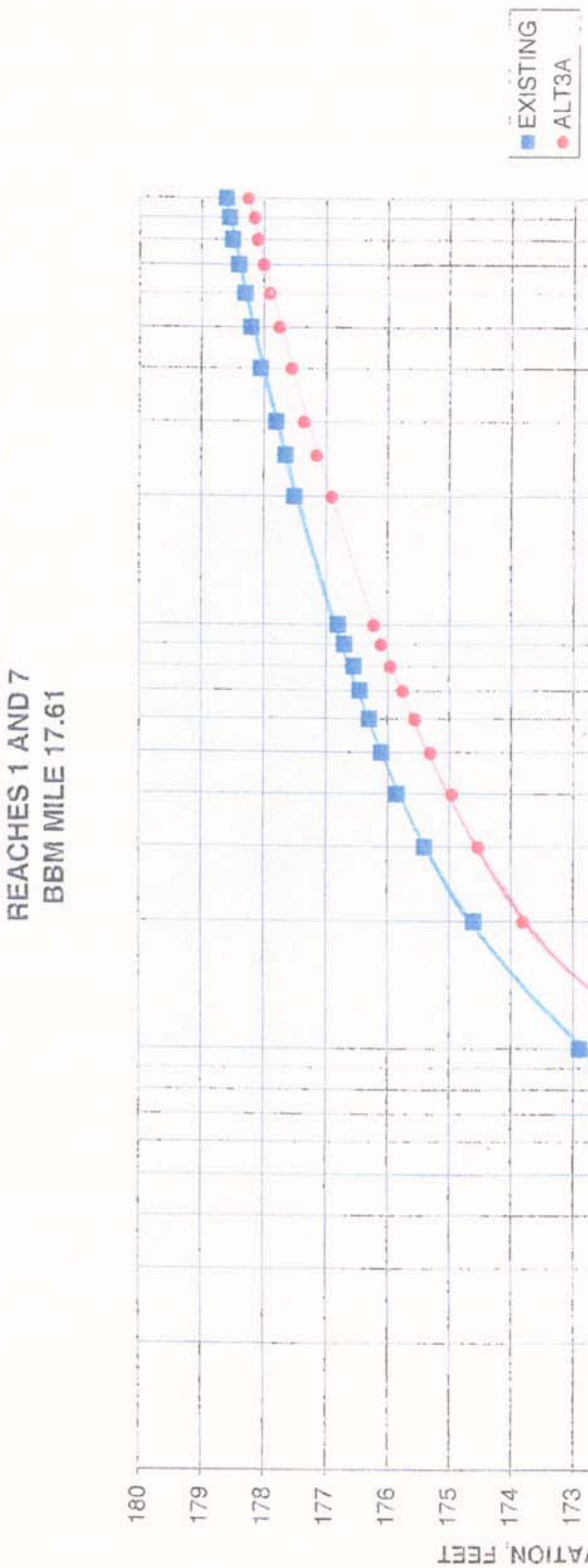

REACHES 1 AND 7
BBM MILE 17.61
EXISTING
ALT3A
ELEVATION, FEET
FREQUENCY, YEARS
180
179
178
177
176
175
174
173
172
171
170
169
168
167
0.1
1
10
100

FIGURE NO. 12

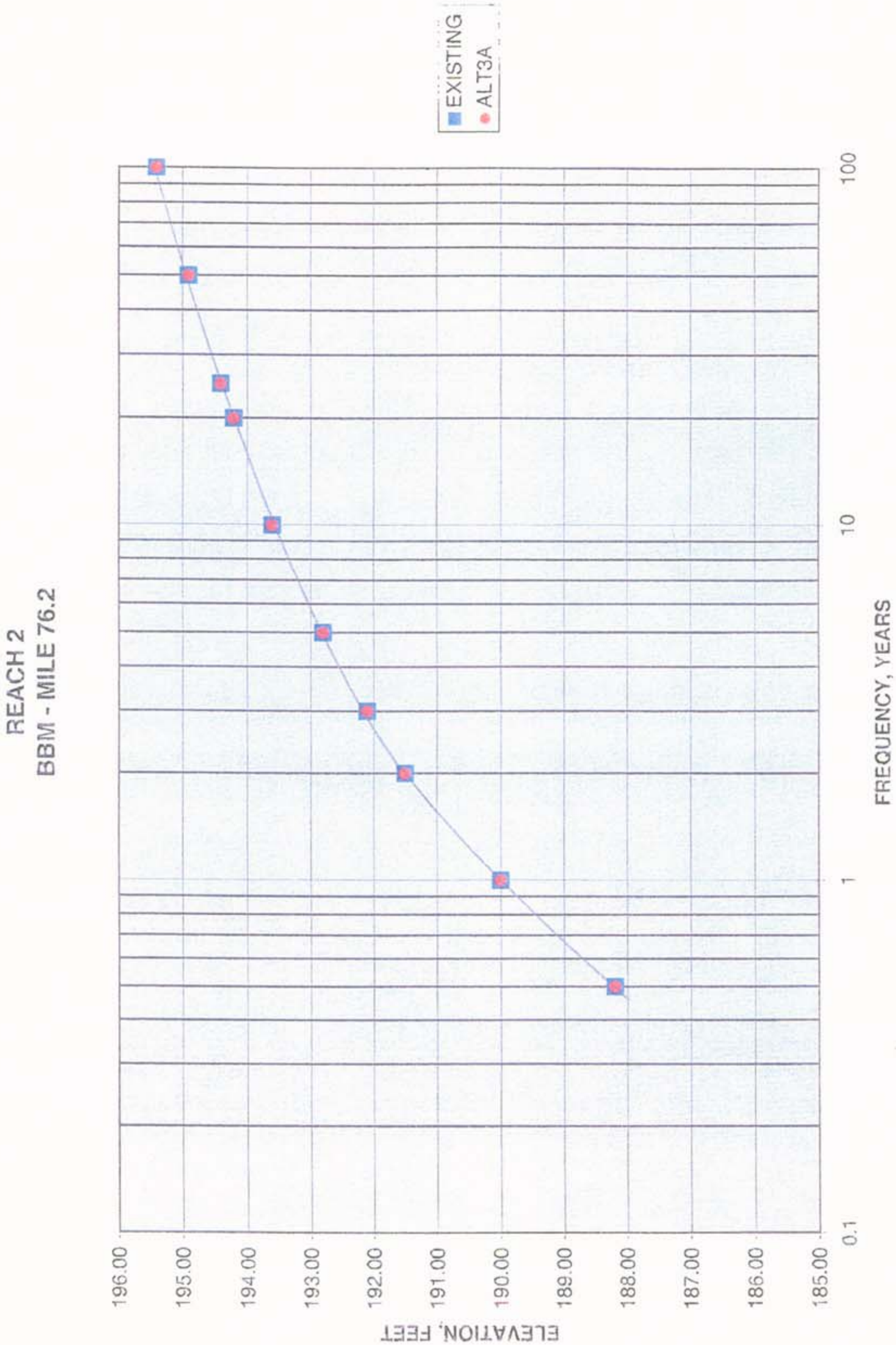

REACH 2
BBM - MILE 76.2
EXISTING
ALT3A
ELEVATION, FEET
196.00
195.00
194.00
193.00
192.00
191.00
190.00
189.00
188.00
187.00
186.00
185.00
FREQUENCY, YEARS
0.1
1
10
100

FIGURE NO. 13

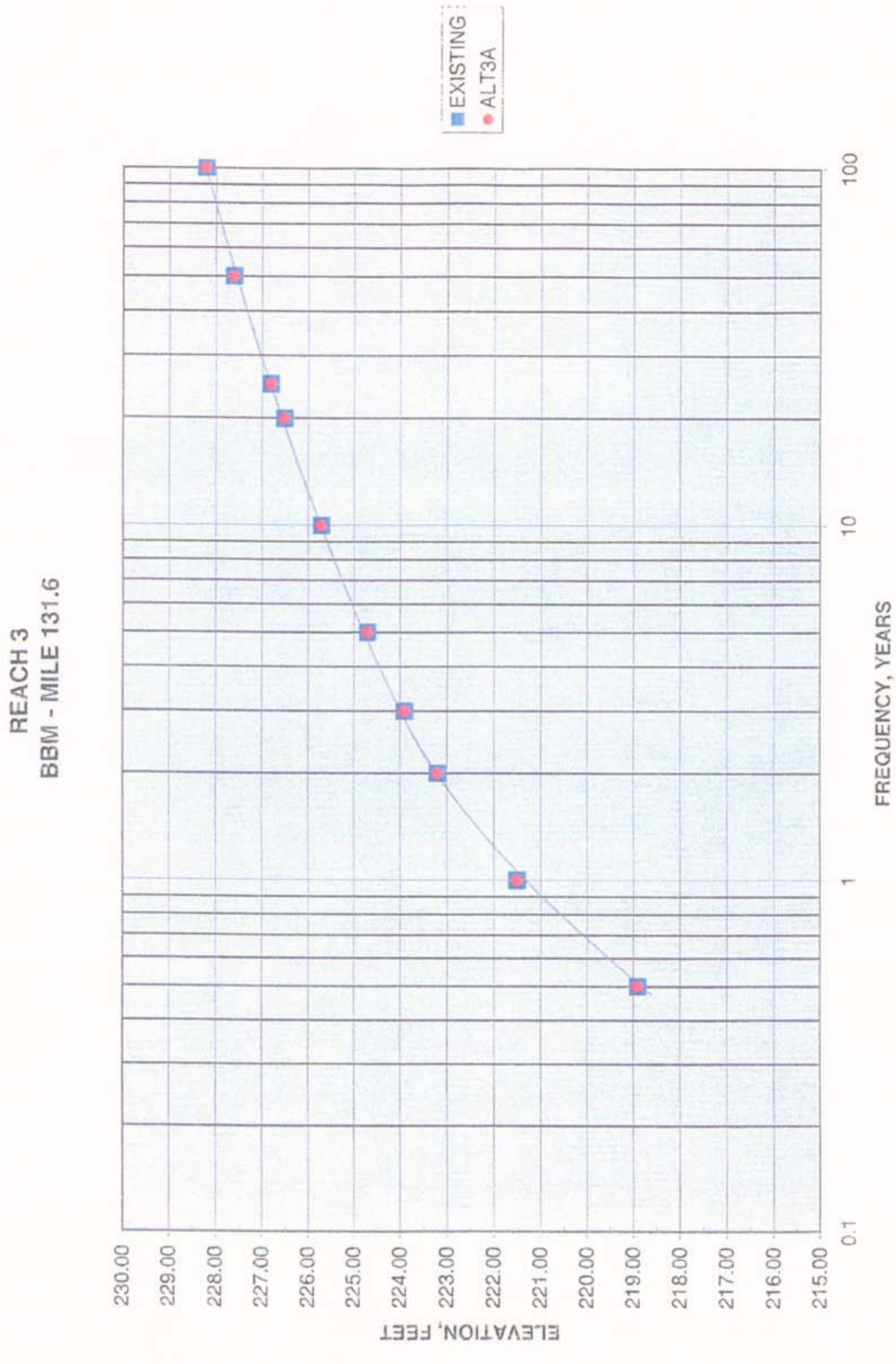

REACH 3
BBM - MILE 131.6
EXISTING
ALT3A
ELEVATION, FEET
230.00
229.00
228.00
227.00
226.00
225.00
224.00
223.00
222.00
221.00
220.00
219.00
218.00
217.00
216.00
215.00
FREQUENCY, YEARS
0.1
1
10
100

FIGURE NO. 14

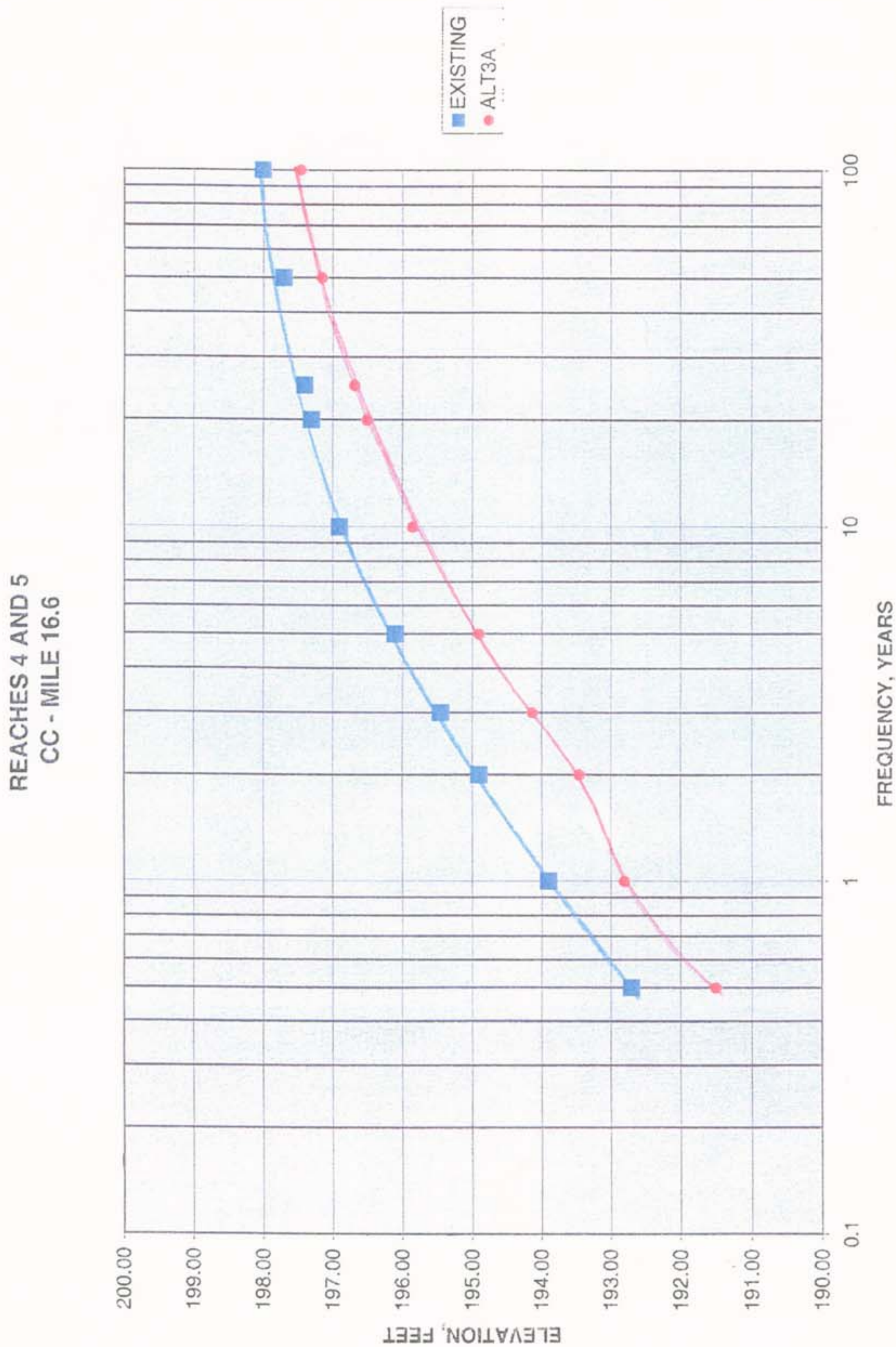

REACHES 4 AND 5
CC - MILE 16.6
EXISTING
ALT3A
ELEVATION, FEET
200.00
199.00
198.00
197.00
196.00
195.00
194.00
193.00
192.00
191.00
190.00
0.1
1
10
100
FREQUENCY, YEARS

FIGURE NO. 15

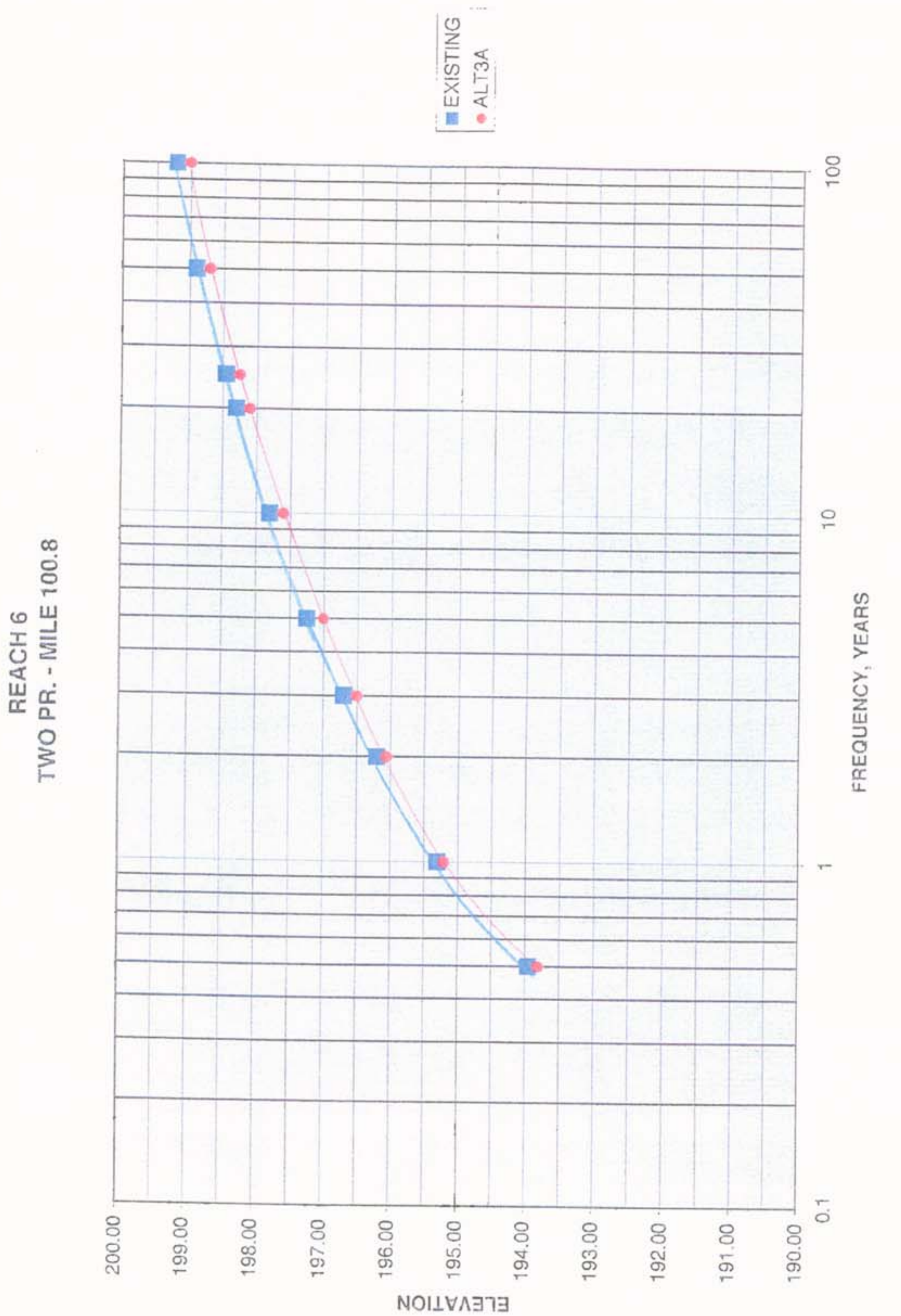

REACH 6
TWO PR. - MILE 100.8
EXISTING
ALT3A
200.00
199.00
198.00
197.00
196.00
195.00
194.00
193.00
192.00
191.00
190.00
ELEVATION
0.1
1
10
100
FREQUENCY, YEARS

FIGURE NO. 16

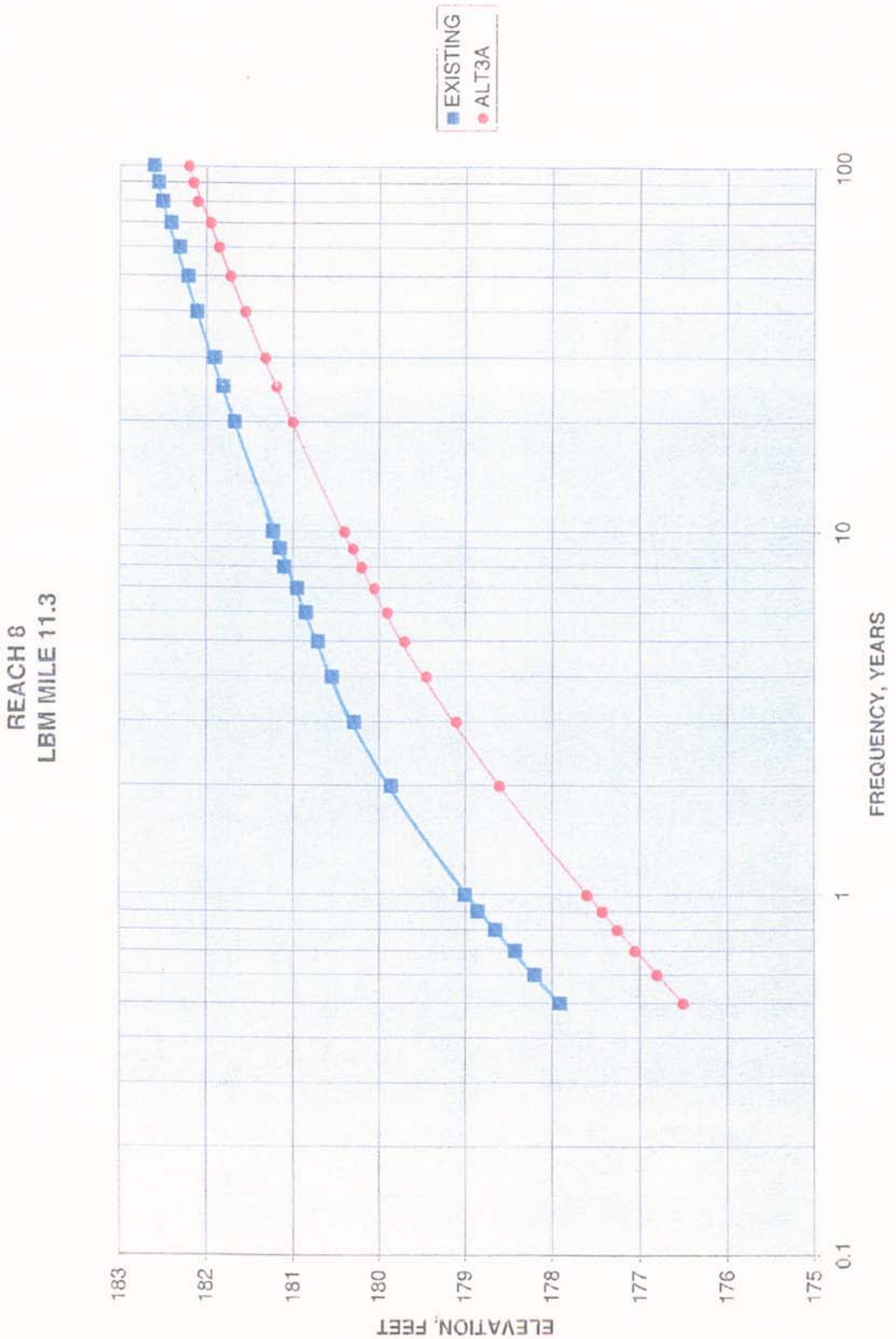

REACH 8
LBM MILE 11.3
EXISTING
ALT3A
ELEVATION, FEET
183
182
181
180
179
178
177
176
175
FREQUENCY, YEARS
0.1
1
10
100

FIGURE NO. 17

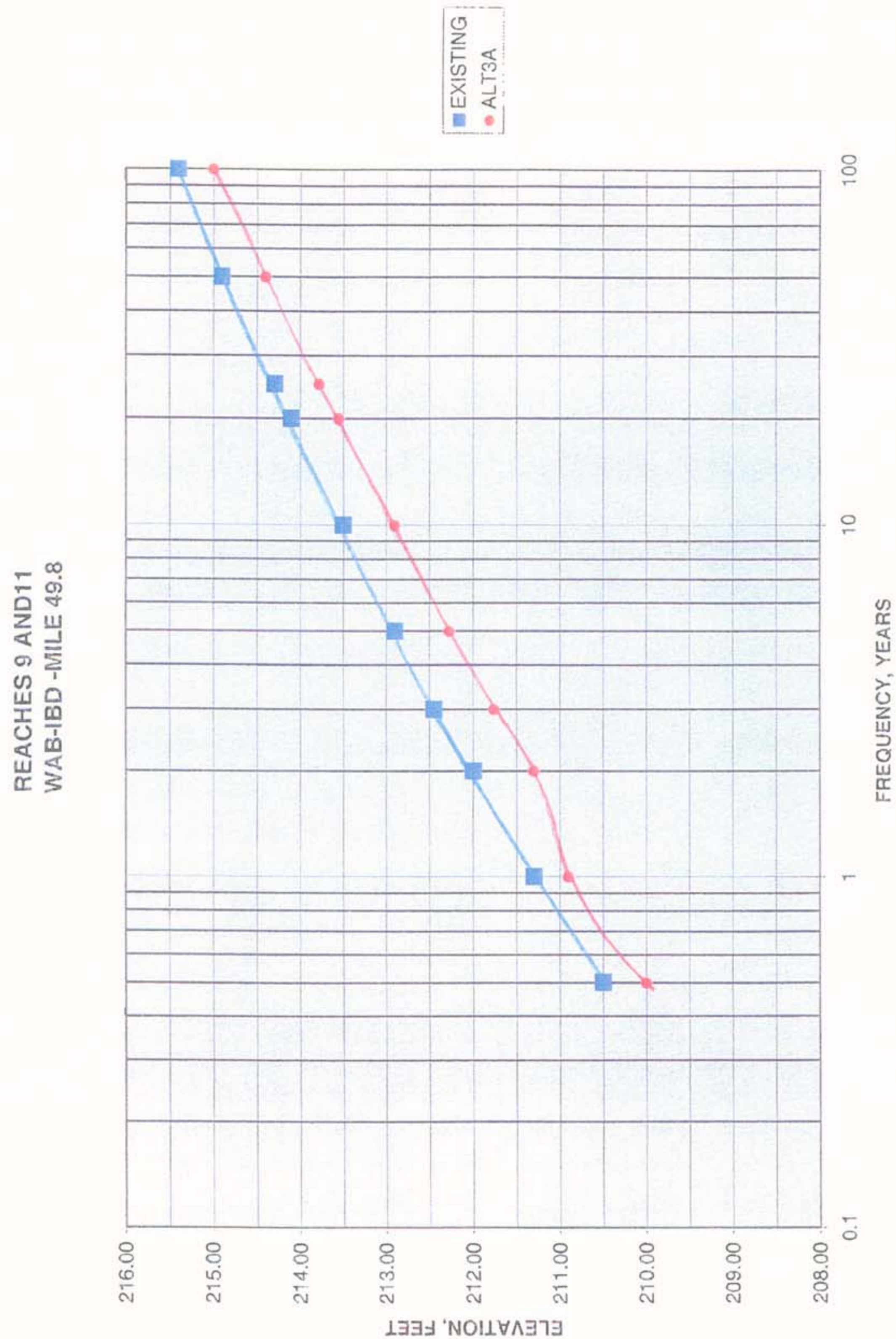

REACHES 9 AND11
WAB-IBD -MILE 49.8
EXISTING
ALT3A
ELEVATION, FEET
216.00
215.00
214.00
213.00
212.00
211.00
210.00
209.00
208.00
FREQUENCY, YEARS
0.1
1
10
100

