UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POST CONSTRUCTION PERFORMANCE EVALUATION

BROWN'S LAKE REHABILITATION AND ENHANCEMENT

FEBRUARY 1993

US Army Corps
of Engineers
Rock Island District

POOL 13
UPPER MISSISSIPPI RIVER
MILE 545.8
JACKSON COUNTY, IOWA

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING – P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

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ENVIRONMENTAL MANAGEMENT PROGRAM
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ACKNOWLEDGEMENT

Many individuals of the Rock Island District Corps of Engineers, the U.S. Fish and Wildlife Sevice, and the Iowa Department of Natural Resources contributed to the development of this first Post Construction Evaluation Report for the Brown's Lake Rehabilitation and Enhancement Project. These individuals are listed below:

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1. INTRODUCTION

a. Purpose

The purposes of this report are as follows:

(1). Summarize the performance of the Brown's Lake EMP project based on the project goals, objectives and the Management Plan;

(2). Review the monitoring plan for possible revisions;

(3). Summarize project operation and maintenance efforts to date; and

(4). Review design criteria to aid in development of future projects.

b. Scope

This report summarizes all available monitoring data, project inspections, and project observations made by the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service and the Iowa Department of Natural Resources for the period from June 1987 to October, 1992.

2. PROJECT GOALS, OBJECTIVES AND MANAGEMENT PLAN

a. General

As stated in the Corps of Engineers Definite Project Report, dated September 1987 (see abstracts in Section 3-C), the Brown's Lake EMP Project was initiated primarily because of rapid accumulation of sediment and deterioration of water quality which resulted in significant winter kills in the lake. Although water quality within the lake was adequate to sustain native fisheries during the summer months, ice and snow cover produced periods when dissolved oxygen became depleted to the point where fish kills occurred.

b. Goals and Objectives

Goals and objectives were formulated during the project design phase. Table 2-1 provides a summary of project goals and objectives.

c. Management Plan

There is currently no formalized management plan developed for this project as thee is for more recently developed EMP projects. The project is operated as generally outlined in the Operation and Maintenance Manual.

Table 2-1
PROJECT GOALS AND OBJECTIVES

Goal	Objective	Project Features
Enhance Aquatic Habitat	Retard the loss of fish and wildlife aquatic habitat by reducing sedimentation in Upper and Lower Brown's Lake.	Deflection Levee
	Improve water quality for Upper and Lower Brown's Lake by decreasing suspended sediment concentrations and increasing winter dissolved oxygen concentrations.	Water Control Structure and Inlet Channel Improvement
	Increase fish habitat in Upper and Lower Brown's Lakes.	Dredging
	Increase fish diversity by providing varied water depths	Dredging
	Increase habitat available for wintering fish by providing deeper water areas.	Dredging
Enhance Wetland Habitat	Increase bottomland hardwood diversity by increasing selected terrestrial elevations and reducing frequency of flooding for such hardwoods	Dredge material Placement and Mast Tree Plantings

3. PROJECT DESCRIPTION

a. Features

The constructed project includes: 1) A deflection levee to prevent Mississippi River flood flows and associated sediment from directly entering the Brown's Lake Complex. 2) A water control structure in the levee to allow inflow of oxygenated water during periods of normal flow. 3) Re-orientation of the inlet channel to restrict/reduce river debris and sediment from reaching Upper Brown's Lake. 4) Hydraulic dredging of approximately 370,000 cubic yards of fine grained sediment and 5) placement of dredged material into a terrestrial site to depths of 6 to 8 feet and re-planting with mast production trees.

The dredging was designed to increase the amount of deep water habitat and encourage the flow of oxygen-rich main channel water into Upper Brown's Lake.

b. Construction and Operation

Dredging for the project began during the Summer of 1988 and was completed in late Fall of 1989. Project construction was essentially complete in September 1990. A map showing the completed project features is presented on Plate 1.

Project operation and maintenance generally consists of: 1) operating the water control structure to insure sufficient dissolved oxygen levels throughout the Brown's Lake Complex during critical times of the year; 2) maintenance of the inlet channel to insure that it is kept free of silt and debris; 3) maintenance of the water control structure gates; 4) mowing and maintenance of the sediment deflection levee and related revetment; and 5) maintenance of the drainage ditch system in the mast tree planting area.

c. Related Studies and Reports

Abstracts of reports which relate to the Brown's Lake EMP project or which were used as references in production of this document are presented below:

1. "Definite Project Report with Environmental Assessment, Brown's Lake Rehabilitation and Enhancement", November 1987.