FIGURE NO. 18

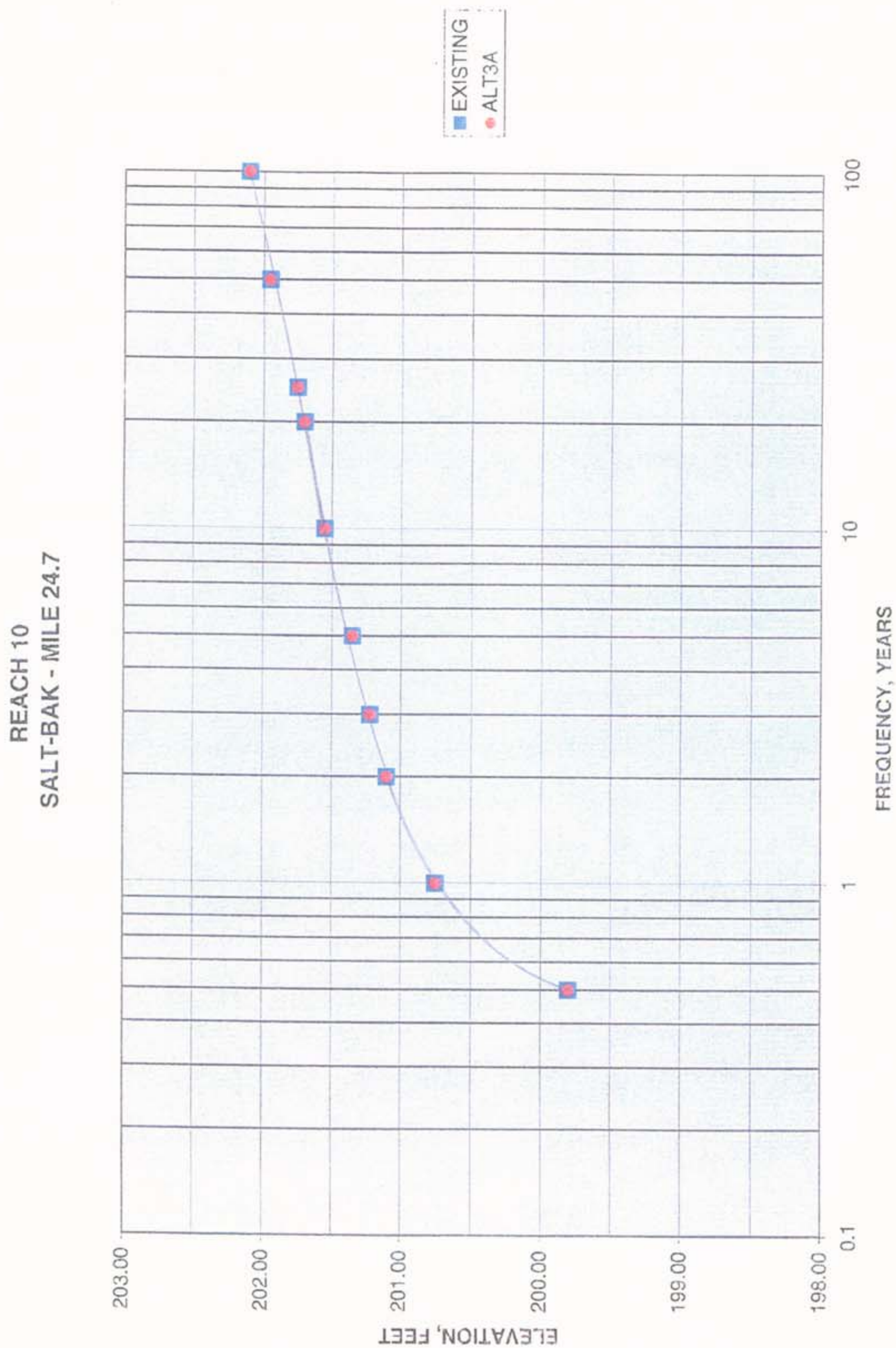

REACH 10
SALT-BAK - MILE 24.7
EXISTING
ALT3A
203.00
202.00
201.00
200.00
199.00
198.00
ELEVATION, FEET
0.1
1
10
100
FREQUENCY, YEARS

FIGURE NO. 19

I-10. MODELING FOR PUMP STATION.

I-10-a. Precipitation Gage Data. Precipitation data was obtained from two contributing National Weather Service rainfall gage stations, Pine Bluff and Stuttgart, Arkansas, in developing the inflow hydrographs. The HEC-IFH computer model was used to develop the inflow hydrographs using the daily precipitation data. Station weights were assigned by the Thiessen Polygon technique and were recomputed as new stations were added and old ones were discontinued.

I-10-b. Interior Ponding Elevations. The HEC-IFH model interior flood hydrograph model, for existing conditions, was calibrated to 48 years of interior daily stage records and rainfall records. Input to the model consisted of daily precipitation data, unit hydrographs and runoff coefficients.

I-11. PERIOD OF RECORD ROUTING MODEL ASSUMPTIONS. The following conditions were assumed in the recommended plan routing procedure:

I-11-a. Elevation-Area Curves. The elevation-area curves used in the period-of-record routing model take into account the effects of actual flooding in the ponding areas and adjacent areas by using actual GIS flood scenes.

I-11-b. Minimum Ponding Elevation. The minimum ponding elevation was set at 15.0 feet, NGVD, year round and used throughout the entire period-of-record.

I-11-c. Pump-on Interior Elevation. The pump-on interior elevation used for the first pump in each scenario was 167.0 feet, NGVD, with additional pumps being brought on line at 0.5-foot increments above 167.0 feet, NGVD. The pump-off elevation was 163.0 feet, NGVD, for all pumps for 1 January through 31 December for the entire period-of-record.

I-11-d. Floodgate/Pump Station Operation. The floodgates and the pump station were operated simultaneously during each analysis.

I-12. PUMP MODEL VERIFICATION. The period-of-record interior flood hydrograph model was verified by using the data developed to represent base conditions and compared to actual observed gage elevations at the Little Bayou Meto Floodgate Structure landside gage. The computed interior water surface elevations for the flood frequency events analyzed (100, 50, 25, 10, 5, 2 and 1-year events) were used as the starting water surface in HEC-RAS water surface profile models for the corresponding events.

I-13. ENVIROMENTAL ANALYSES. The Big Bayou Meto basin was divided into 11 hydrologic reaches for the purpose of analyzing the hydraulic effects from each alternative considered. Hydraulic parameters were determined for each reach that included daily stage data for the period of record (1949-1997), stage duration, stage frequency and stage-area curves. Daily stages for reach gages that did not have observed stage data were determined using a stage relation between that gage and a gage with observed data. Stage-frequency, stage-duration and stage-area data were used to compute the data required to analyze the waterfowl, fisheries and terrestrial habitat. This data was used to evaluate the environmental effects of each alternative considered during the Bayou Meto study. The two-year flood was used as the basis for computing all environmental effects on the project. A description of the parameters and methods used in determining effects of proposed work follows:

I-13-a. Waterfowl. The waterfowl habitat was analyzed by using a computer program called ENV-DUC1.EXE, which looks at the period-of-record computed stage output data and by specifying certain conditions will compute average annual duck acres. The conditions that were used to analyze the waterfowl habitat in this area were a time frame from 01 November to 28 February and a maximum depth of 1.5 feet for feeding habitat. The period-of-record used was from 1949 to 1997. Duration of flooding is an important criteria in analyses of environmental impacts. The model keeps track of each day of flooding to determine the duration of flooding for the acres flooded. Then the number of days flooded is checked for the appropriate criteria to determine if the acres are suitable habitat or not. The routine uses stage as an indication of whether the acres are still flooded. When the acres are flooded initially, the stage is recorded and a counter is used to track the duration until they are no longer flooded.

Depth is another important criteria in the analysis of environmental impacts. The depth utilizes stages to help determine the depth of flooding. The depths are then added to or subtracted from, depending on if the stages are rising or falling. Once the depth falls to or below zero, then the acres are removed from the flooded area. All flooded acres are checked against the depth criteria to determine whether the flooded acres would be suitable habitat.

The routine that records the flooded acres uses stage and total acres flooded to determine the number of acres flooded. The difference in acres flooded from one day to the next is used to account for the number of new acres being flooded or the number of acres that are no longer flooded. Stage is used to help to determine the number and if the acres are still flooded or not. It is also used to determine the number of acres to decrease the acres flooded when the stage falls from one day to the next. The average daily duck acres computed for Base Conditions and the Alternatives are as follows:

WATERFOWL ACRES

ALTERNATIVE	REACH 1	REACH 2	REACH 3	REACH 4	REACH 5	REACH 6	REACH 7	REACH 8	REACH 9	REACH 10	REACH 11
EXCOND	428	1980	214	314	854	1241	352	7244	254	615	1093
ALT 2	428	1980	171	182	586	1227	352	6614	223	615	987
ALT 2A	428	1980	171	179	582	1227	352	6614	223	615	987
ALT 3A	428	1980	171	179	582	1227	238	5229	223	615	987
ALT 3B	428	1980	171	179	582	1227	191	4275	223	615	987

I-13-b. <u>Fisheries</u>. The fisheries habitat was analyzed by using a computer program called <u>ENV-FSH1.EXE</u>, which looks at the period-of-record two-year computed stage output data and by specifying certain conditions will compute average daily fish acres. The conditions that were used to analyze the fisheries habitat in this area was a time frame from 01 March to 30 June, maximum depth of 10 feet, a minimum depth of 1.0 feet, and an 8-day minimum continuous duration. The period-of-record was from 1949 to 1997. The duration of spawning is important for egg incubation since eggs can be stranded and desiccated if water levels drop before hatching. Incubation times range from 2 to 14 days. The area covered by the two-year frequency is the study area for the aquatic analyses. A daily routing is used that keeps a record of the number of acres flooded each day, the number of days flooded and the depth of flooding. The flooded acres at or below the two-year frequency during the time span specified are considered the rearing acres. The daily rearing acres are summed up for the time period and divided by the number of days in the time period to give the average daily rearing acres. The spawning acres are the number of acres that are flooded for the number of consecutive days required for spawning and for the minimum depth required. The daily spawning acres are summed up for the time period and divided by the number of days in the time period to give the average daily spawning acres. The acres are then classified by land use. This is currently done by a land use analysis for the two-year frequency area. It is assumed that the flooded acres for this analysis are determined by the land use percentage developed at approximately the two-year area. The average daily fish acres computed for Base Conditions and the Alternatives are shown below.

Fish Acres

SPAWNING ACRES

ALTERNATIVE	REACH 1	REACH 2	REACH 3	REACH 4	REACH 5	REACH 6	REACH 7	REACH 8	REACH 9	REACH 10	REACH 11
EXCOND	674	3008	251	206	543	2660	640	11544	117	683	1024
ALT 2	674	3008	183	118	357	2547	640	10139	92	683	935
ALT 2A	674	3008	183	114	337	2547	640	10139	92	683	935
ALT 3A	674	3008	183	114	337	2547	429	6220	92	683	935
ALT 3B	674	3008	183	114	337	2547	317	4543	92	683	935

REARING ACRES

ALTERNATIVE	REACH 1	REACH 2	REACH 3	REACH 4	REACH 5	REACH 6	REACH 7	REACH 8	REACH 9	REACH 10	REACH 11
EXCOND	1383	5796	783	793	2060	4935	1230	29603	407	1558	2570
ALT 2	1383	5796	628	373	1297	4738	1230	25856	345	1558	2342
ALT 2A	1383	5796	628	363	1262	4738	1230	25856	345	1558	2342
ALT 3A	1383	5796	628	363	1262	4738	872	20836	345	1558	2342
ALT 3B	1383	5796	628	363	1262	4738	872	20836	345	1558	2342

Rearing acres = total average daily acres
Spawning acres = acres with a duration of flooding greater than or equal to 8 days

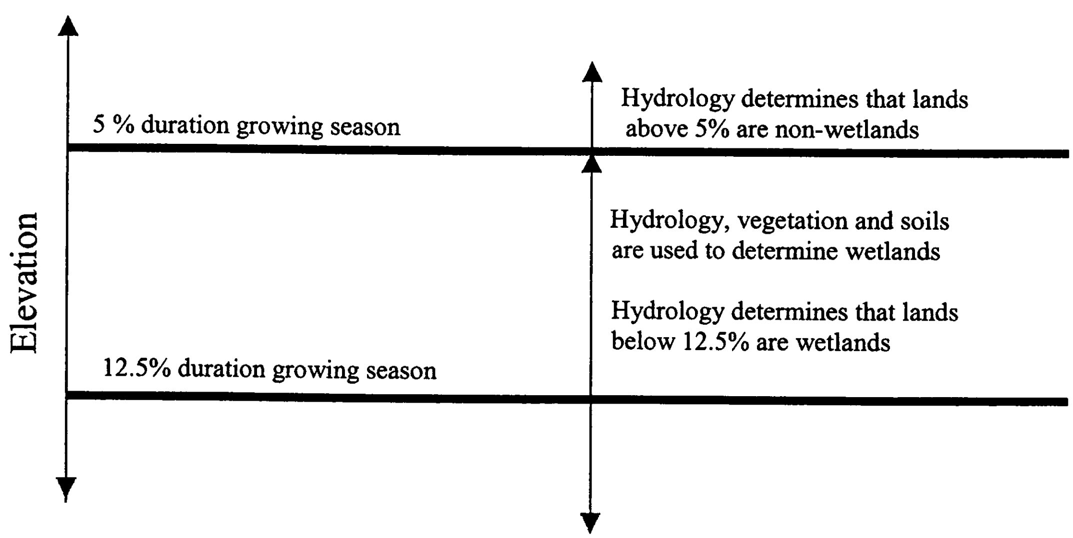
I-13-c. Terrestrial Impacts. In order to determine the effects on terrestrial acres, a numeric model was used that computes the number of forests (bottomland hardwood (BLH) and cypress) that were flooded at least 90 days (cumulatively) at any time of the year. This is accomplished by computing the stage that would be equaled or exceeded 25% of each year for the period of record (1949 to 1997), then taking the average of those values. This stage is then used to compute the acreage of woods from the stage-area data. The percent of BLH and cypress is then applied to the total wooded acreage to get the acres of each type. In order to get the average cumulative flood duration in forest acres that are flooded for at least 90 days another numeric model is used. The output data are given below.

TERRESTRIAL IMPACTS										
	EXISTING CONDITIONS					ALTERNATIVE - 3A				
REACH NUMBER	WOODED ACRES	BOTTOMLAND HARDWOOD ACRES	CYPRESS ACRES	DAYS INNUNDATED	PERCENT OF YEAR	WOODED ACRES	BOTTOMLAND HARDWOOD ACRES	CYPRESS ACRES	DAYS INNUNDATED	PERCENT OF YEAR
1	424	424	0	115	31.5	361	361	0	115	31.4
2	457	457	0	117	32	457	457	0	117	32
3	290	290	0	113	30.9	236	236	0	114	31.1
4	86	86	0	111	30.3	55	55	0	110	30.1
5	288	287	1	111	30.4	145	145	1	111	30.4
6	288	288	0	111	30.4	145	145	0	111	30.4
7	96	96	0	114	31.3	86	86	0	114	31.2
8	13283	13150	132	113	31	9115	9024	90	112	30.7
9	54	49	4	116	31.8	45	41	4	117	32
10	111	110	1	117	32	111	110	1	117	32
11	206	200	6	115	31.6	165	160	5	117	31.9

I-13-d. Wood Duck Impacts. To determine the effects on Wood Duck, the minimum number of acres that would be flooded continuously each year during March, April and May were computed. This was done by computing the minimum stage that would occur continuously during that three-month period and getting the acreage from the stage-area data. The data output is shown below.

WOODDUCK IMPACTS MINUMUM NUMBER OF ACRES THAT ARE FLOODED CONTINUOUSLY DURING MARCH, APRIL, AND MAY EACH YEAR.											
EXISTING CONDITIONS	REACH 1	REACH 2	REACH 3	REACH 4	REACH 5	REACH 6	REACH 7	REACH 8	REACH 9	REACH 10	REACH 11
ELEVATION	162.2	180.5	206.2	188.54	188.5	185	162.2	175.9	203.4	193.2	203.4
ACRES	115	38	200	70	205	665	36	9542	28	71	110
ALTERNATIVE 3A											
ELEVATION	162.1	180.5	205.1	188.5	188.5	184.8	162.1	175.9	202.9	193.2	202.9
ACRES	100	38	145	68	205	600	33	9542	18	71	76

I-14. **WETLAND HYDROLOGY.** **Wetlands are recognized as nationally** significant resources and the current government policy is "No Net Loss of Wetlands." The most significant in understanding **wetlands is that hydrology creates and maintains all wetlands.** The Corp's Wetland Delineation Manual (ERDC Technical Report, Y-87-1) defines wetlands as: "Those areas that are inundated or **saturated by surface or ground water at a frequency and duration** sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for a life in saturated soils conditions." The manual continues to refine the definition by explicitly stating the conditions that satisfy the component for hydrological duration. "An area may have wetland hydrology, if it is inundated or saturated to the surface for at least 5% of the growing season in most years. In most years means at least 50 years out of 100, or 50% probability in any one year. Areas that are irregularly or saturated less than 5% of the growing season continuously are not wetlands. Areas that are inundated or saturated more than 12.5% of the growing season continuously are wetlands." The minimum 5% duration refers to a single, continuous episode of inundation. The growing season is defined as the portion of the year when soil temperature (measured 20 inches below the surface) is above biological zero (5 degrees C or 41 degrees F). In the absence of data on soil temperature, the growing season can be estimated from data given in most Natural Resource Conservation Service (NRCS) county soil surveys. Starting and ending dates generally are based on the 28 degrees F air temperature thresholds for the average year. The growing season for the Bayou Meto area was determined from NRCS data from the website ftp://ftp.wcc.nrcs.usda.gov/support/climate/wetlands/ar/05001.txt. The computed growing season at Stuttgart, Arkansas, was the period 2/26 to 11/24 (272 days X 5% = 13.6 days). A schematic depicting wetland hydrology is as follows:



The NRCS, which has the responsibility to determine "Farmed Wetlands," defines wetlands as: "Areas that have a predominance of hydric soils and that are inundated or saturated by surface water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soils conditions. To be a farmed wetland, it must be inundated at least 15 consecutive days during the growing season in most years. The key features of this definition are: 1) hydrophytic vegetation; 2) hydric soils; and, 3) wetland hydrology. All three must be present for an area to be considered a wetland; however, past studies have shown that wetland hydrology is the control that depicts wetlands, particularly when evaluating inundation for 5% of the growing season.

I-15. WETLAND DELINEATION. Delineating wetlands for a large study area such as the Bayou Meto Project area requires an off-site, landscape scale delineation. The Vicksburg District has been performing this type of wetland delineation for more than ten years. Although the specifics of the technique have been refined over the years, the basic elements have remained the same. The method uses Landsat satellite imagery to provide the aerial extent of wetlands. In addition to the satellite imagery, the method uses the period-of-record stage data at all gages within the study area, an ArcView GIS model and on-site verification utilizing procedures in the 1987 Wetland Delineation Manual.

Previously, this method has been successfully utilized on several projects, including: Upper Yazoo Projects, Upper Steele Bayou, Project, Mississippi River Levees, and the Yazoo Backwater Pumps Project. Each application has included some refinements to the basic concept of utilizing satellite imagery to delineate the aerial extent of wetlands. The basic process involves these five steps:

1. Analyze stage data to determine the 5% duration elevation at each gage.

2. Find and classify a satellite image (or images), where the observed stage data is similar to the 5% duration elevation.

3. Verify that the flooded areas on the classified satellite images accurately reflect the stages on the date of the flood scene.

4. Field verification the wetland delineation using on-site methods.

5. Apply the Flood Event Assessment Tool (FEAT) GIS model to simulate the pre- and post-project wetland extent.

For the first applications of this off-site method, Landsat MSS imagery was utilized to delineate flooded area and wetlands. This imagery has a raw pixel size of 79 by 57 meters. The imagery was re-sampled to 50 by 50 meter pixels. Each pixel represents 0.25 hectares or 0.62 acres. This pixel size was determined adequate for planning purposes on large area projects (>500,000 acres). Later Thematic Mapper (TM) imagery was utilized. TM imagery has a raw pixel size of 28.5 meters on a side. Each pixel of a TM scene represents 0.081225 hectares or 0.20 acres. TM was imagery was used for the land-use classification and the wetland delineation for this project. The observed stages were compared to the dates of available TM imagery and to the 5% duration elevation. The 23 Mar 97 flood scene was selected as most representative of the 5% duration elevation. Table 1 lists the two-year frequency elevations, the 5% duration elevation and the observed elevations at the gages within the project area on 23 Mar 97. Frequently, the two-year flood frequency elevations are incorrectly considered as equivalent to the 5% duration elevation. The two-year frequency elevations are presented in Table 1, below, for comparison. The 5% duration elevation is given as the upper bounds of wetlands in the 1987 Wetland Delineation Manual.

Table 1

Gage/Date	1Mar89	23Mar97	5% Duration	2-year Frequency
BBM @ Bayou Meto	176.02	173.38	172.89	174.05
BBM @ Stuttgart	190.24	188.5	189.14	190.83
BBM @ Lonoke	218.21	214.01	212.81	222.59
Wabbeseka Bayou @ Wabbeseka	185.7	191.2	190.91	195.65
Crooked Creek near Humphrey	188.6	190	189	194.49

The raw satellite imagery was classified with an unsupervised classifier (MAPIX, Canonical Classifier, Delta Data Systems). Classification is a term, which describes the process that sorts multi-banded digital imagery into groups or clusters, which are statistically similar. If the selection of training clusters is performed manually, the classification is termed supervised. If the clustering is performed by a computer based on statistically derived classes, the classification is termed unsupervised. The raw classified scene contained between 65 and 70 classes. A color table was constructed for the image utilizing statistical information derived from the individual bands. The color table was based on the reflectance values from bands 2, 3 and 4, which yielded a "false color" image. Water appeared cyan to deep blue, while vegetation appeared as shades of red. The raw classes were grouped into two classes: wet or dry. All pixels in the wet category were compared to the 1999 land-use classification to determine the land-use of the flooded acres. All pixels from the resultant map except the permanent water classes of the land-use classification were considered flooded.

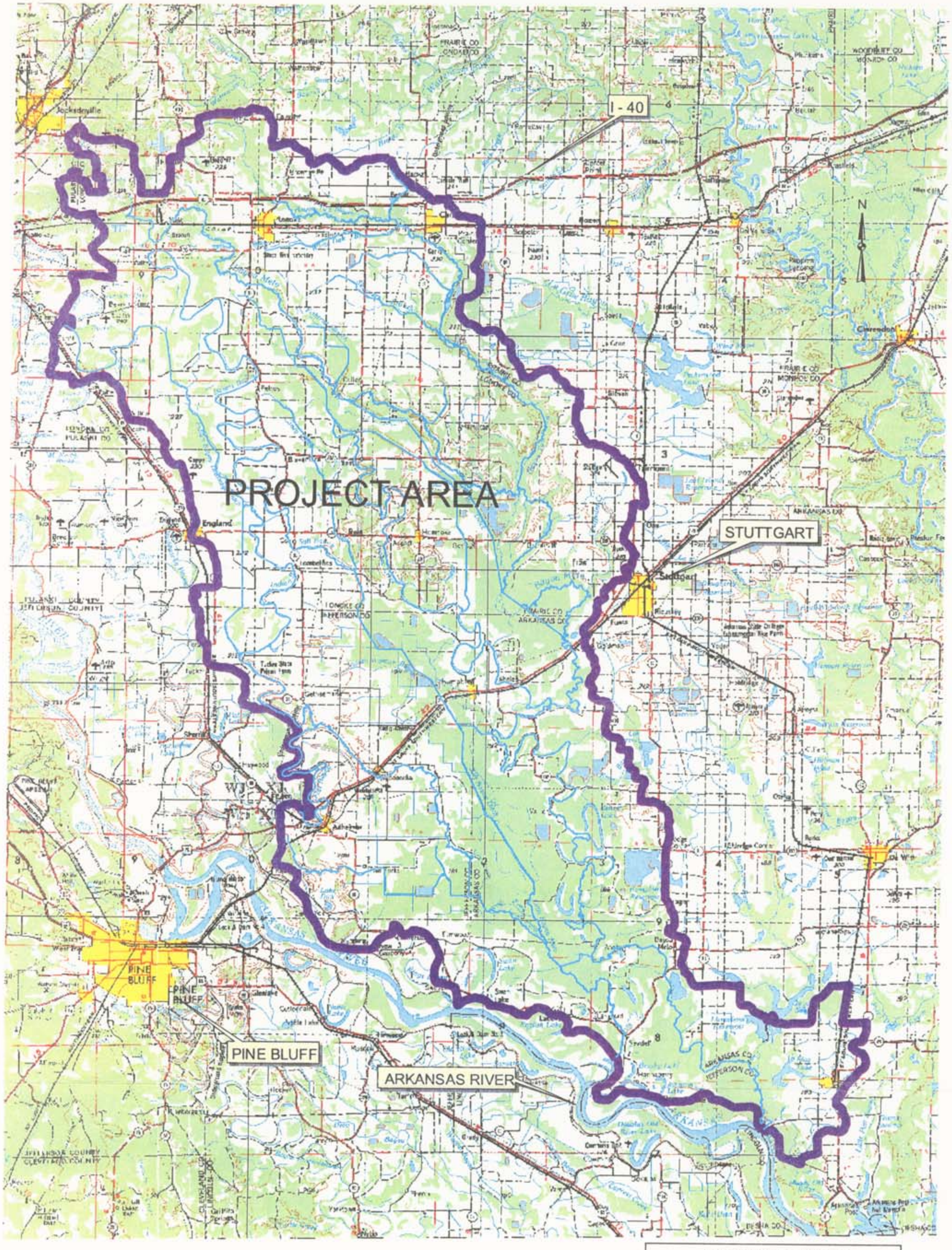
Verification of the flooded area could not be performed by on-site observations, because the flood scene represented a past event. Instead the classified flood scene was printed at 1:24,000 scale on clear vellum and sandwiched with a 1:24,000 scale quad map. The extent of flooding was compared to the flood elevations for that date and the elevation contours by visual comparison on a light table. The water surface at points along the river between gages was determined by linear interpolation.

The District's Regulatory Branch performed field verification of the wetland delineation. On-site techniques or visual verification using DRG maps with the flood scene superimposed on the quad map. Plate I-35 presents the 5% duration flood scene.

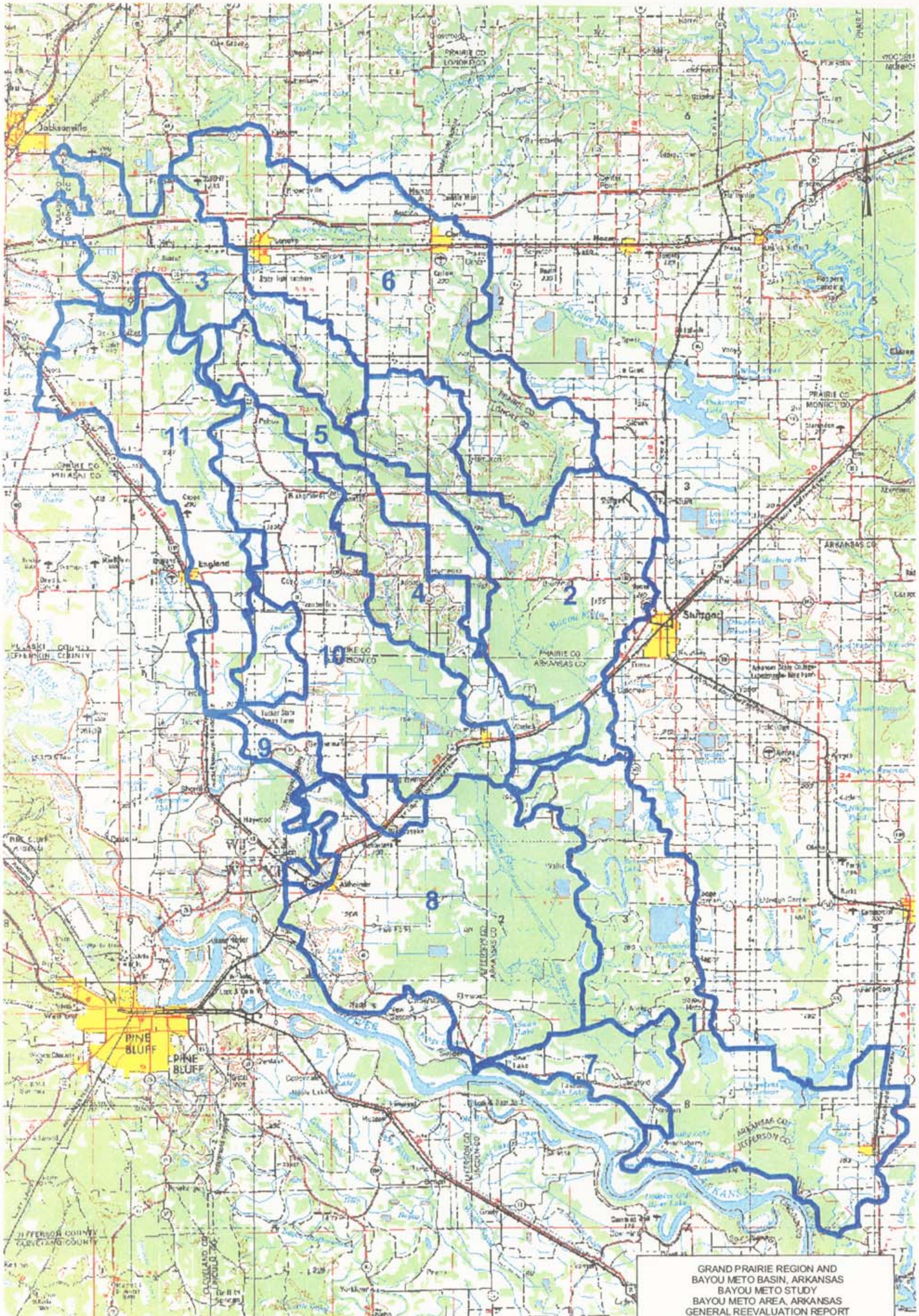
After the wetland delineation is field verified, the pre-project conditions are modeled with the FEAT extension to ArcView 3.x. The model is first run to simulate a flood-scene such as the 23 Mar 97 scene. Water surface elevations at points between the gages will be adjusted to best simulate the aerial extent of the satellite image. The model is then verified against a second flood scene. Once the model is calibrated and verified, it can be used to simulate the pre- and post-project 5% wetland extent. The landuse of the flooded areas under the two conditions are compared to determine the indirect impacts to wetlands due to the project. The pre/post project 1, 10 and 100-year events are presented in Plates I-36, I-37 and I-38, respectively.

I-16. NAVIGATION. None of the alternative plans considered for this study will impact navigation of the existing Arkansas River system.

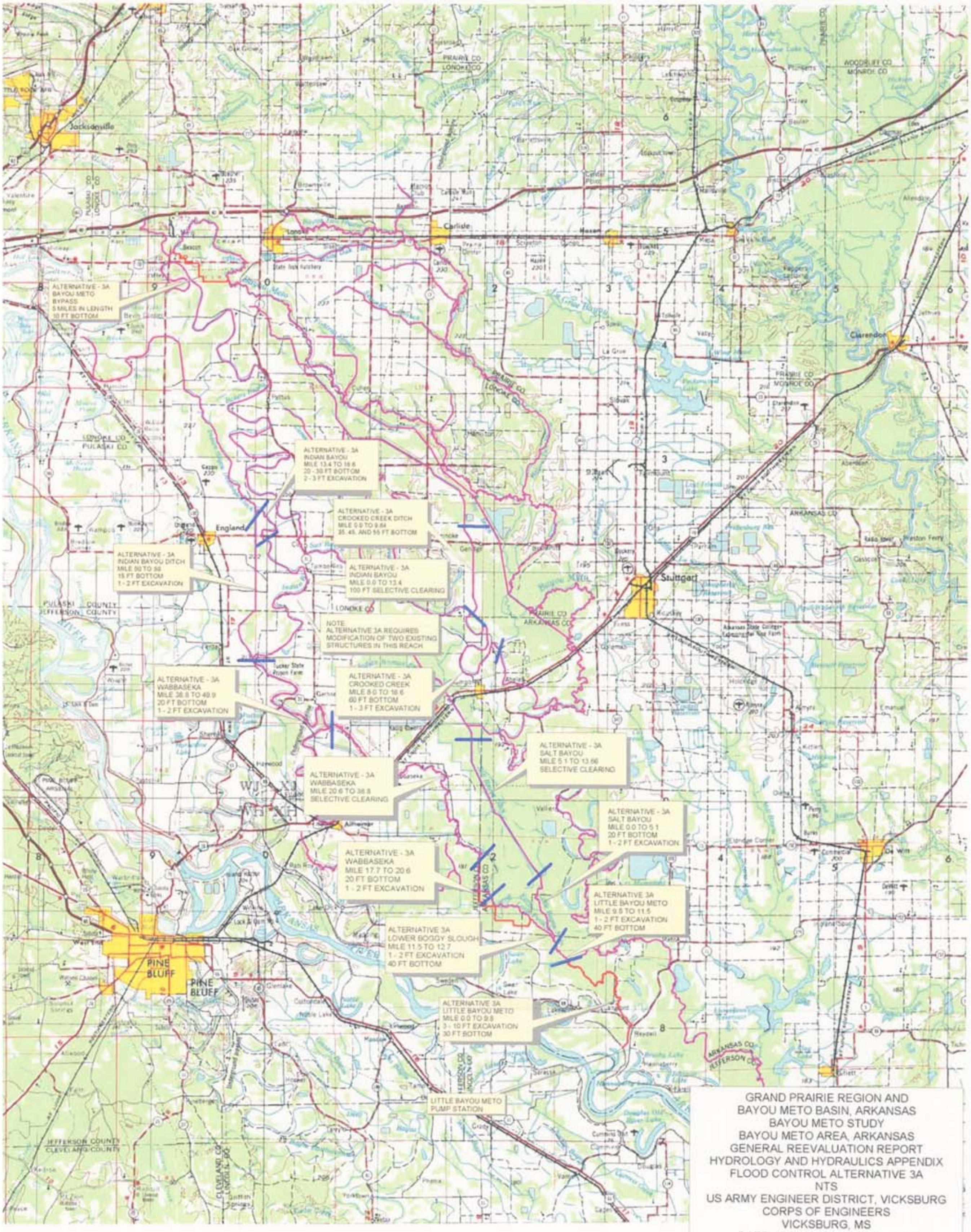
I-17. SEDIMENTATION. Sediments transported by streams in the Bayou Meto Basin consist primarily of fine silt and clay particles that are carried in suspension. Based upon the nature of the sediment load and past experience in the area, no sediment related problems are expected.



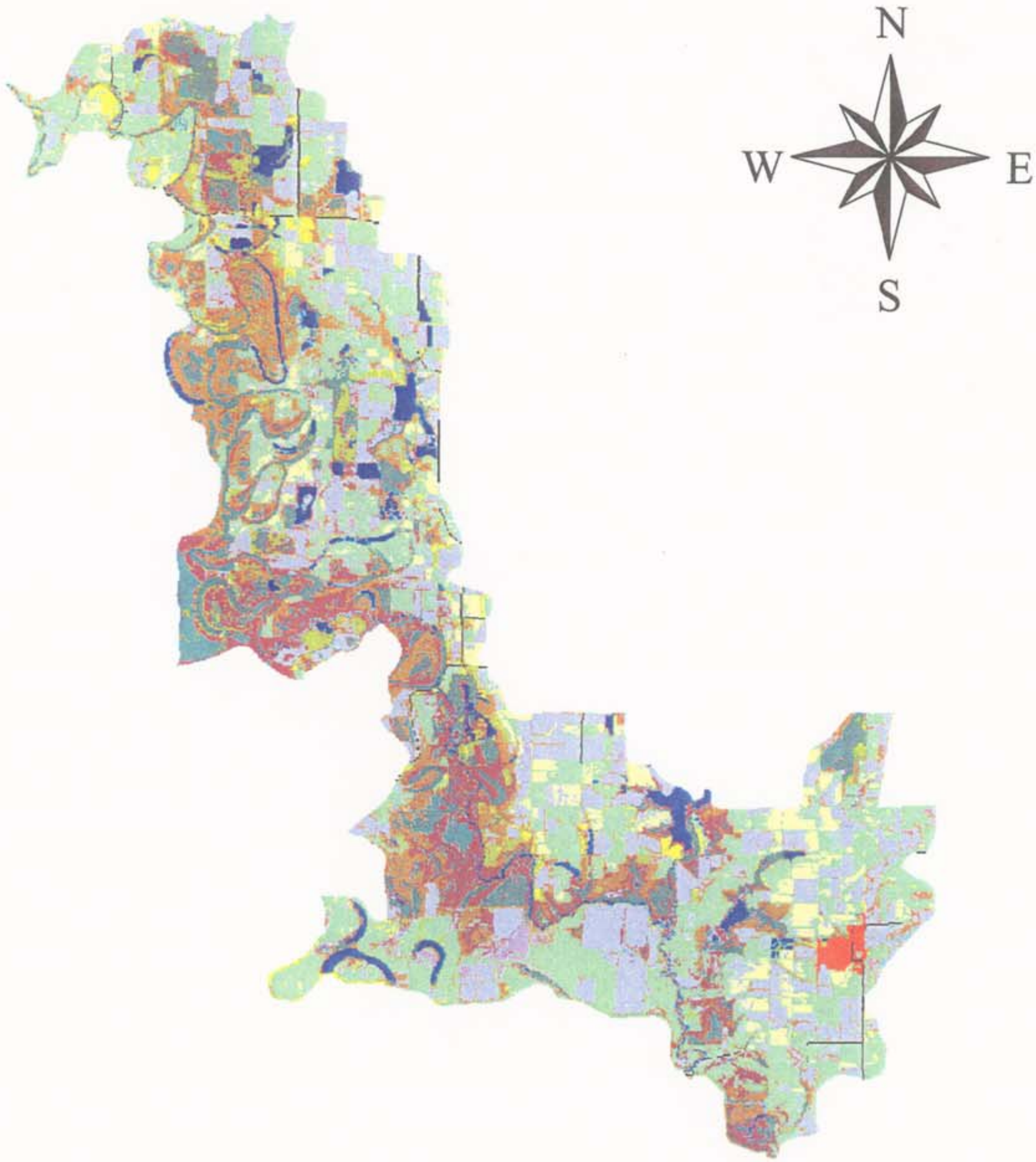
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
PROJECT AREA
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 01



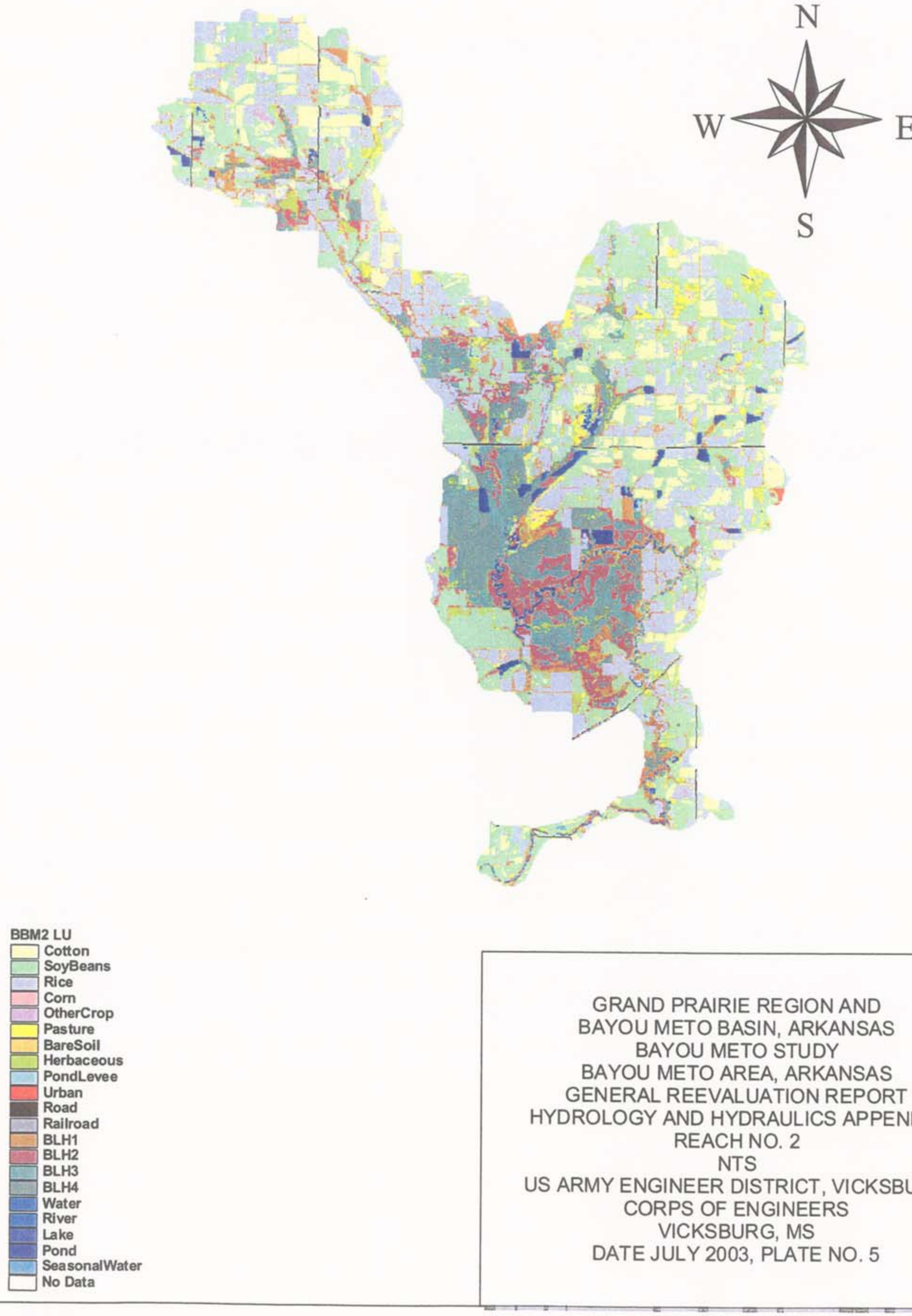
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
HYDROLOGIC REACHES
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 02



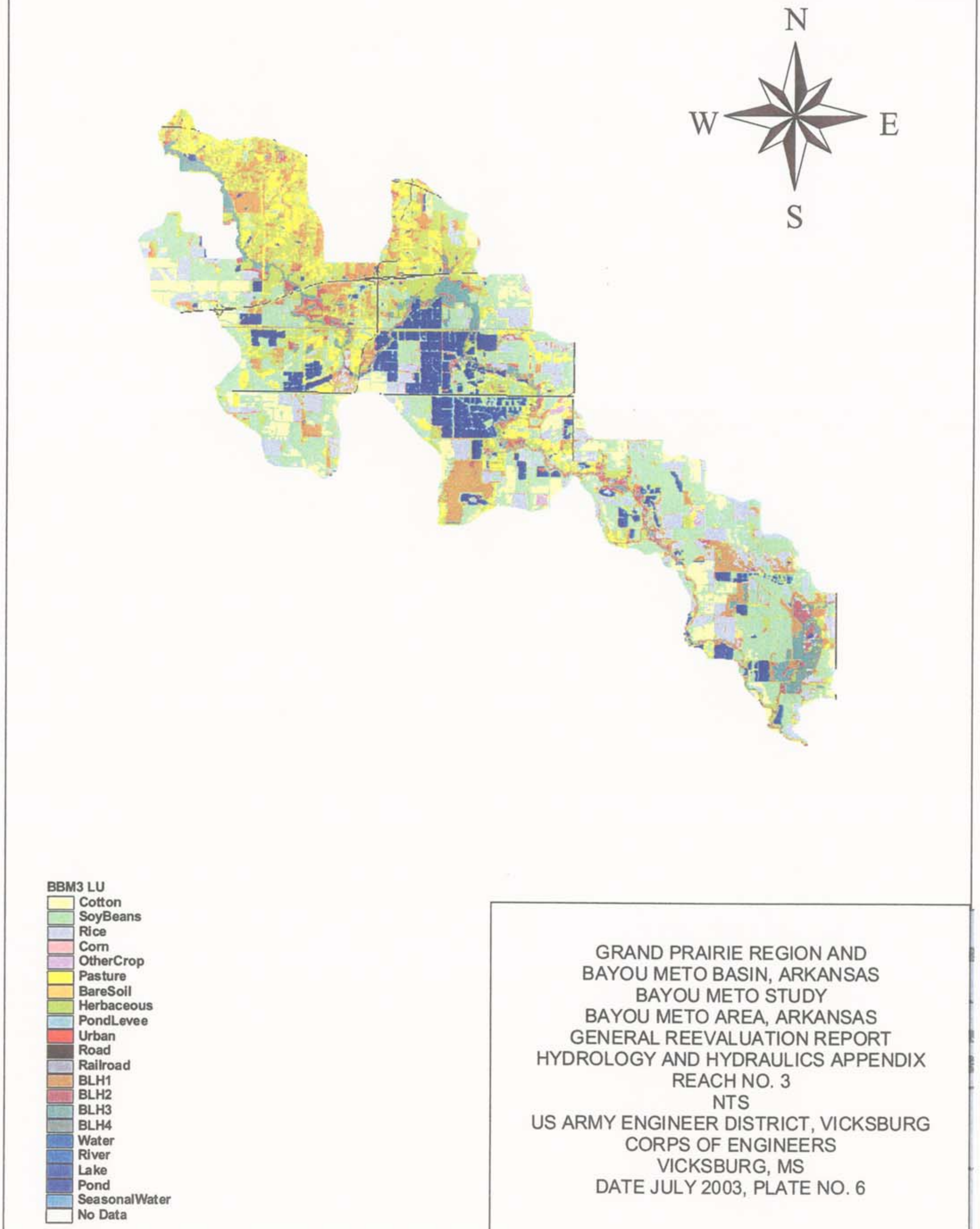
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL ALTERNATIVE 3A
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I -03