This report presents a detailed proposal for the rehabilitation and enhancement of Brown's Lake. The report marks the conclusion of the planning process and serves as a basis for approval of the preparation of final plans and specifications and subsequent project construction.

2. **"Operation and Maintenance Manual, Browns Lake Rehabilitation and Enhancement", January 1991.**

This manual has been prepared to serve as a guide for the operation and maintenance of Brown's Lake Rehabilitation and Enhancement. Operations and maintenance instructions for the major features of the project are presented. These instructions are consistent with the general procedures presented in the Definite Project Report. This manual has been written for management personnel familiar with the project and does not contain detailed information which is common to site personnel or which is presented in other existing manuals or regulations.

3. **"An evaluation of the Brown's Lake EMP Backwater Rehabilitation and Enhancement Project", A draft scope of work submitted to the Environmental Management Technical Center, LaCrosse, WI, by the Iowa Department of Natural Resources, Bellevue Fisheries, December 1988.**

This report presents a draft scope of work for evaluation of the success or failure of the Brown's Lake Rehabilitation and Enhancement Project. This report forms much of the basis for the development of the Performance Evaluation Plan.

4. **"Largemouth Bass Use of Newly Dredged Canals and Response to Change in Water Quality During the Winter Period in Upper and Lower Brown's Lakes, Pool 13 Upper Mississippi River", by John Pitlo Jr., Iowa Department of Natural Resources, Bellevue Research Station, July 1991.**

This report presents the results of a study of largemouth bass response to water quality changes in Brown's Lake. Twenty largemouth bass were implanted with radio transmitters. Movements of the bass were tracked as dissolved oxygen declined in January 1991. One water control gate was opened on January 17 when dissolved oxygen concentrations had dropped to 2-3 ppm throughout the system. Movements of the bass were tracked as dissolved oxygen increased in the backwater channels.

This study showed that dissolved oxygen concentrations in the Brown's Lake complex can be increased rapidly during the winter by opening the water control structure. Largemouth bass respond to the increased oxygen levels by moving back into Upper and Lower Brown's Lake.

5. **"Federal Aid to Fish Restoration, Annual Performance Report, Mississippi River Investigations, Project No. F-109-R-6", Iowa Department of Natural Resources, March 1991.**

This report summarizes fish studies in selected areas of Mississippi River Pools 9, 10, 12 and 13. The abundance, standing stock, age, growth and total mortality of largemouth bass in these areas are estimated. Upper and Lower Brown's Lakes are addressed in this report.

6. "Site Manager's Project Inspection and Monitoring Results" - 9/11/91, 9/19/91, 9/26/91, 5/19/92, 5/20/92, 8/11/92.

These reports outline the results of U.S. Fish and Wildlife Service inspections of the deflection levee, water control structures, inlet channel improvements, side channel excavation, lake dredging, and the dredged material placement site.

4. OPERATION, MAINTENANCE AND MONITORING TASKS

a. General

The Performance Evaluation Plan is presented in Appendix B. This plan was developed during the design phase and serves as a guide to measure and document project performance. The Resource Monitoring and Data Collection Schedule is presented in Appendix C. This schedule presents the types and frequency of data that have been collected to meet the requirements of the Performance Evaluation Plan. A summary of the Resource Monitoring and Data Collection Schedule is presented on Plate 1.

b. Corps of Engineers

The Rock Island District Corps of Engineers (COE) has collected data at 8 sedimentation transects, 4 water quality stations and 2 vegetation transects. The relative success of the project related to original project objectives will be measured using this data along with other data, field observations and project inspections performed by the United States Fish and Wildlife Service (USFWS) and the Iowa Department of Natural Resources (IDNR). The COE has overall responsibility to measure and document project performance. The physical locations of the sampling stations referenced on the Performance Evaluation Plan and the Resource Monitoring and Data Collection Schedule are presented on Plate 1.

c. Fish and Wildlife Service

The USFWS is responsible for operating and maintaining the Brown's Lake EMP Project. The USFWS has collected data at 3 sedimentation transects, 6 water quality stations, and 1 vegetation transect. Data collection and monitoring being

done by the USFWS is being performed under the Long Term Resource Monitoring (LTRM) Program (PL99-662). The USFWS Refuge Manager is required to conduct annual inspections of the project and participate in periodic joint inspections of the project with the COE. As Refuge Manager the USFWS is also in a position to make regular field observations which aid in determining the relative success or failure of the Brown's Lake Project.

d. Iowa Department of Natural Resources

The IDNR has collected data at 5 sedimentation transects and 4 fish stations. As manager of the adjacent Green Island Refuge, the IDNR is in a good position to make regular field observations of the Brown's Lake Project which aid in determining the relative success or failure of the Project.