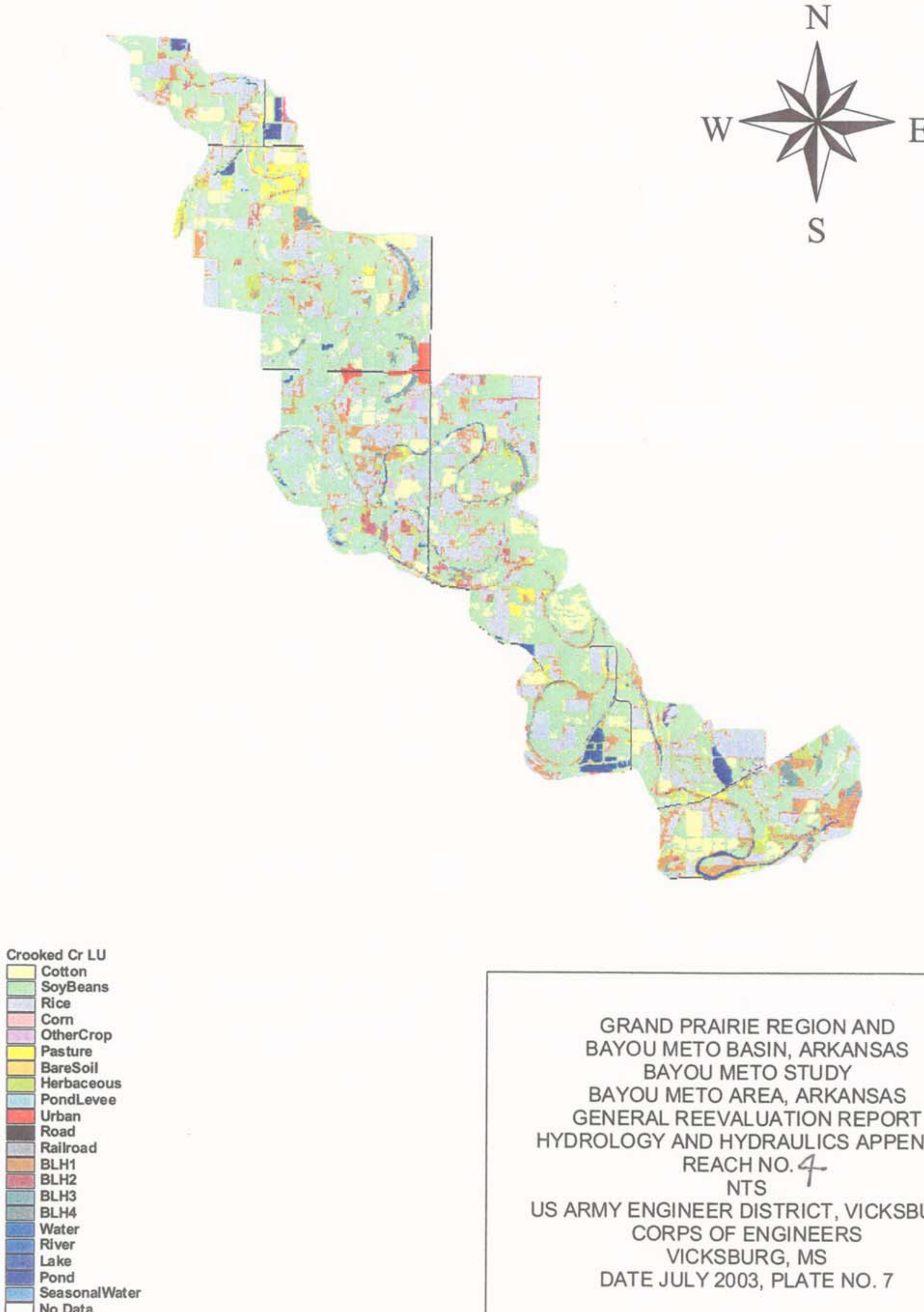
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 1
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 4



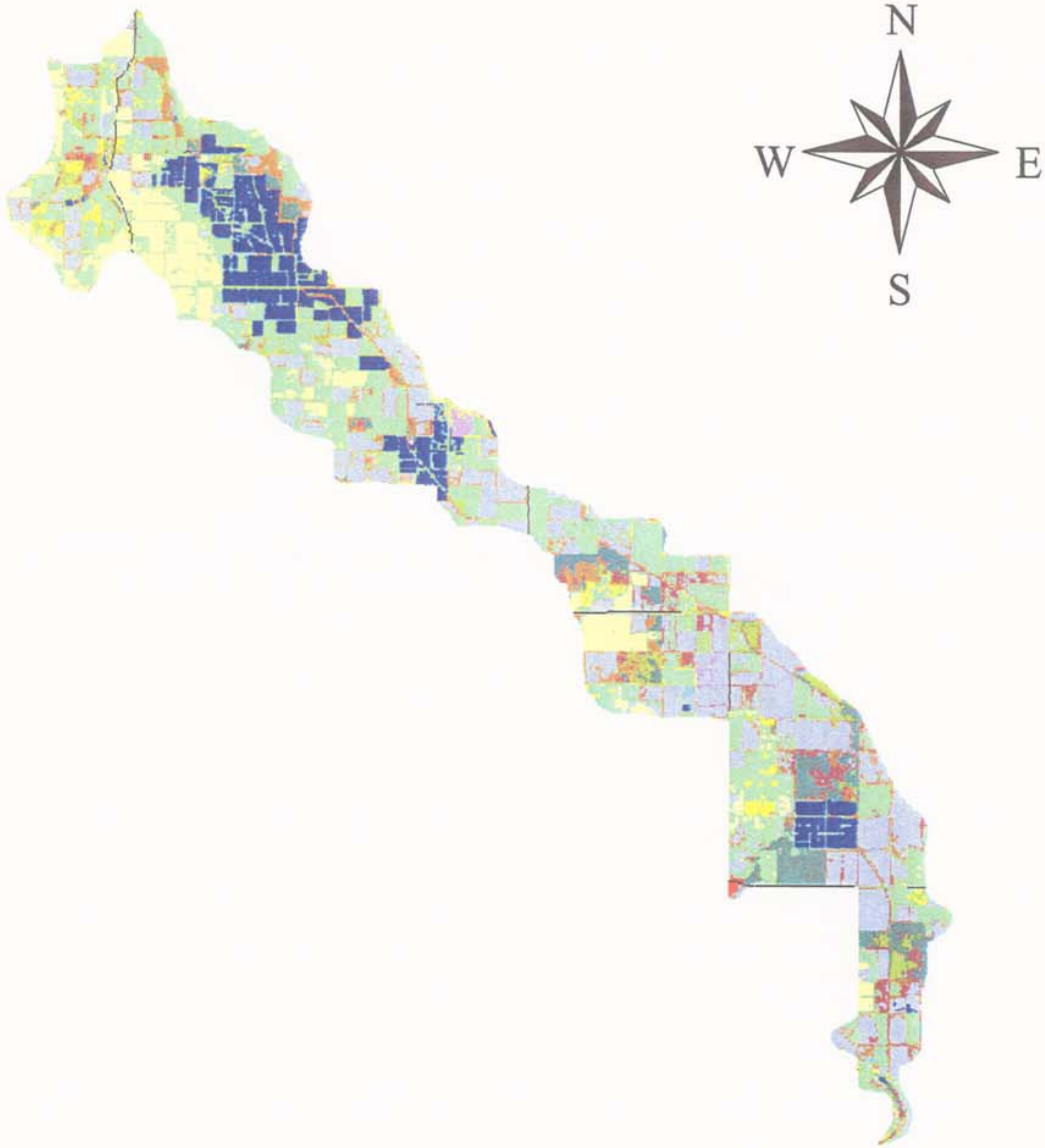
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 2
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 5



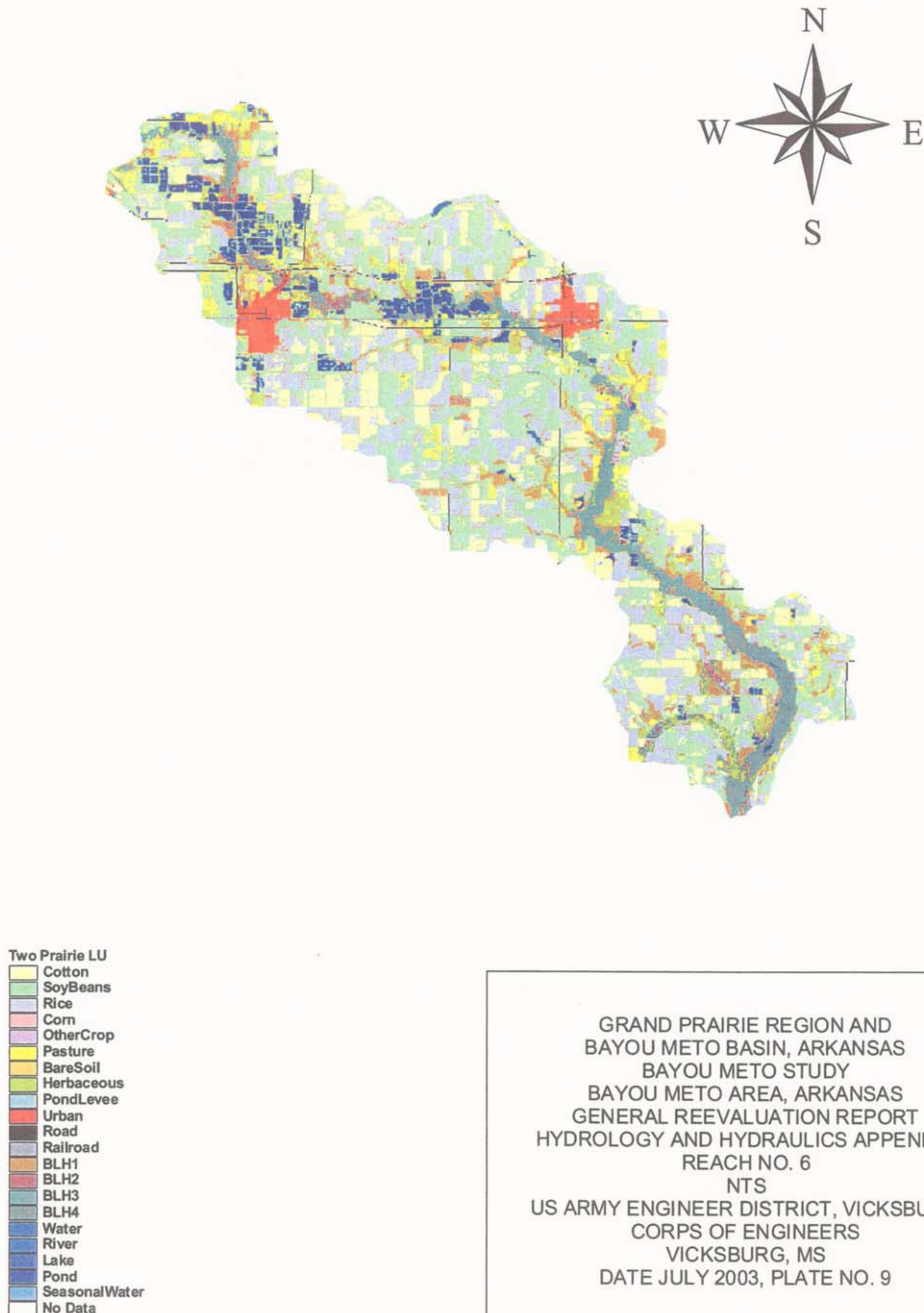
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 3
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 6



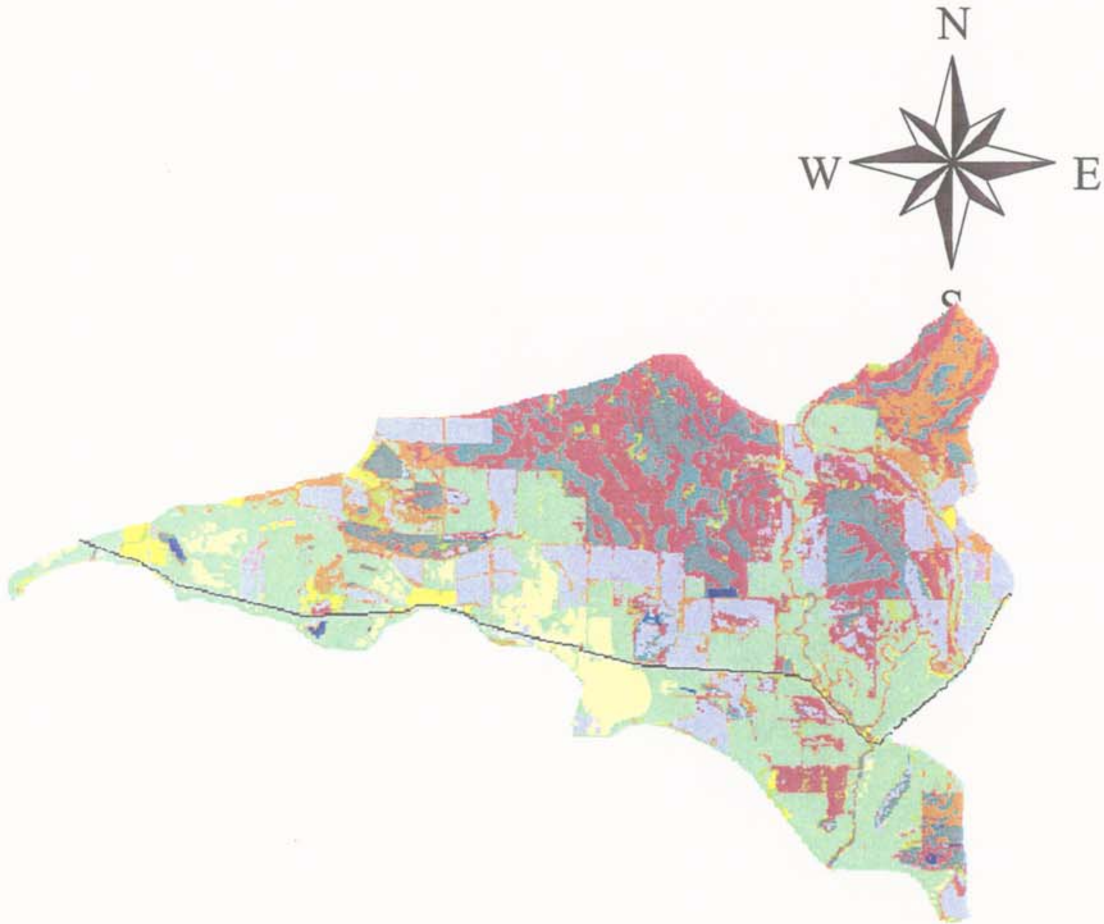
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 4
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 7



GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 5
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 8



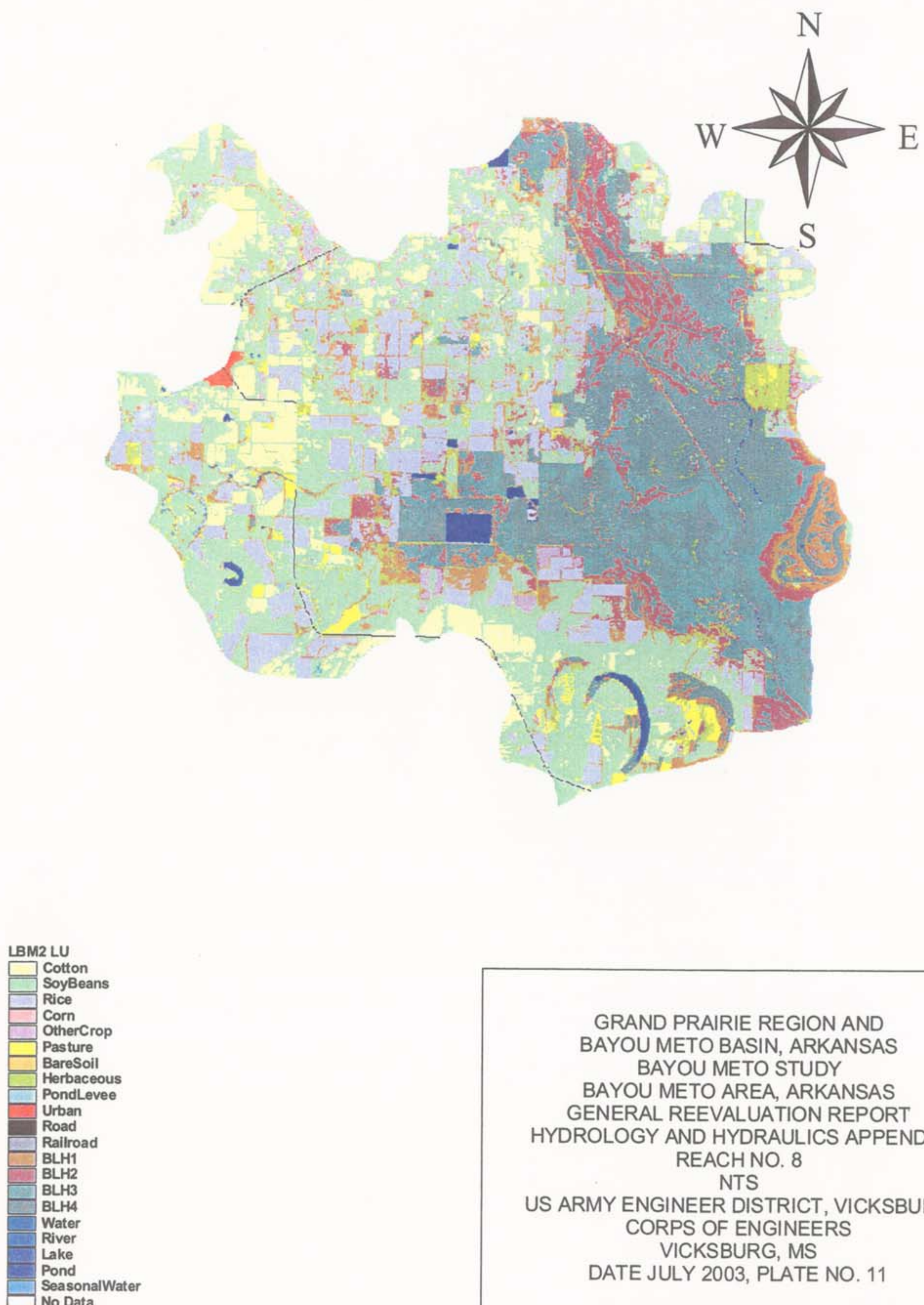
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 6
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 9



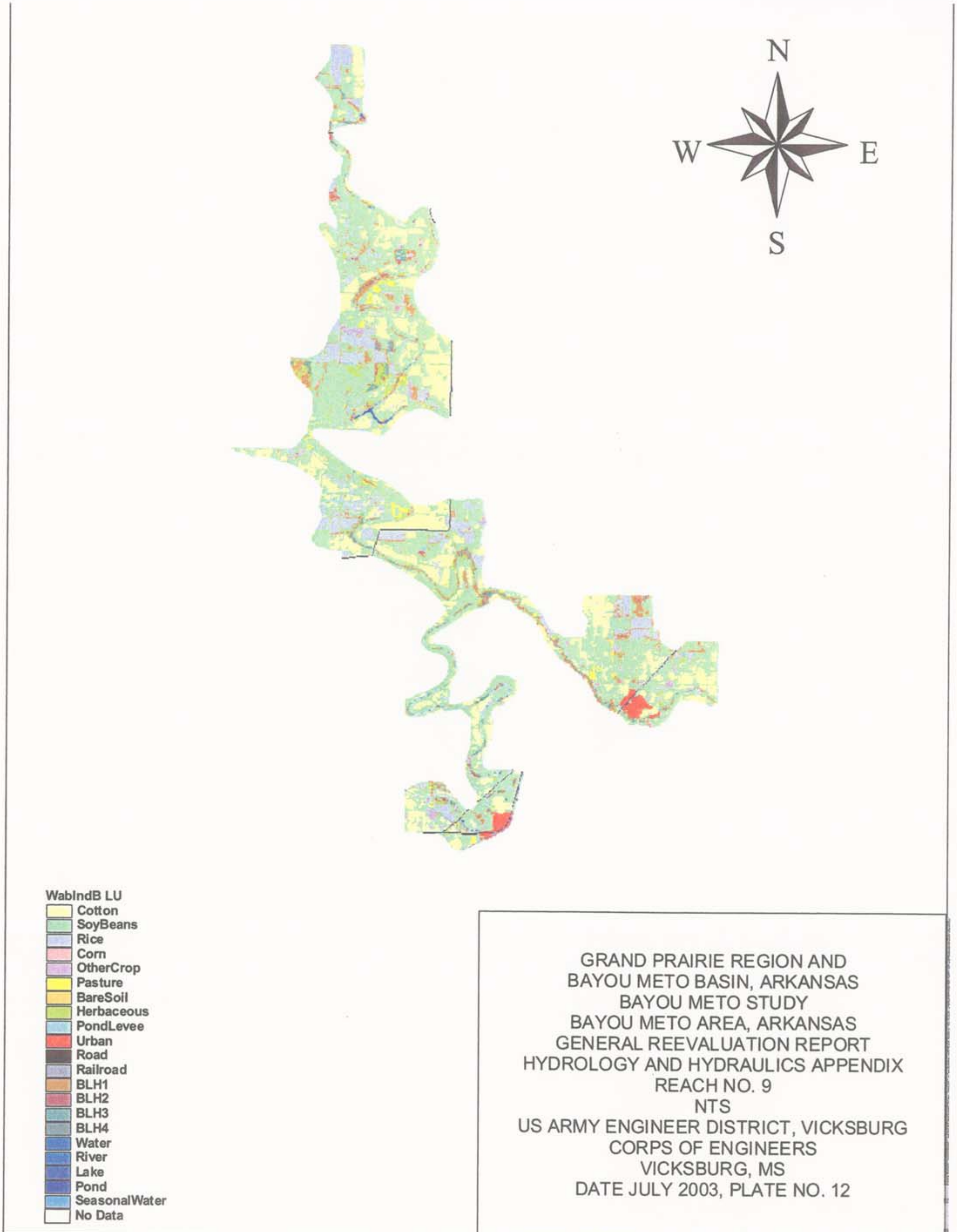
LBM1 LU

- Cotton
- SoyBeans
- Rice
- Corn
- OtherCrop
- Pasture
- BareSoil
- Herbaceous
- PondLevee
- Urban
- Road
- Railroad
- BLH1
- BLH2
- BLH3
- BLH4
- Water
- River
- Lake
- Pond
- SeasonalWater
- No Data

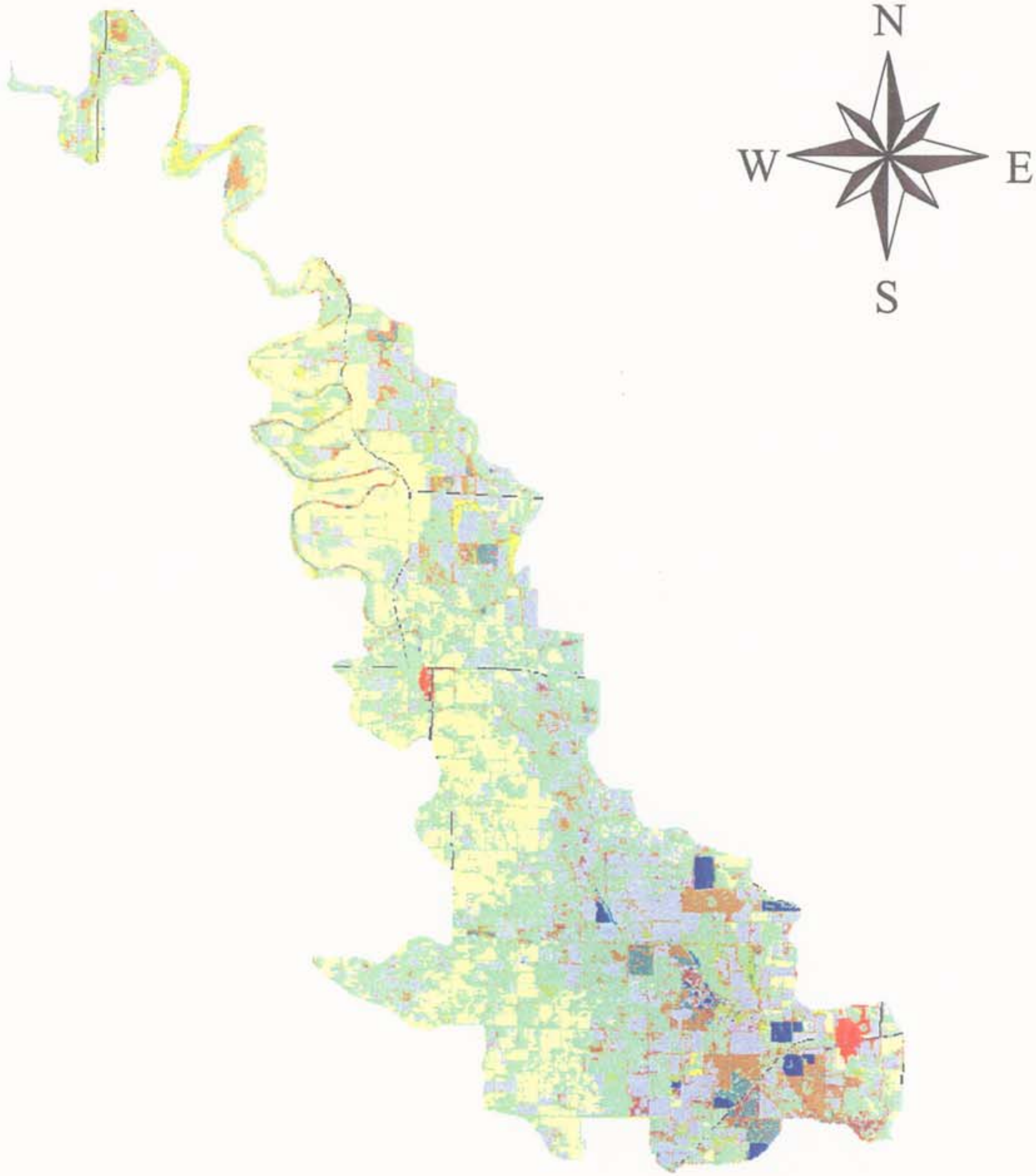
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 7
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 10



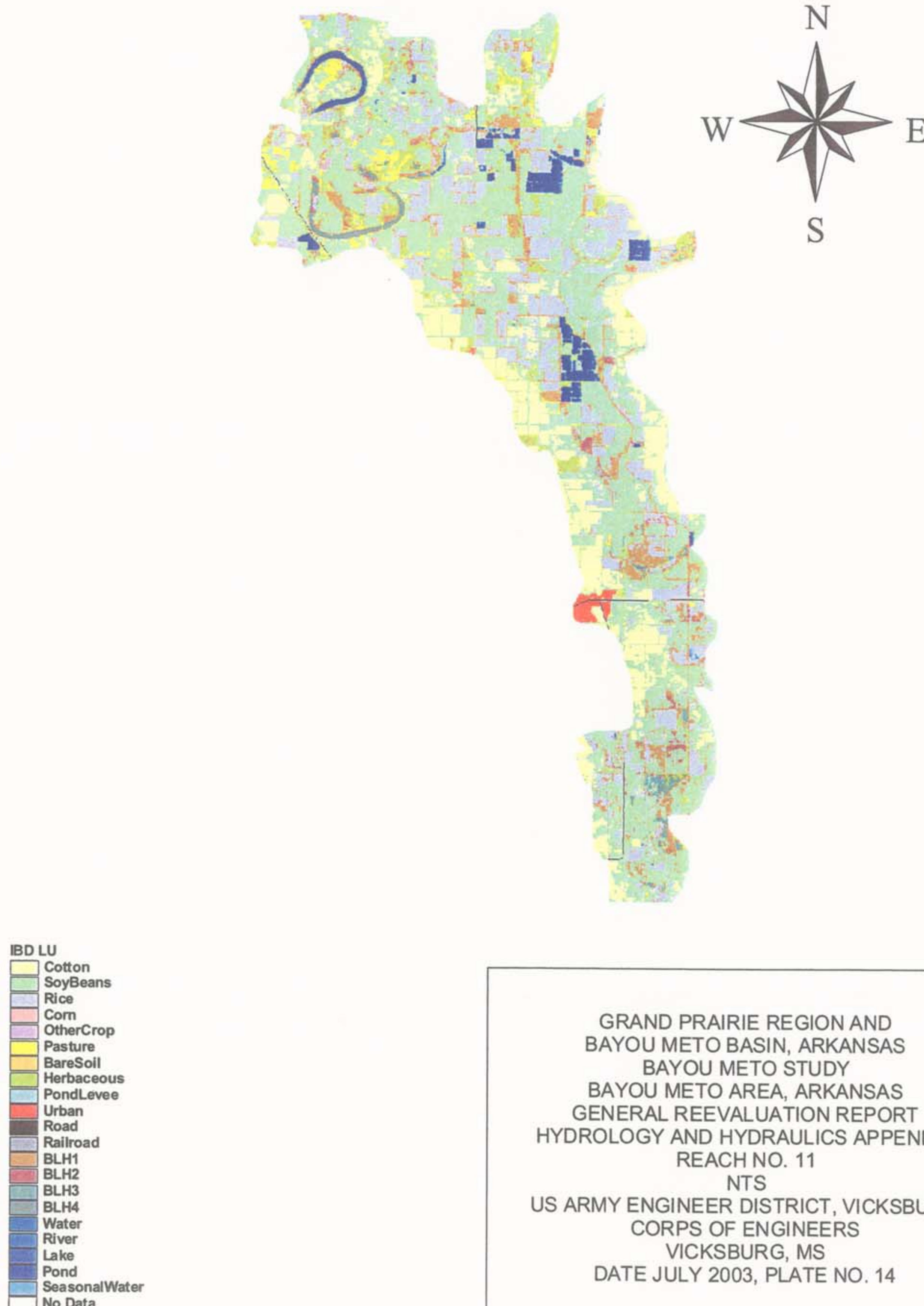
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 8
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 11



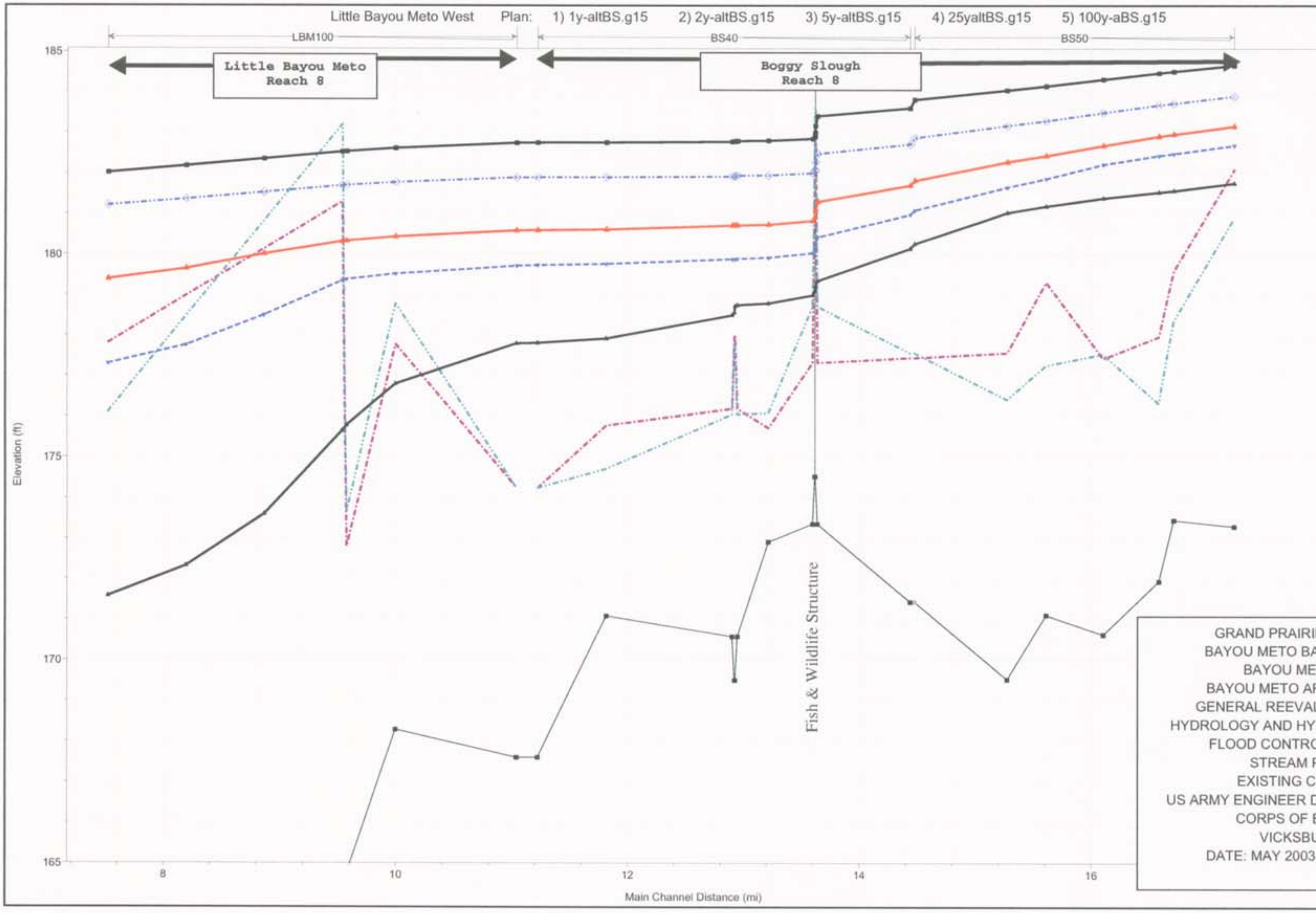
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 9
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 12



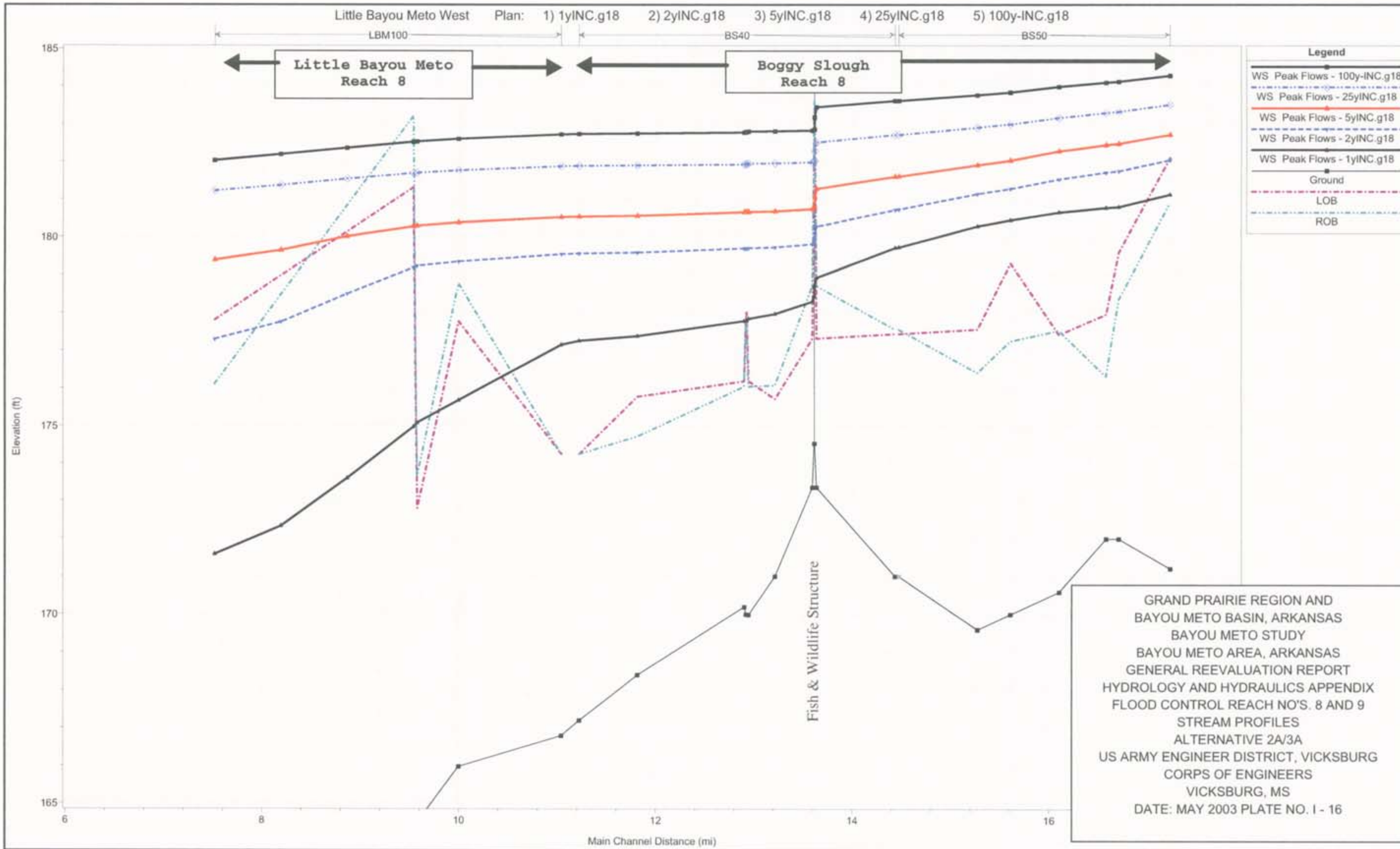
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 10
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 13



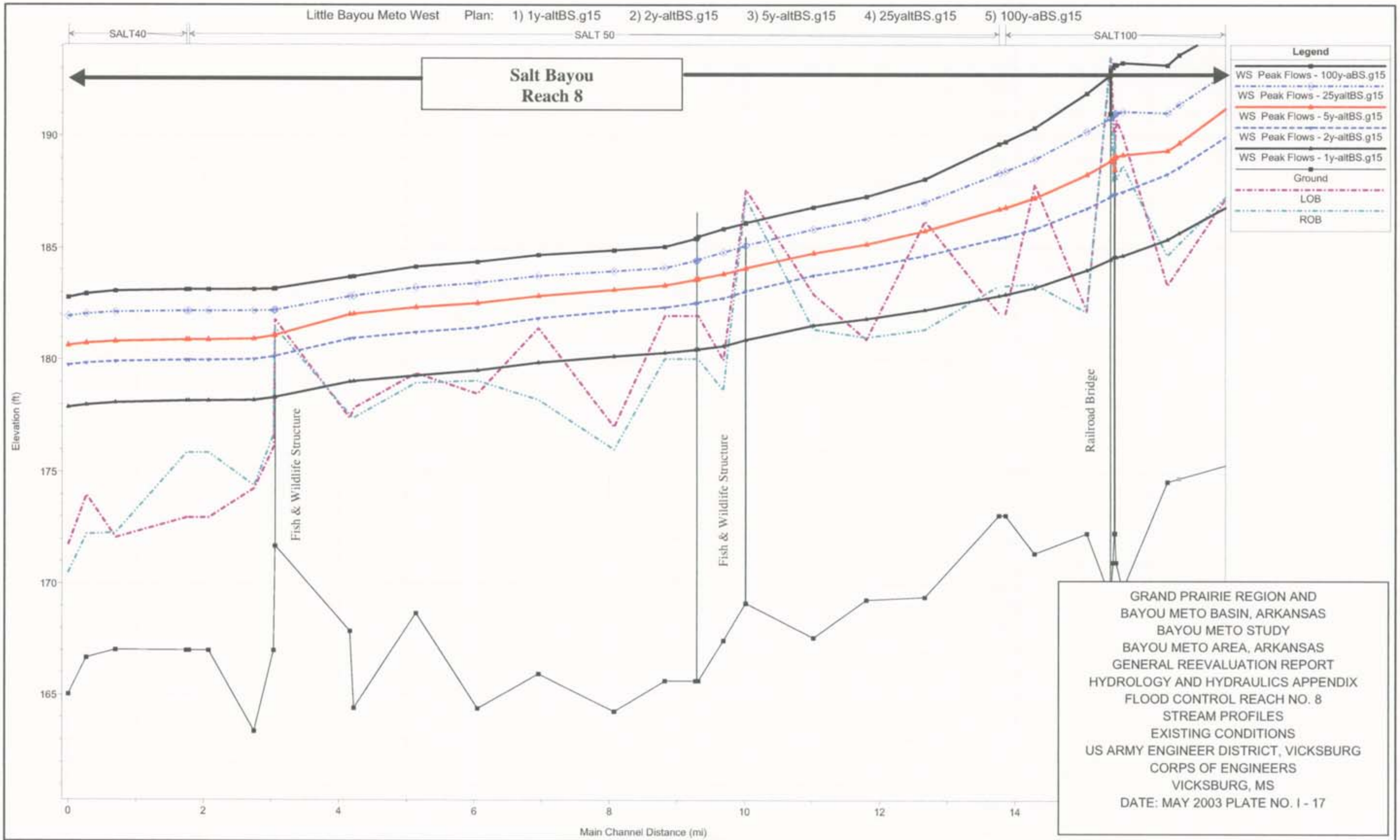
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NO. 11
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE JULY 2003, PLATE NO. 14



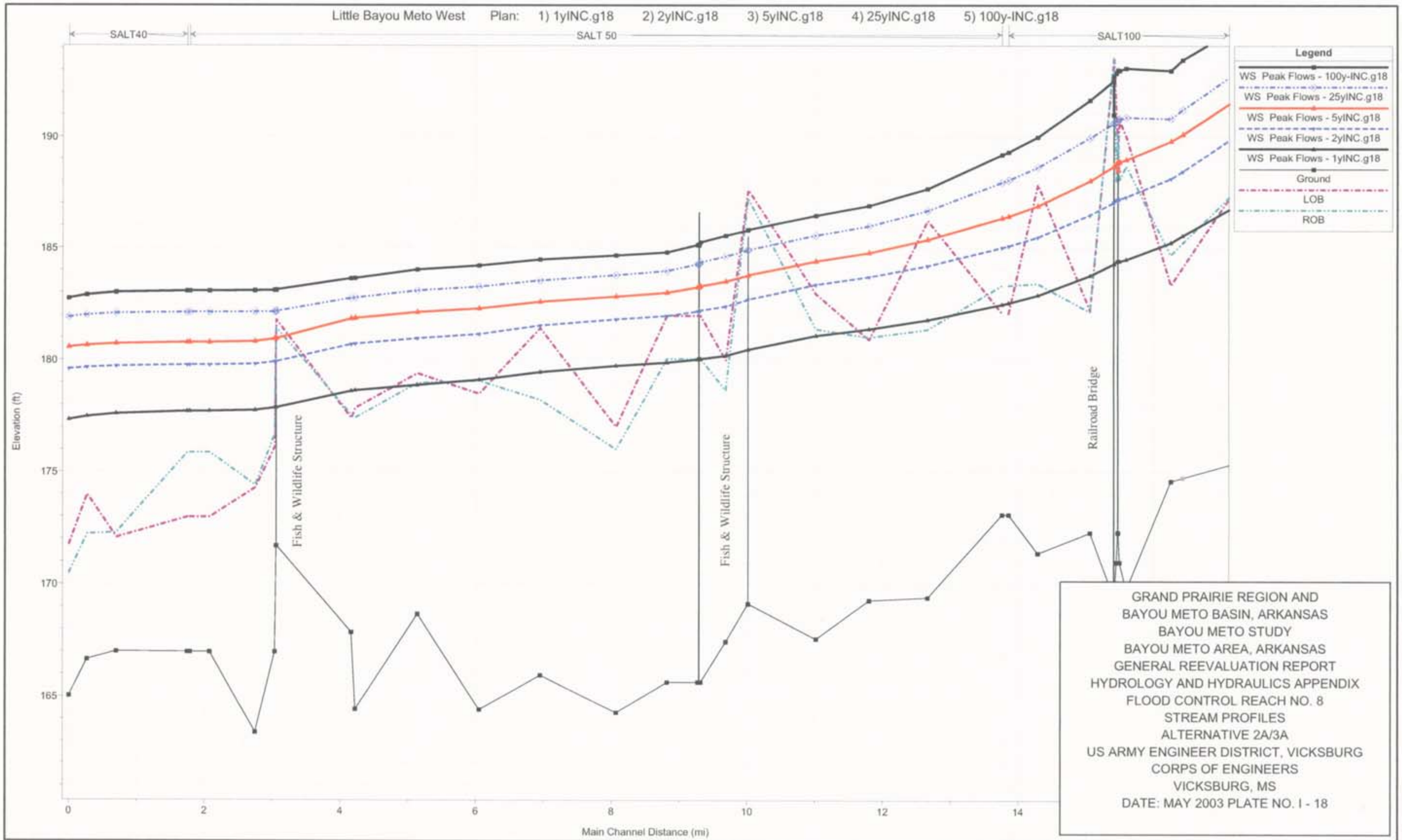
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 8
STREAM PROFILES
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I -15



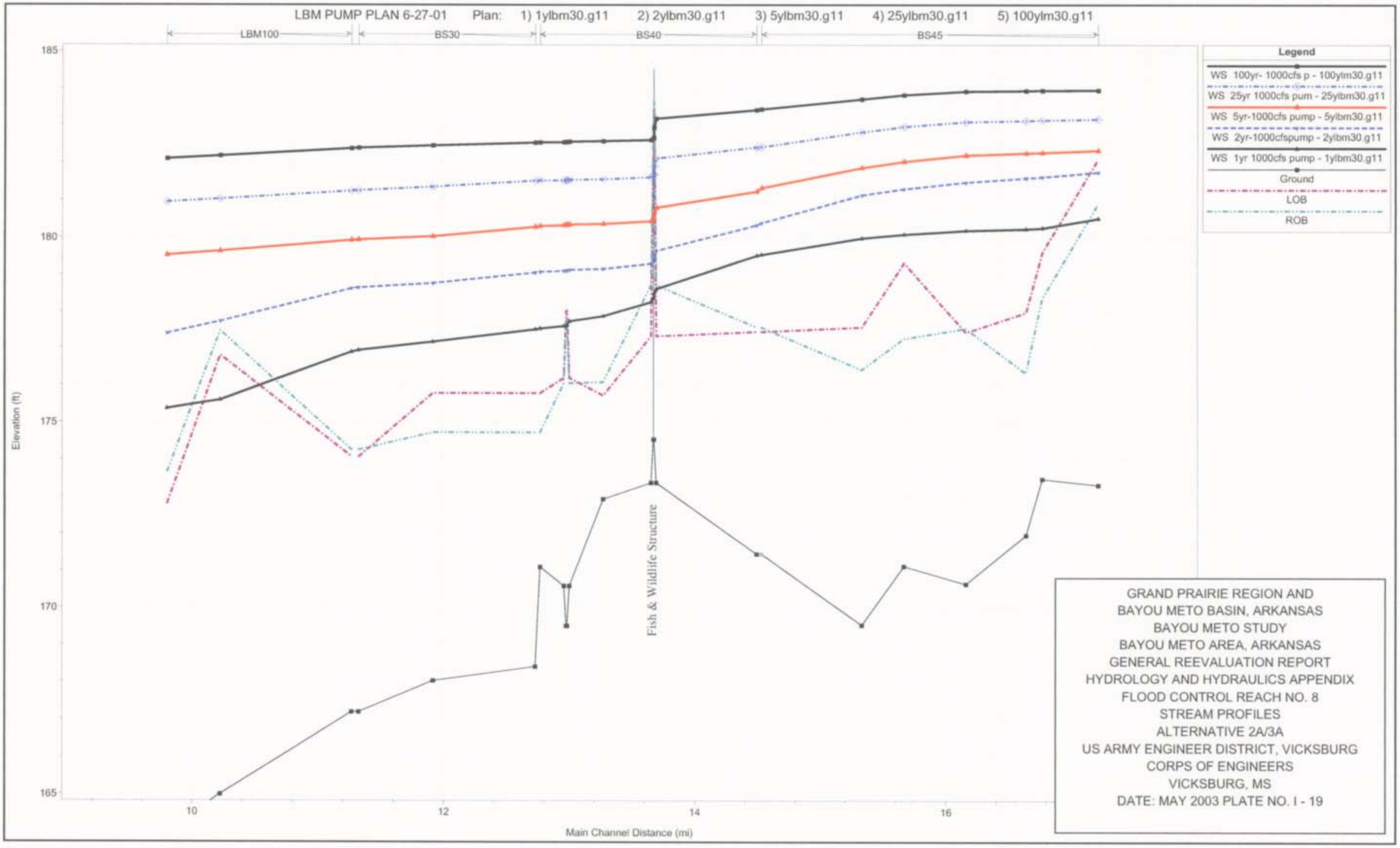
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO'S. 8 AND 9
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 16