5. EVALUATION OF AQUATIC HABITAT OBJECTIVES

a. Reduce Sedimentation

(1). Monitoring Results

As indicated on the Monitoring Plan Map (Plate 1) and in Table B-1, sedimentation rates are being monitored at 17 separate locations within the Brown's Lake Complex. Historic transect data at most of these sites is also available. Sediment transect information currently being collected by the FWS/LTRM and the IDNR will be collected yearly. COE transects will be taken every 5 years as outlined in Table C-1.

Transects taken by the FWS/LTRM at locations M545.5C and M545.4B are shown on Plates 2 and 3 respectively. No transect information has yet been collected at location M544.2C. Plates 2 and 3 show that during the period from 1990 to 1991 approximately 0.5 to 1.0 foot of sediment accumulated in the bottom of the dredged channels in Upper Brown's Lake. During the period from 1991 to 1992 it appears that an additional 0.5 foot of sediment accumulated in the bottom of the dredged channel at M545.4C.

Transects taken by the IDNR at locations M544.9E, M545.0C, M545.2I, M545.6B, and M545.8E are shown on Plates 4 thru 8. IDNR transects are being taken at locations where no dredging has been done. Data collection at several of these locations began in 1984. Data is currently available thru 1989. However, data was also collected in 1990 and will be available for inclusion in future reports. These transects indicate that the lake bottom appears to be changing. However, there is not enough data to determine the rate of sediment accumulation at these locations. There

is no steady trend toward shallower depths for each successive year. Some of the variation in data is due to the difficulty of being able to take the sounding at exactly the same location each year.

The COE transects will be taken in 1995. No data is yet available at these sites.

Historic sediment transects were taken at the locations shown on Plate 1. These transects were taken in 1929-1930, 1938 and 1987. Based on these transects, the pre-project rate of sediment deposition throughout the Brown's Lake Complex has averaged from 0.06 to 0.13 foot per year. Plotted historic transects are shown on Plates 9 thru 12. These historic transects will be compared to the COE transects in future reports to evaluate the post construction rate of sedimentation.

(2). Conclusions

With the limited amount of data available at this point in the post-construction monitoring effort, it is difficult to draw a conclusion as to the average yearly rate of sedimentation throughout the Brown's Lake Complex. The FWS/LTRM transects show sediment accumulation occurring in the dredged channels. The source of this sediment could be re-suspension of other lake sediments and sloughing of the channels or it could be coming from the River's sediment load. Most probably it is both. The longer COE transects which are scheduled to be taken in 1995 should yield information which will allow calculation of actual post-construction sedimentation rates within the Brown's Lake Complex and help determine the sources of sedimentation in the dredged channels.

b. Improve Water Quality

(1). Monitoring Results

Water quality parameters are being monitored at 10 separate sites as indicated on Plate 1 and in Table C-1. No pre-project water quality data is available. However, based on the occurrence of significant winter kills, it is reasonable to conclude that water quality and dissolved oxygen, in particular, was at a low level and would continue to deteriorate without implementation of the project.

Water quality has been periodically monitored since June, 1987. Test parameters and range of values observed are as follows:

Table 6-1 POST CONSTRUCTION WATER QUALITY SUMMARY	
PARAMETER	OBSERVED RANGE
Air temperature	-7.7 to 36.0 Deg C
Water temperature	0.6 to 31.0 Deg C
Ice thickness	0.0 to 20.3 cm
Snow Depth	>2.5 cm
Secchi disk depth	0.1 to 0.97 m
Turbidity	6 to 80 NTU
Suspended solids	5 to 174 mg/l
Specific conductivity	250 to 498 umhos/cm
pH	6.82 to 9.6
Total alkalinity	104 to 204 mg/L
Chlorophyll A	2.0 to 192.3 mg/L
Chlorophyll B	0.0 to 28.0 mg/m
Chlorophyll C	0.0 to 35.6 mg/m
Pheophytin A	0.0 to 171 mg/m
Water depth	0.2 to 4.4 m

(2). Conclusions

Since the completion of dredging in the summer of 1989, water depth has remained steady at approximately three meters around the dredged areas, and no significant sediment accumulation has occurred. Dissolved oxygen concentrations have ranged from 8.47 mg/l to 11.42 mg/l during the critical winter months. These D.O. levels are adequate to sustain native fisheries; furthermore, a study performed by the IDNR in 1991 showed that D.O. levels within Brown's Lake can be rapidly improved by the use of the water control structure. Monitoring of several tagged largemouth bass indicated that they responded almost immediately to the improved water quality by moving into the protected area.