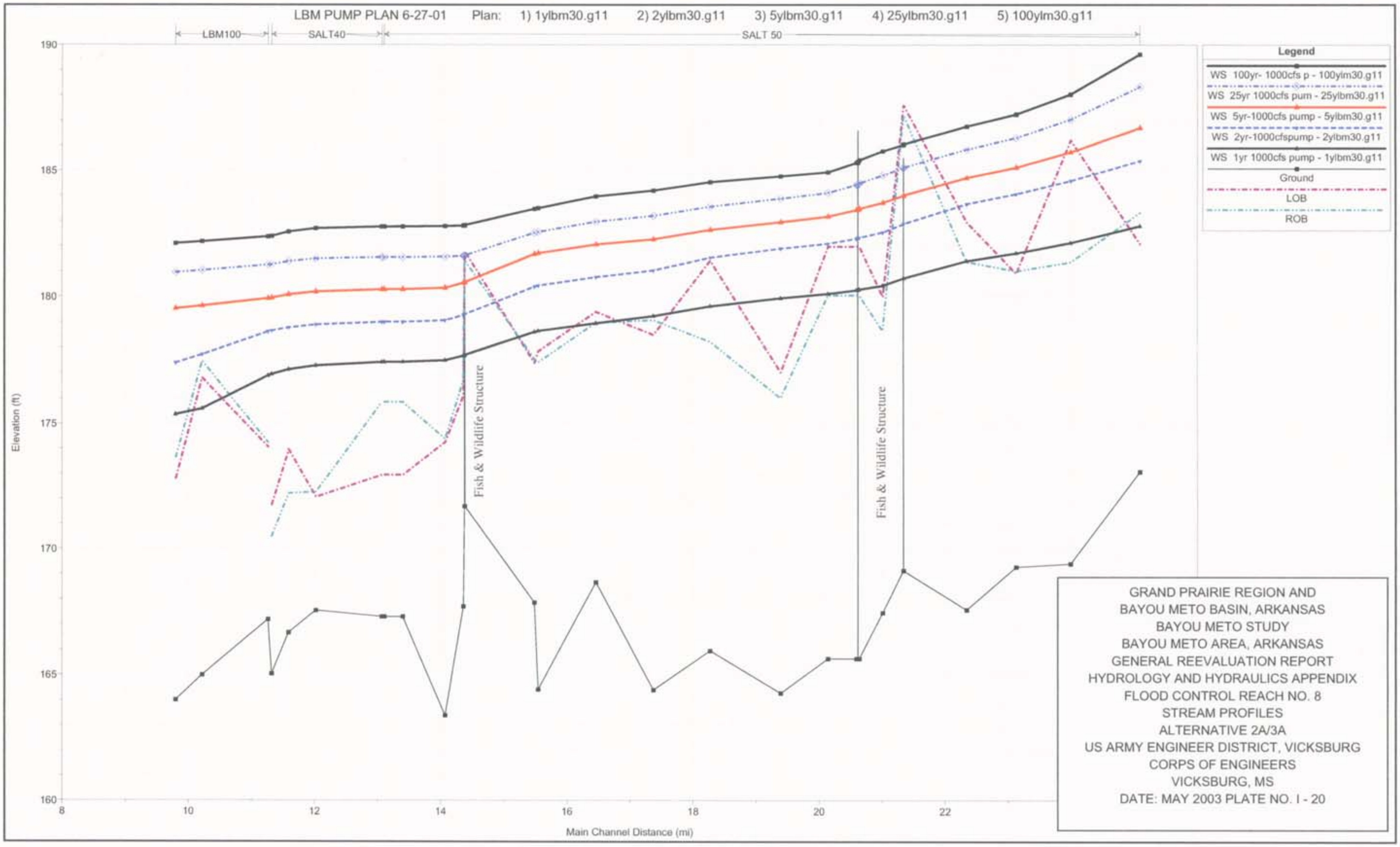
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 8
STREAM PROFILES
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 17



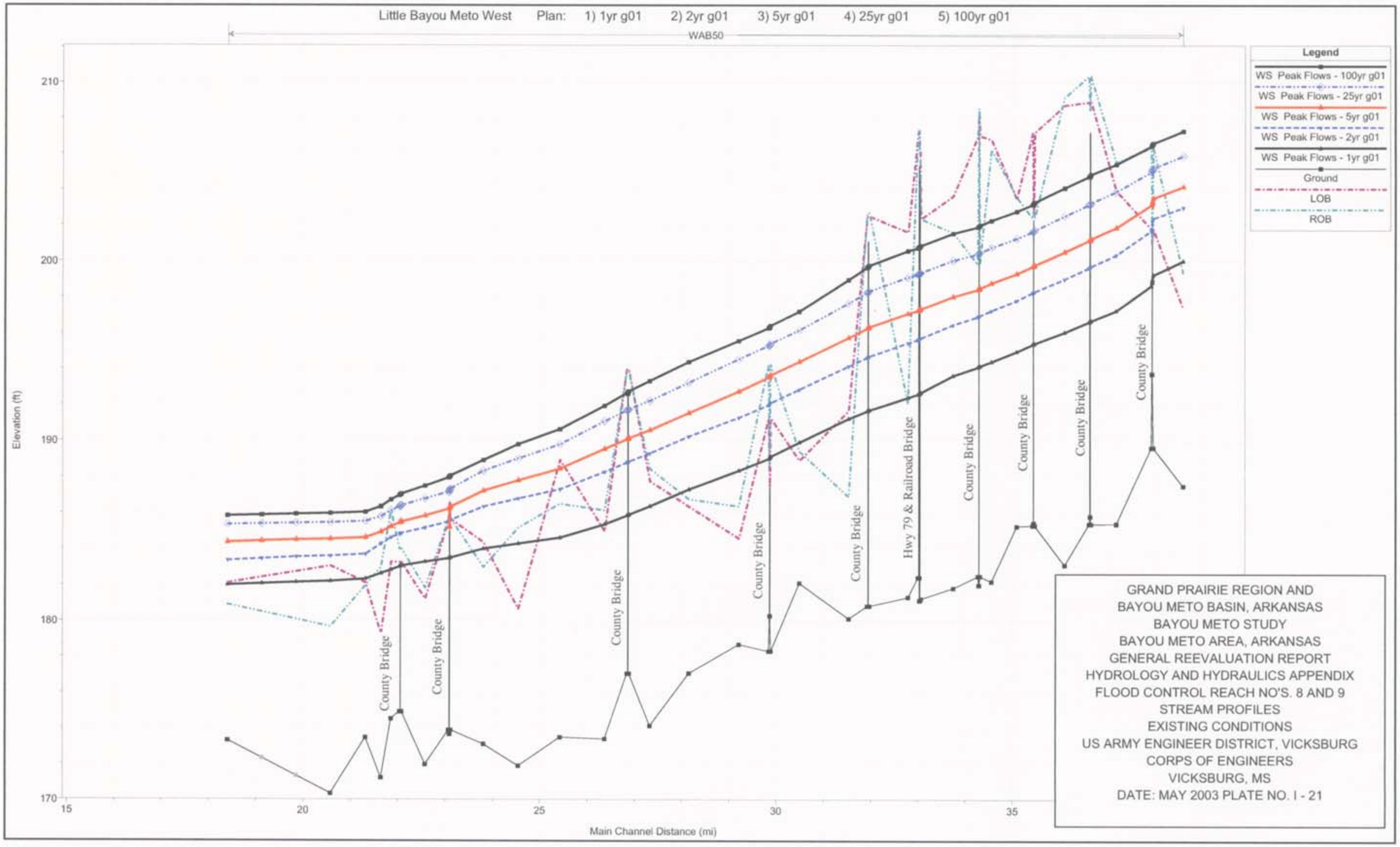
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 8
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 18



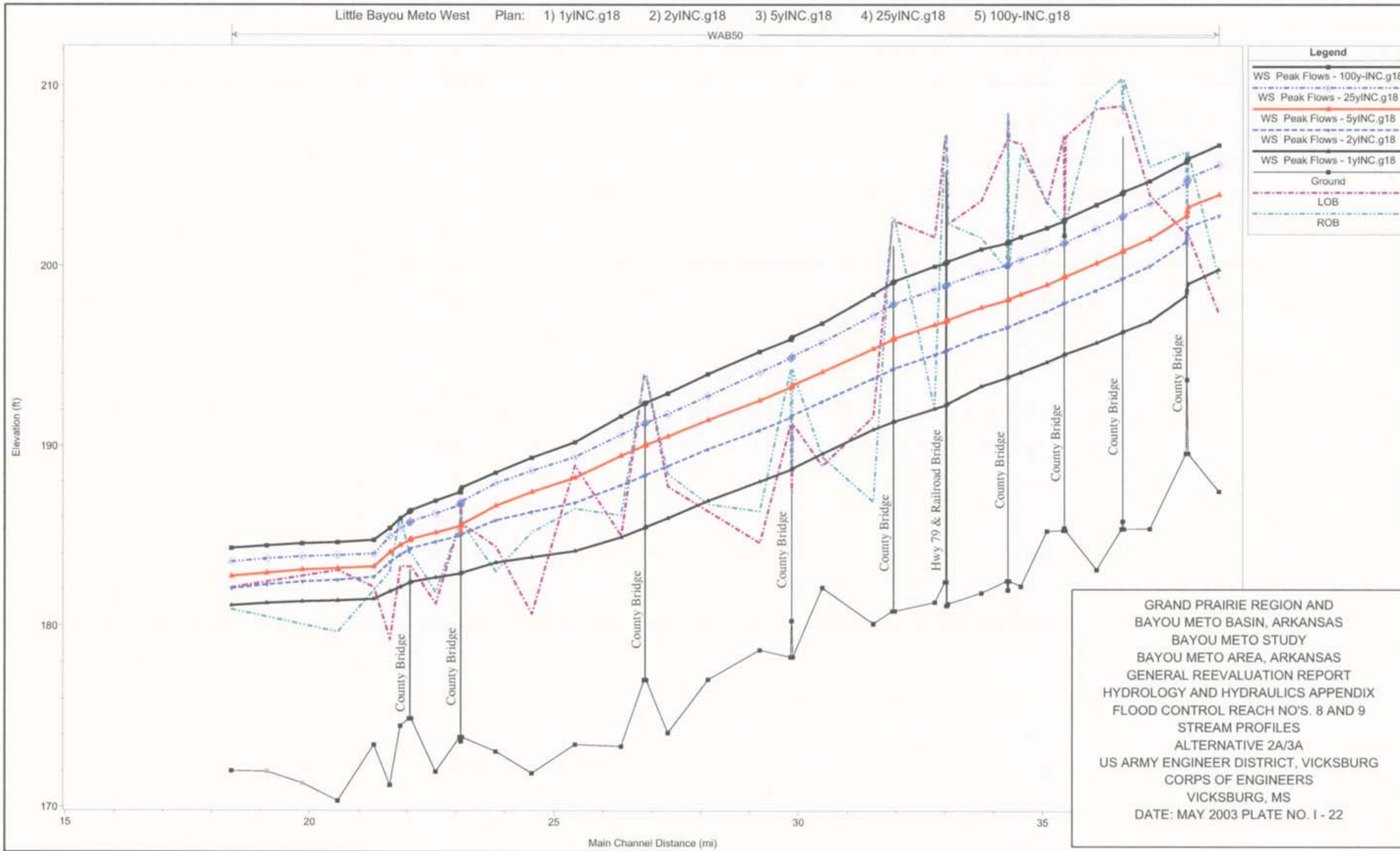
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 8
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 19



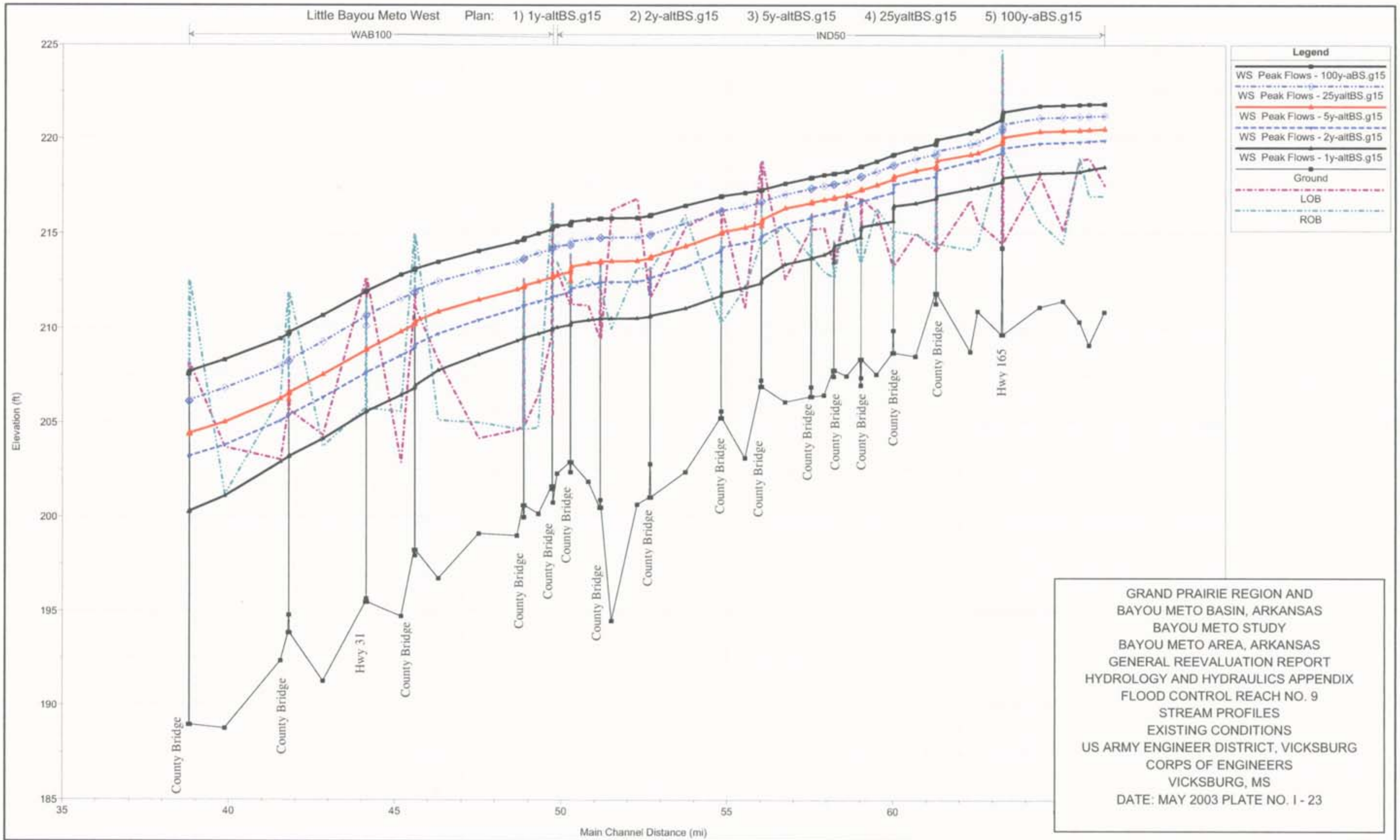
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 8
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 20



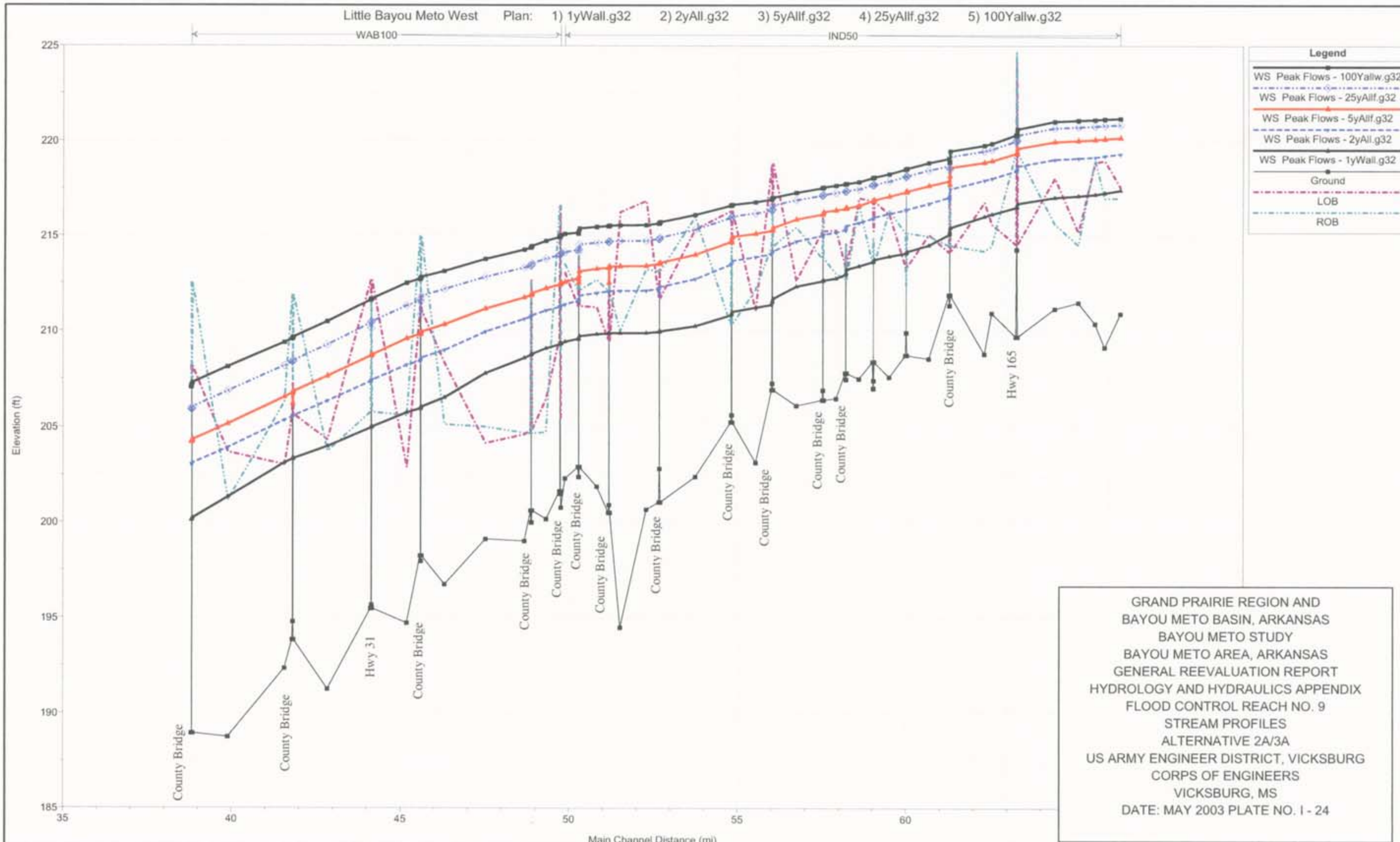
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO'S. 8 AND 9
STREAM PROFILES
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 21



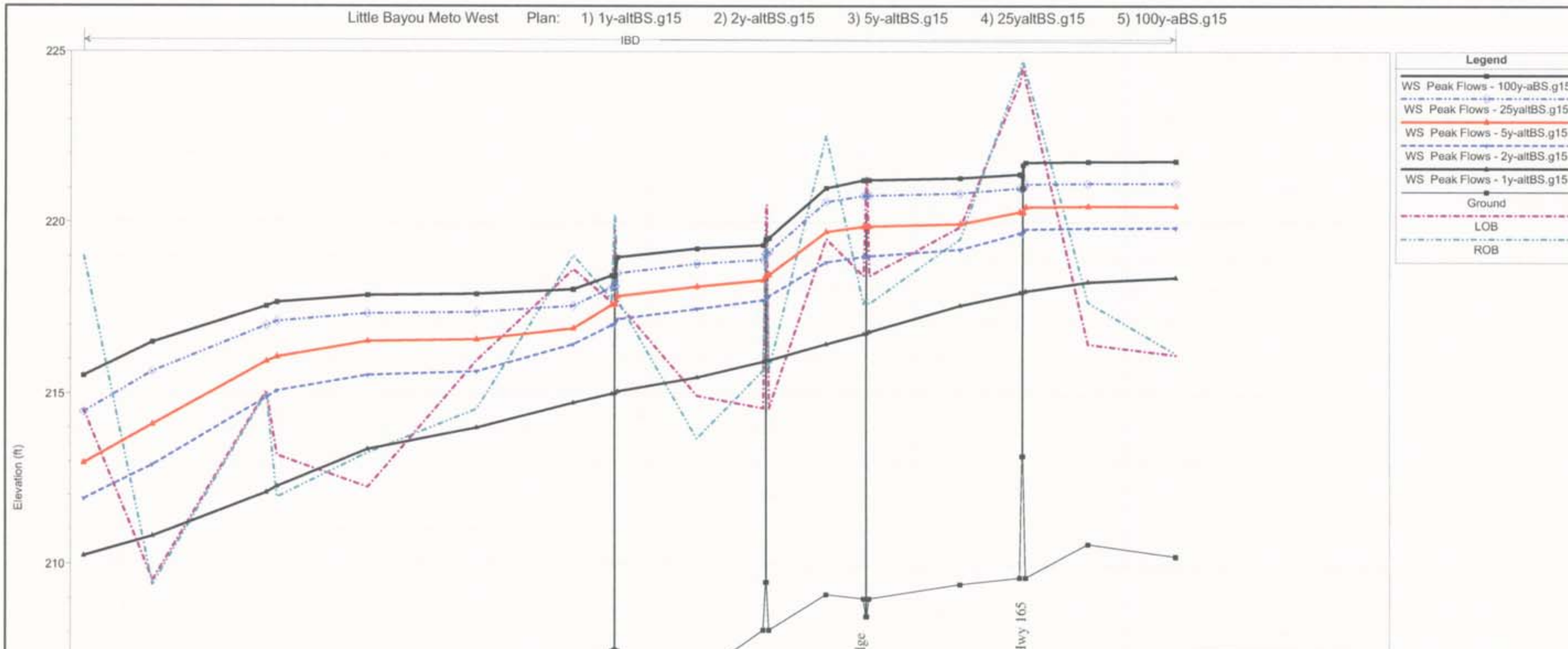
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO'S. 8 AND 9
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 22



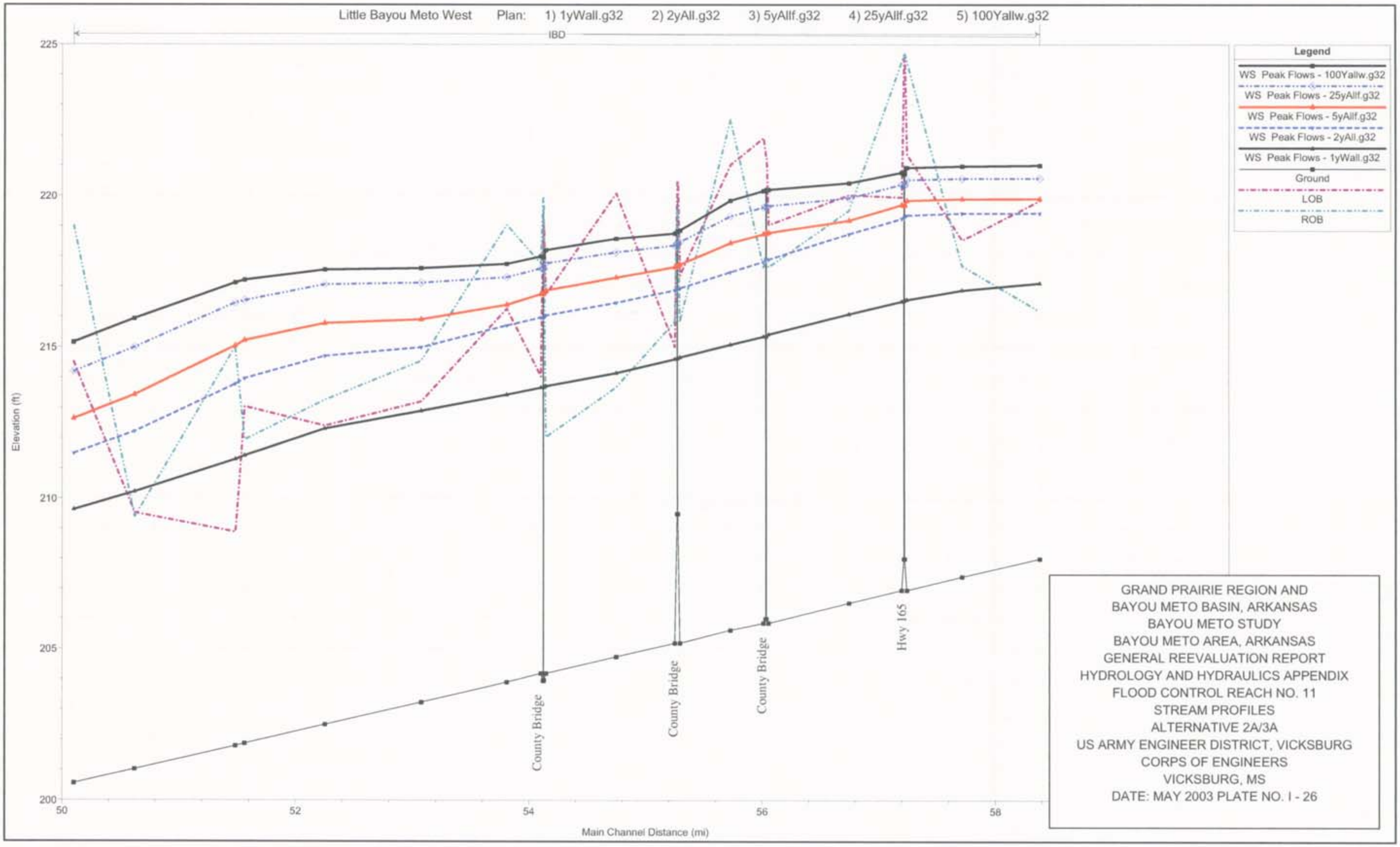
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 9
STREAM PROFILES
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 23



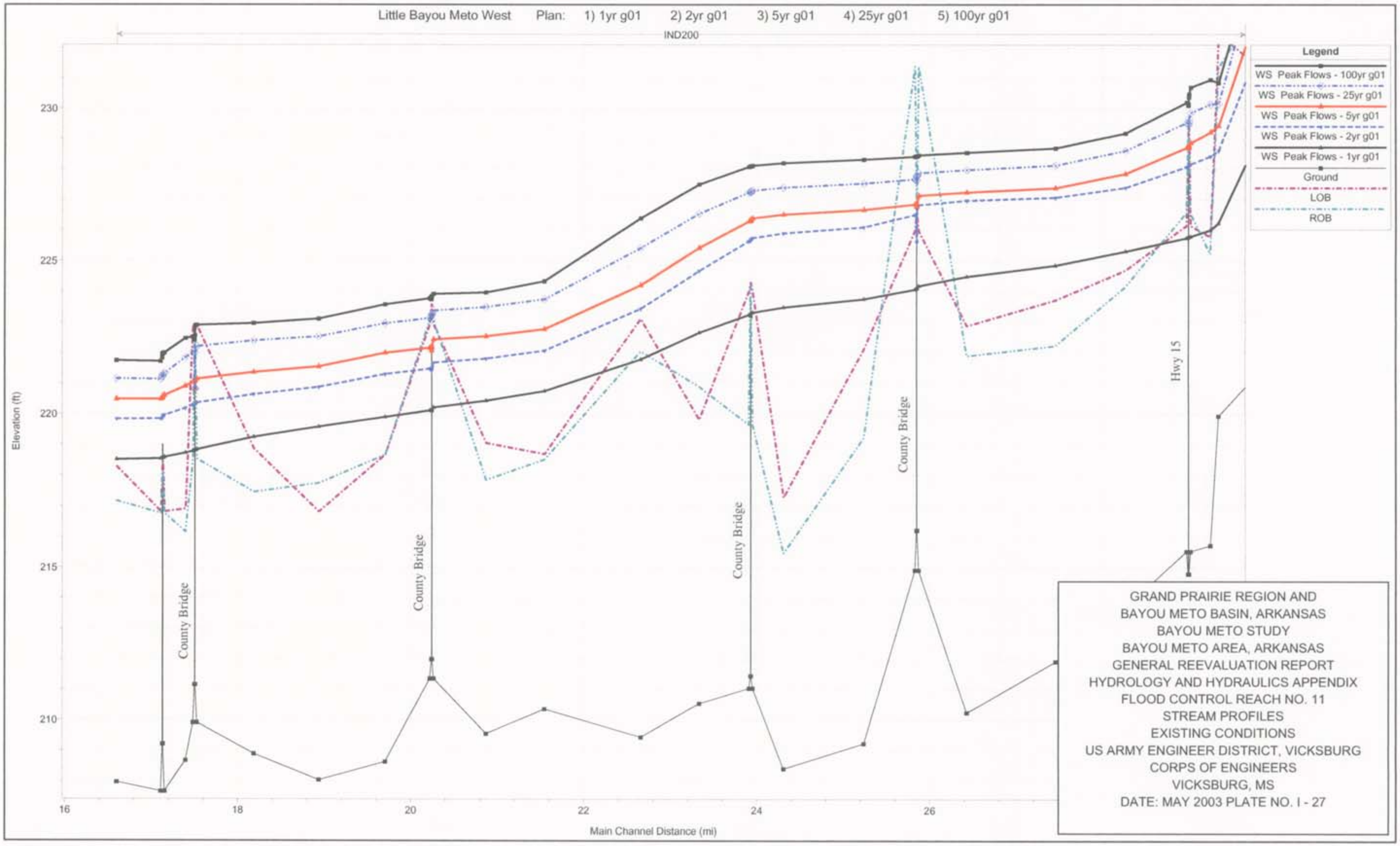
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 9
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 24



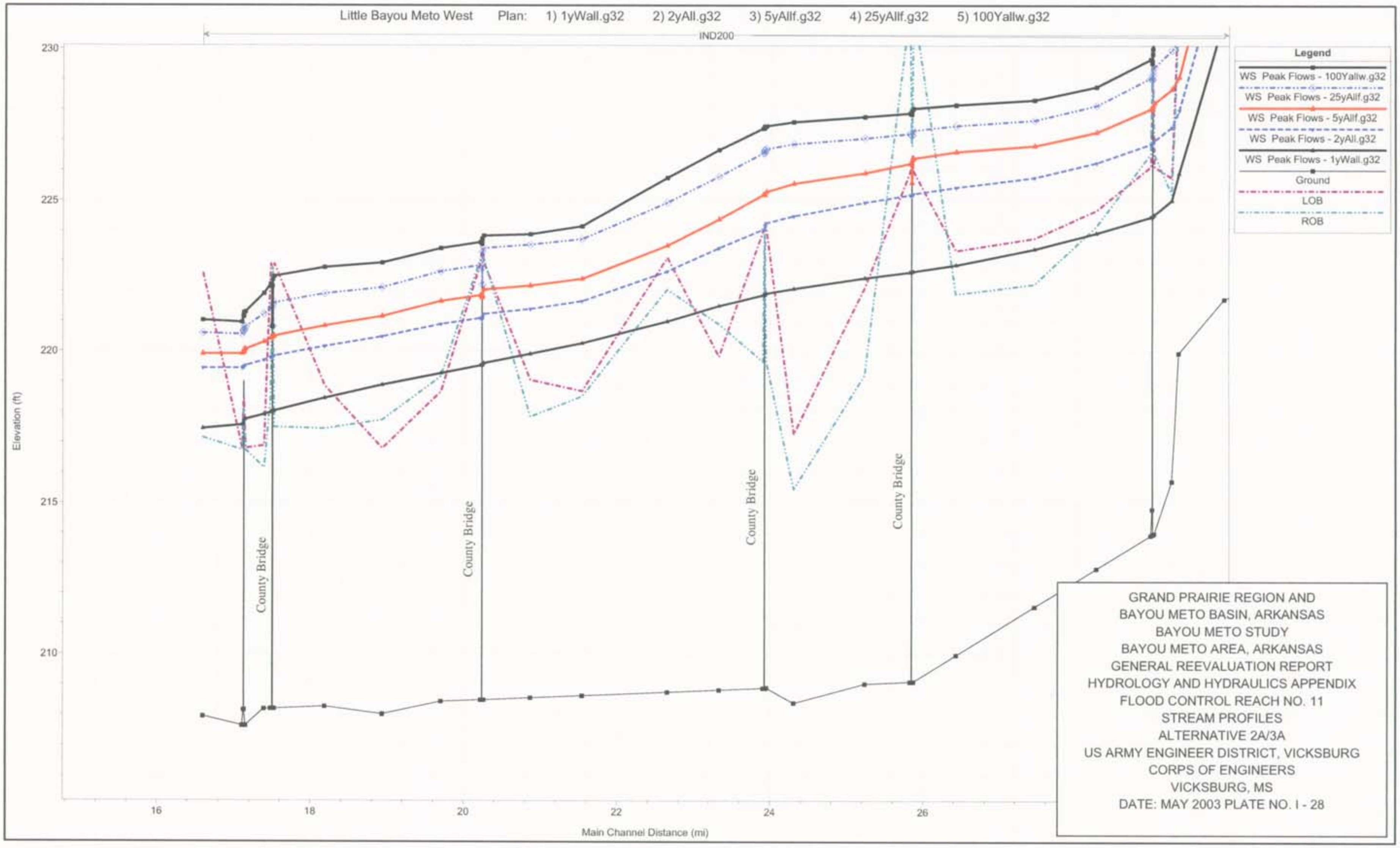
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 11
STREAM PROFILES
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 25



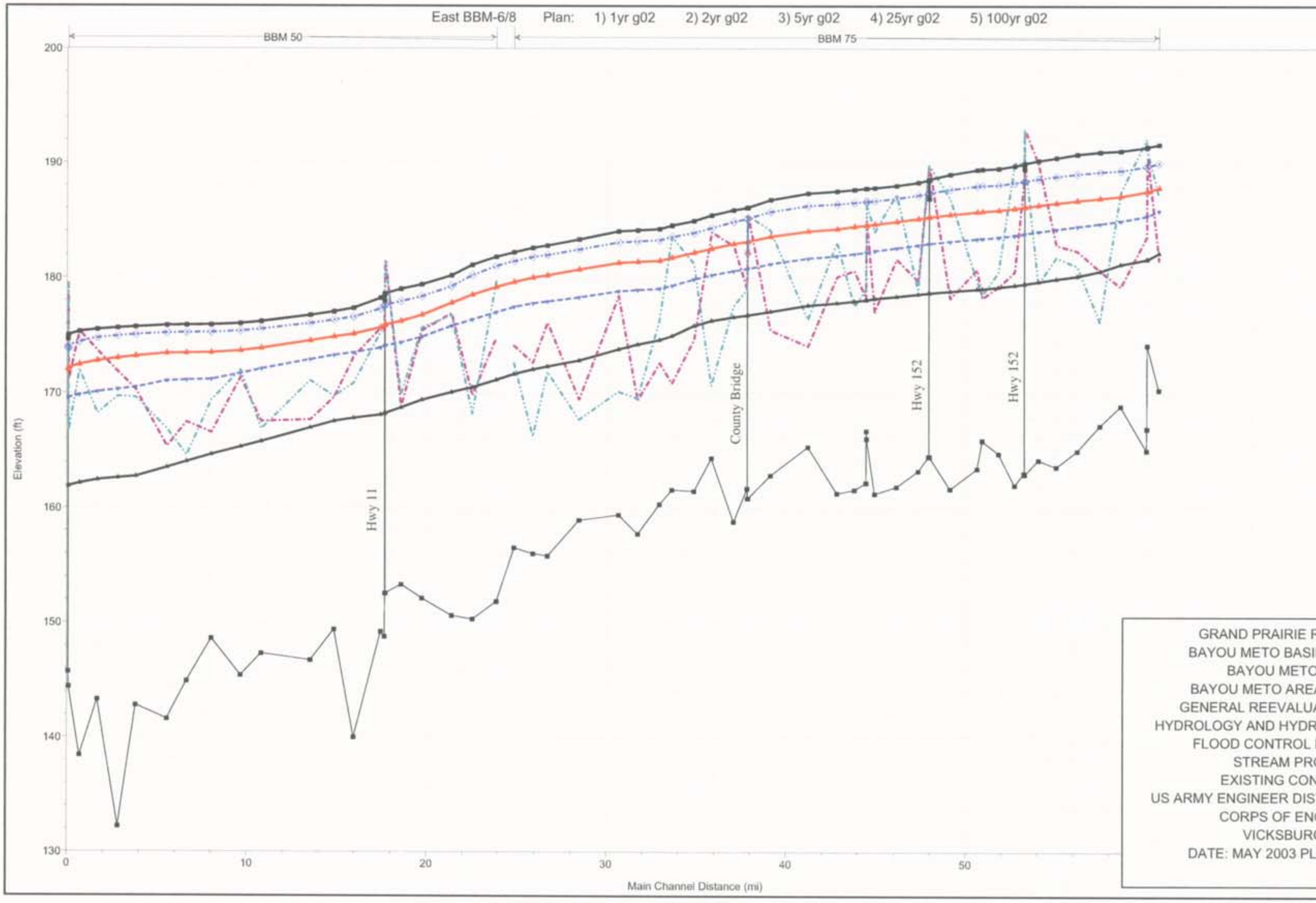
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 11
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 26



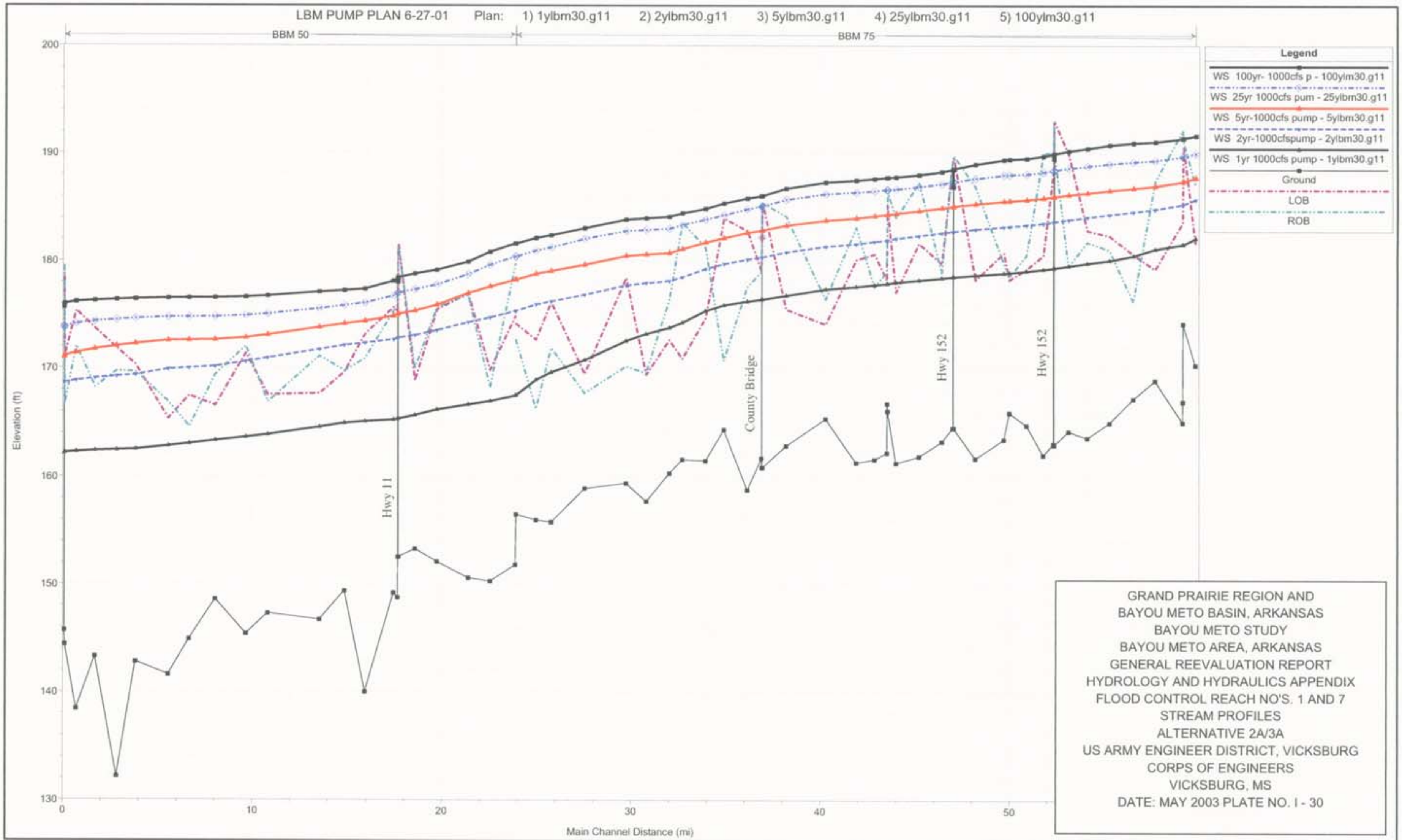
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 11
STREAM PROFILES
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 27



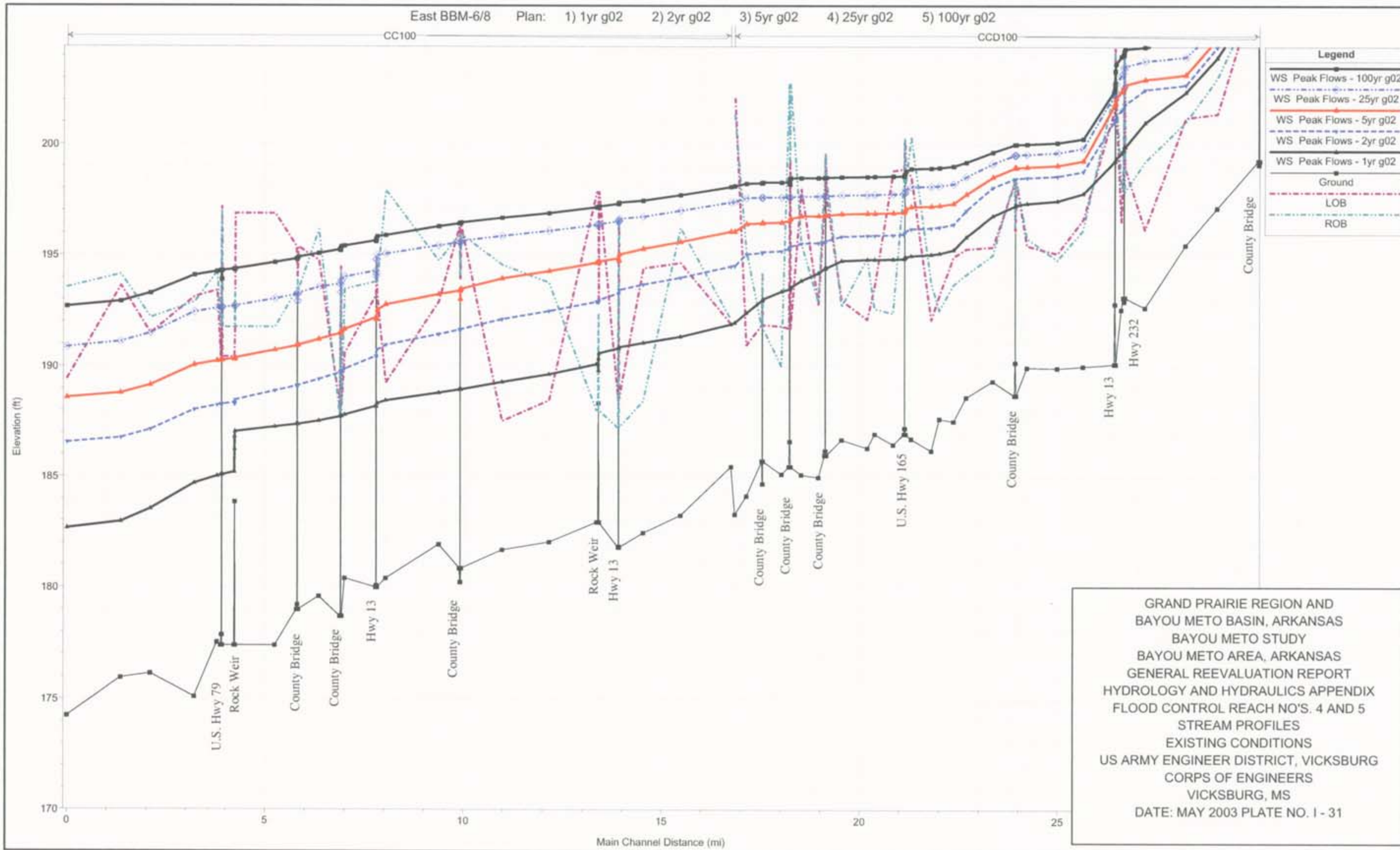
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 11
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 28



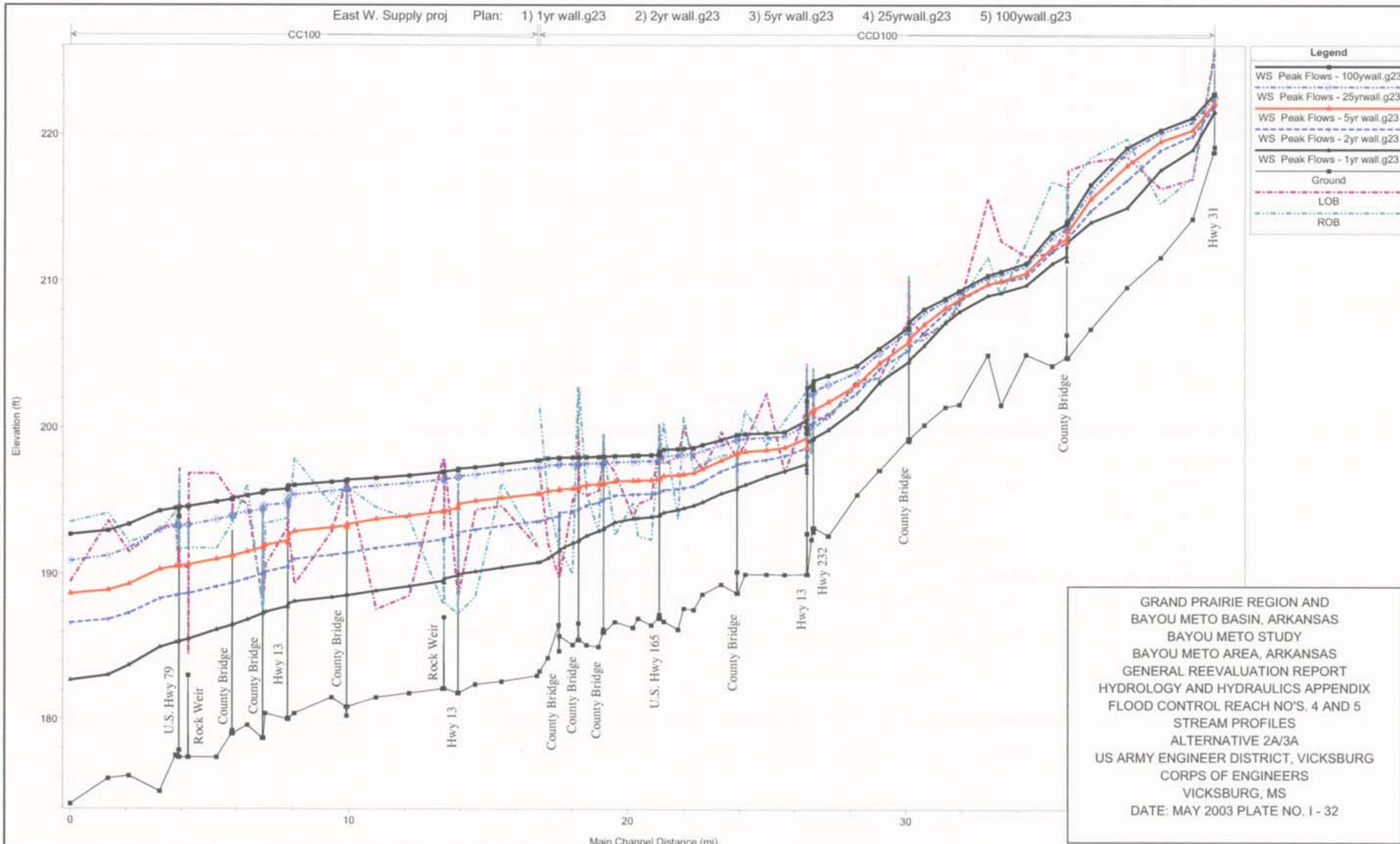
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 1
STREAM PROFILES
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 29



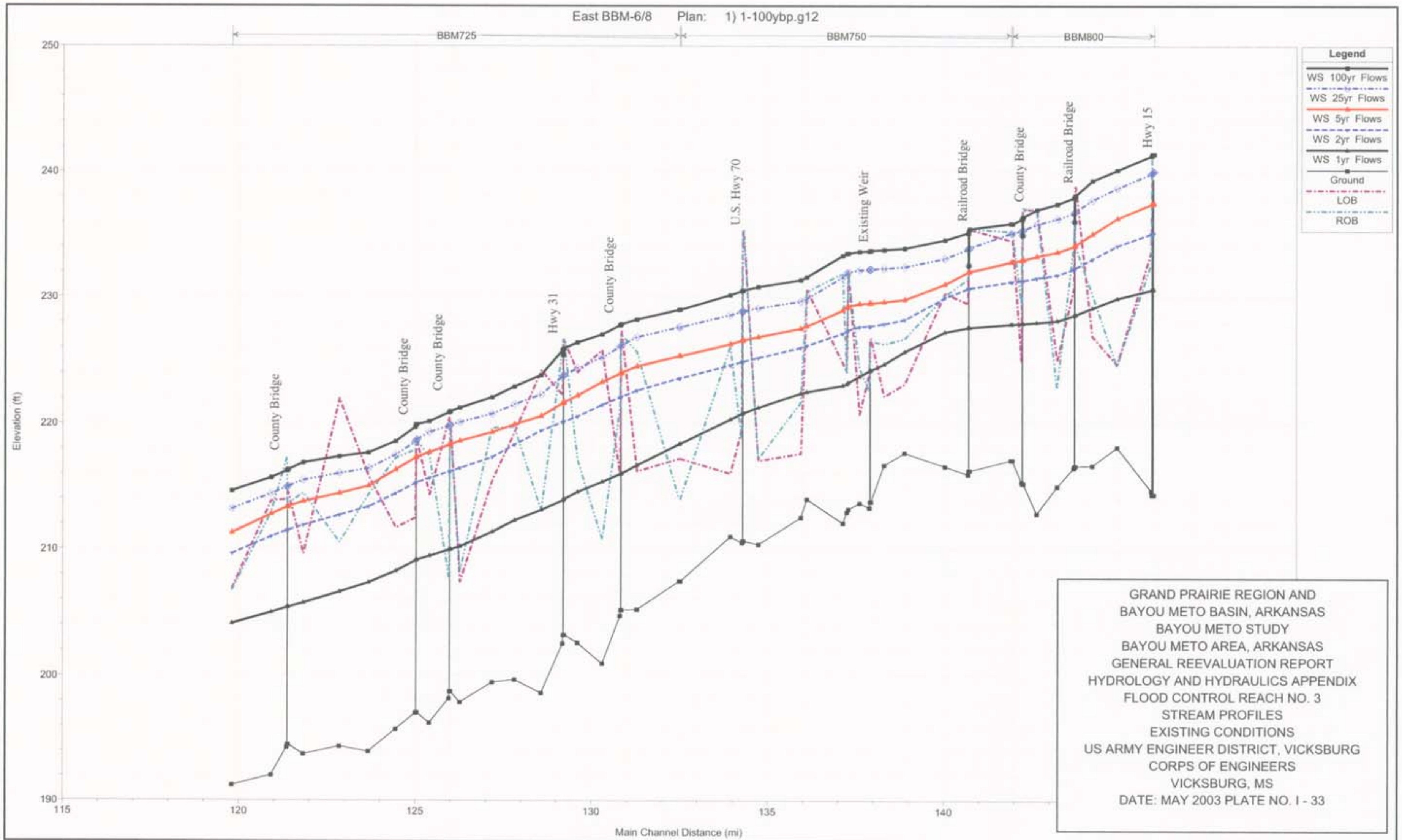
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO'S. 1 AND 7
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 30



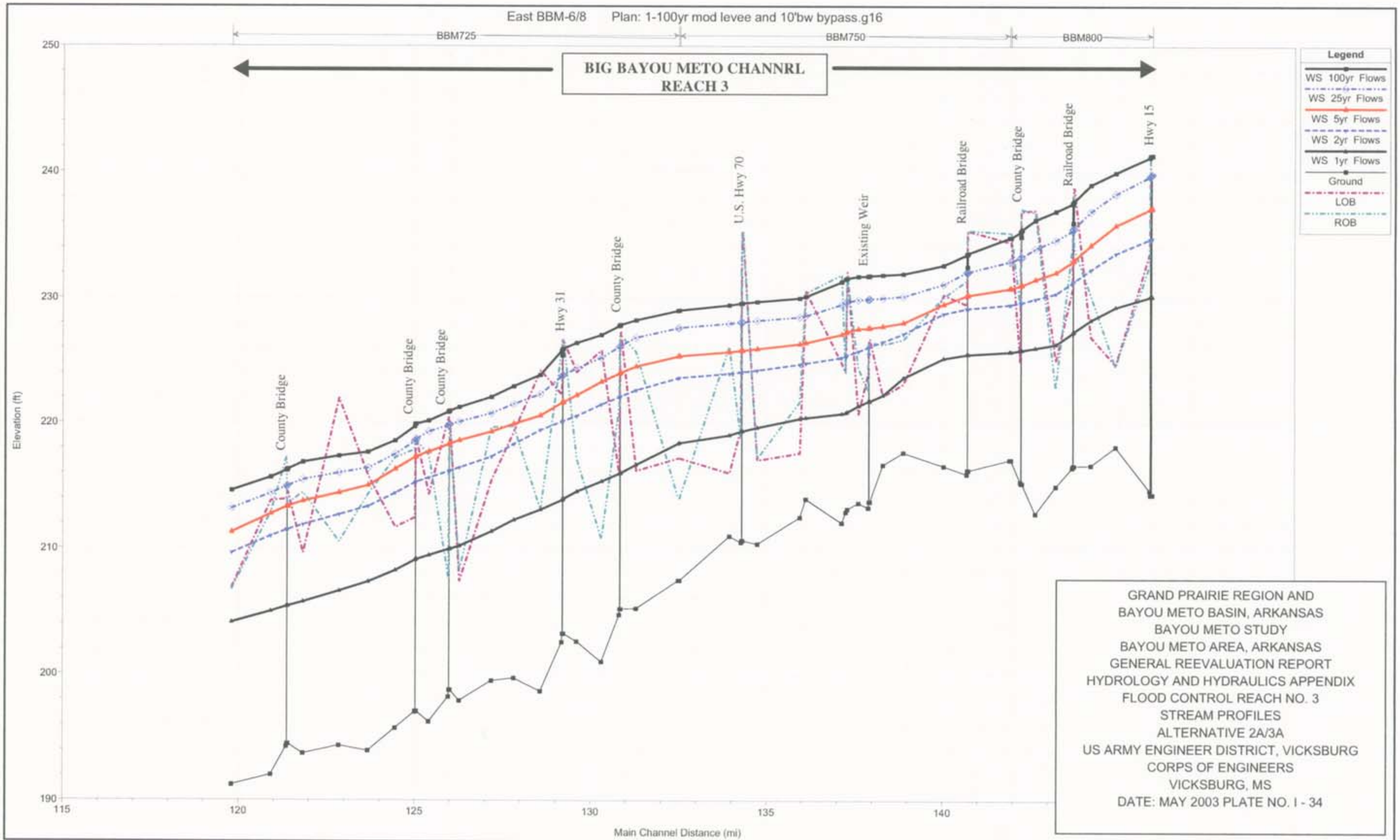
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO'S. 4 AND 5
STREAM PROFILES
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 31



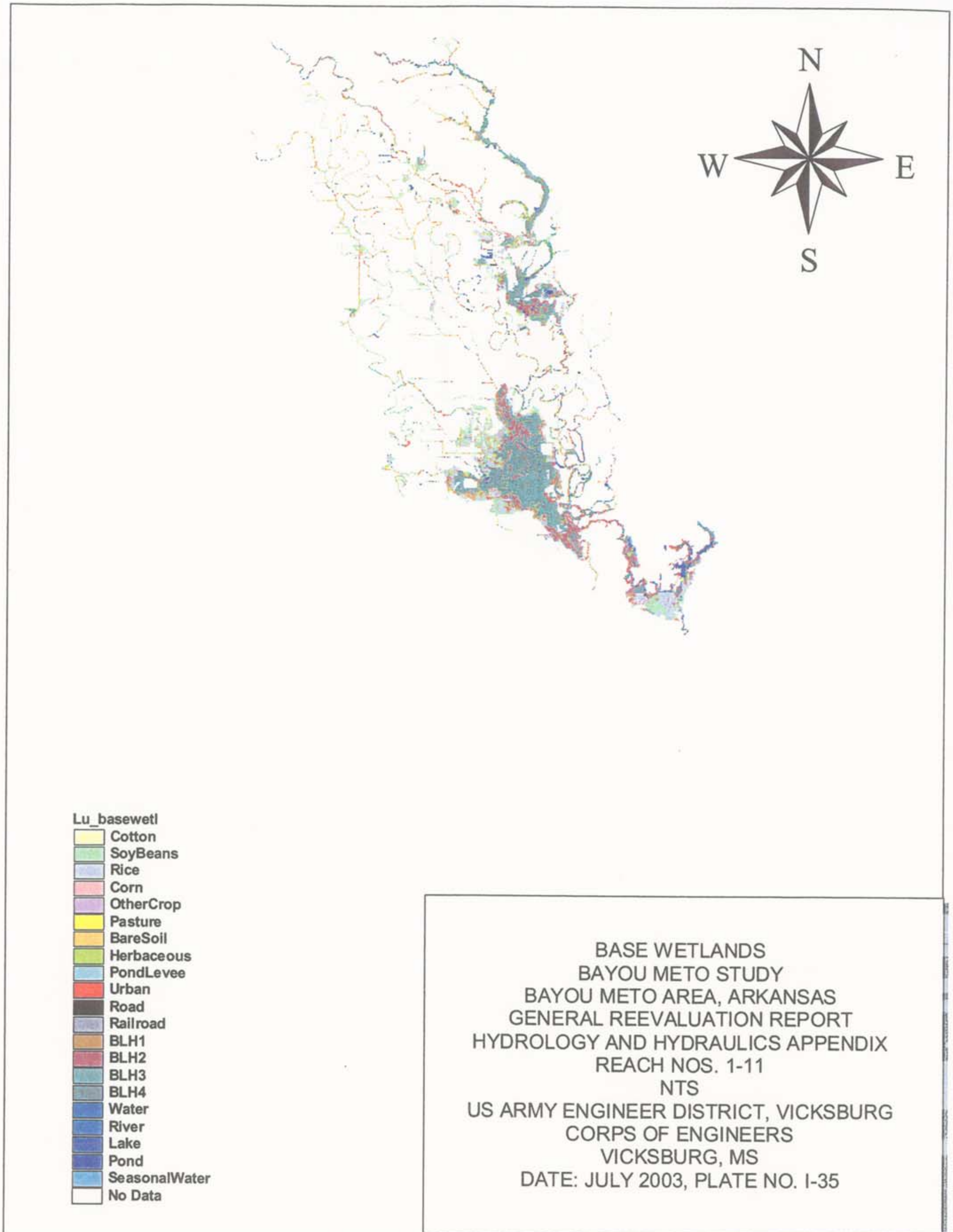
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO'S. 4 AND 5
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 32



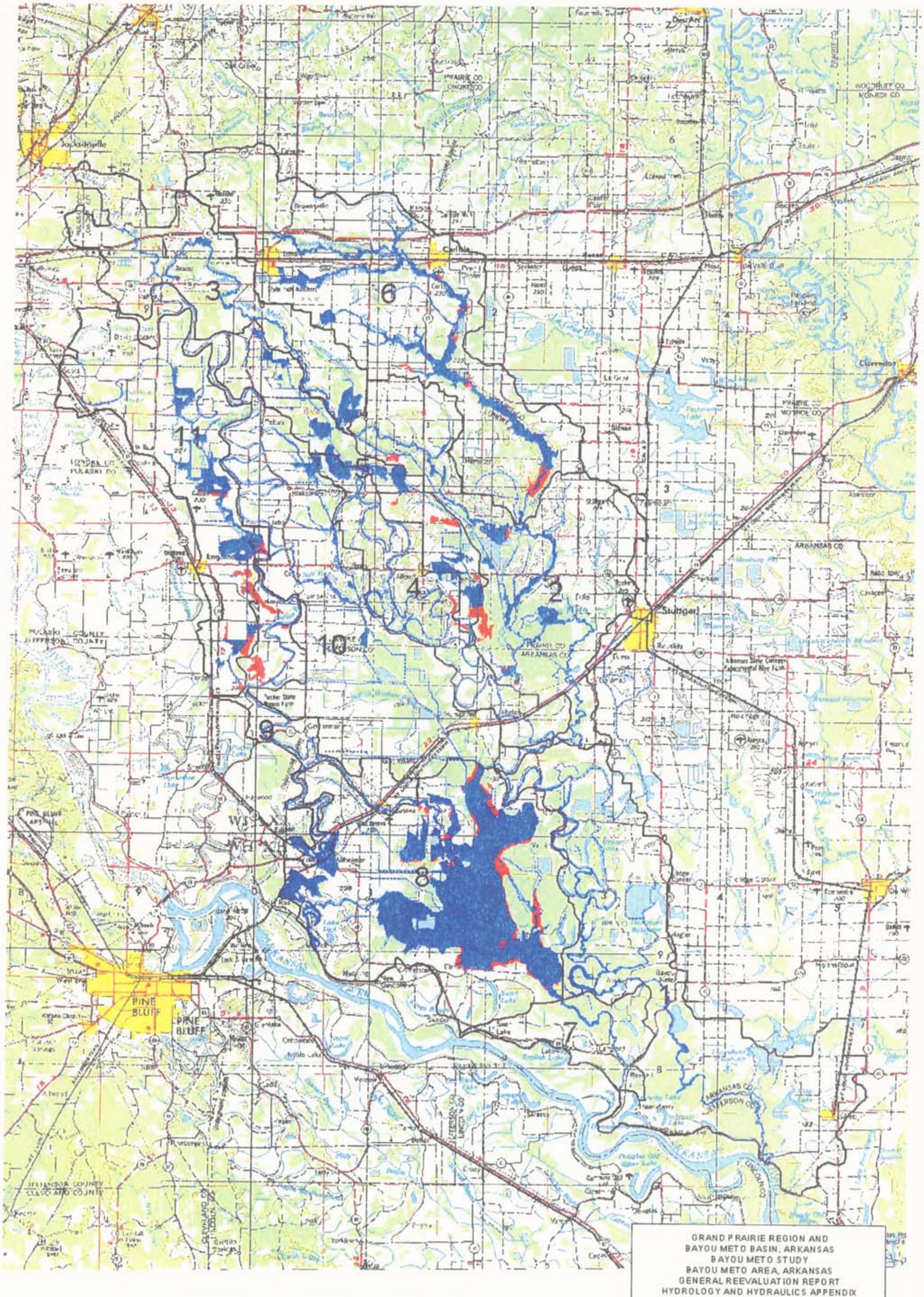
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 3
STREAM PROFILES
EXISTING CONDITIONS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 33



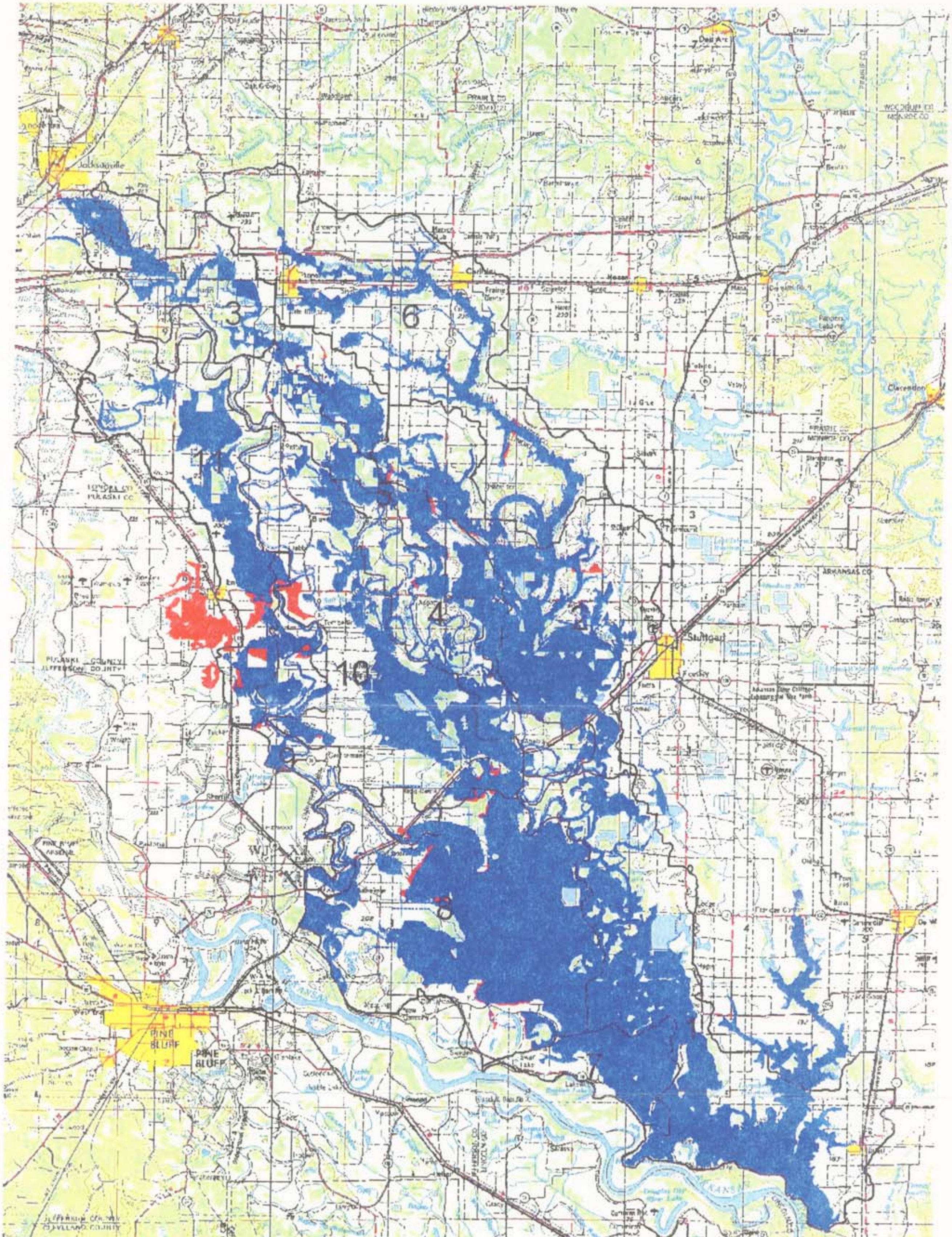
GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
FLOOD CONTROL REACH NO. 3
STREAM PROFILES
ALTERNATIVE 2A/3A
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 34



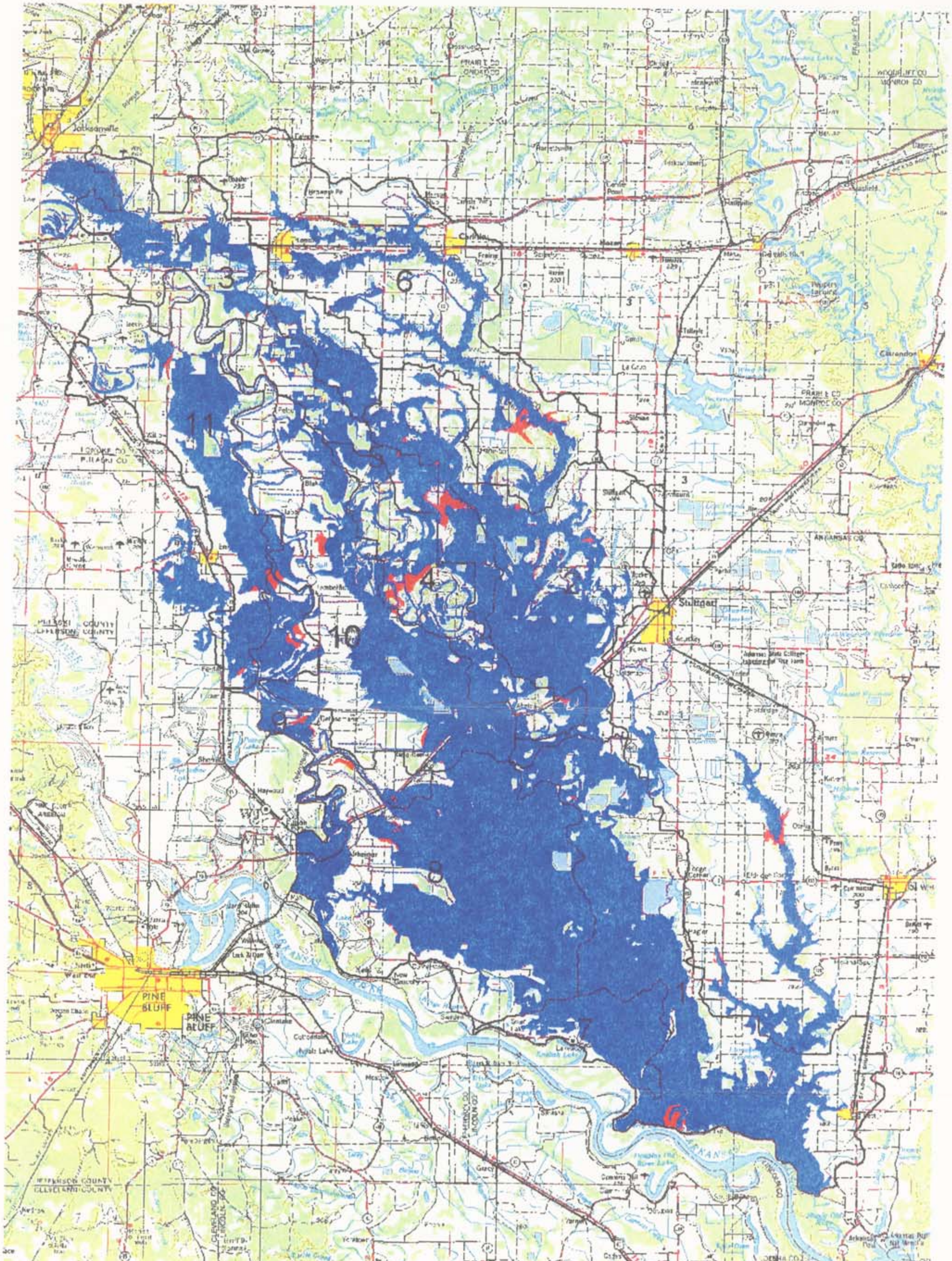
BASE WETLANDS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
REACH NOS. 1-11
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: JULY 2003, PLATE NO. I-35



GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
PRE/POST PROJECT 1 YR EVENT
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I-36



GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
PRE/POST PROJECT 10 YR EVENT
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I - 37



GRAND PRAIRIE REGION AND
BAYOU METO BASIN, ARKANSAS
BAYOU METO STUDY
BAYOU METO AREA, ARKANSAS
GENERAL REEVALUATION REPORT
HYDROLOGY AND HYDRAULICS APPENDIX
PRE/POST PROJECT 100 YR EVENT
NTS
US ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MS
DATE: MAY 2003 PLATE NO. I-39