c. Increase Fish Habitat and Fish Diversity

(1). Monitoring Results

Fish habitat is being monitored by observing changes in sedimentation transect depths over time and by monitoring water quality. The results of sediment transect measurements and water quality monitoring are presented in the preceding paragraphs. The abundance of fish and species diversity within the Brown's Lake Complex are being monitored with creel surveys and radio telemetry studies. Creel surveys were conducted within the Brown's Lake Complex in 1988 and 1990. A radio telemetry study has been prepared for the USFWS by the IDNR entitled "Largemouth Bass Use of Newly Dredged Canals and Response to Change in Water Quality

During Winter Period in Upper and Lower Brown's Lakes, Pool 13, Upper Mississippi River".

Plate 1 shows 4 fish stations at which the IDNR had originally planned to do fish netting and electro-fishing studies. Sampling at these four stations has not been done since completion of the project. The IDNR feels that sampling at these four sites would yield highly variable results with no definitive conclusion as to the project impacts on the fishery. The IDNR is planning no future sampling at these four sites.

(2). Conclusions

As previously stated, depths in the channels shown on Plate 1 were increased to approximately 3 meters by dredging. Small amounts of sediment have re-deposited in the bottom of these channels. These dredged channels have provided an increase in fish habitat. The COE sediment transects scheduled to be completed in 1995 will provide a basis for determining the sedimentation rate for the first five years of the project.

Water quality has been greatly improved during periods of low dissolved oxygen by opening the water control structure at the upper end of the Brown's Lake Complex and allowing highly oxygenated water to enter from the Mississippi River. The combination between deeper depths and higher dissolved oxygen levels have provided a viable over-wintering area for fish within Upper and Lower Brown's Lake.

As presented in Appendix A, Upper Brown's Lake was dry during the 1988 creel period. Therefore, comparative statistics are only available for Lower Brown's Lake and Lainsville Slough for the 1988 and 1990 creel surveys. The catch rate in Lower Brown's Lake and Lainsville Slough increased from 0.95 fish per hour in 1988 to 1.92 fish per hour in 1990. These creel surveys represent conditions immediately before and after project construction. Improvements in these creel statistics are likely due to the habitat improvement project.

The radio telemetry study presented in Appendix B investigated the impact of dissolved oxygen levels on movement of Largemouth Bass into the Brown's Lake Complex during the Winter of 1990-91. Twenty Largemouth Bass were implanted with radio transmitters to determine fish use of the dredged channels and response to water quality changes. The bass moved out of Upper and Lower Brown's Lake into Lainsville Slough when dissolved oxygen levels dropped below 3 ppm in January 1991. The water control structure was opened at this point and within 8 days the bass had moved back into the Brown's Lake Complex. Dissolved oxygen

concentrations had rebounded to over 12 ppm at a point 2 miles downstream of the water control structure just 3 days after it was opened. Thus, the ability to introduce oxygenated water into the Complex during periods of low dissolved oxygen concentrations is a key element in providing year-round habitat for native fisheries.

6. EVALUATION OF WETLAND HABITAT OBJECTIVES

a. Increase Bottomland Hardwood Diversity

(1). Monitoring Results

Bottomland hardwood diversity is being monitored by taking yearly vegetation transects at the three locations shown on Plate 1. Two transects are located across the dredged material placement site. This site was re-planted with mast producing hardwoods in June 1992. No planting of trees within the placement site was successful before this time due to consolidation and drainage problems. Thus these vegetation transects have not yet been taken.

In May, 1990 a 150 foot wide strip immediately adjacent to the upstream dredge material containment levee was direct seeded with pin oak acorns. Approximately 25,000 acorns were dropped by helicopter onto this 150 foot wide strip. On May 20, 1991 a strip survey of this area was conducted by the COE. Strips three feet wide and fifteen feet apart were surveyed for pin oak seedlings. Based on this survey it is estimated that 1200 pin oak seedlings were growing on the site at this time.

The FWS/LTRM vegetation transect, V-545.0B, was taken in 1990 and 1991. This transect is being taken to monitor short and long-term impacts of project construction on aquatic and wetland vegetation across the Brown's Lake Complex. The results of these transect investigations are not yet available from the Environmental Management Technical Center.

(2). Conclusions

It is too early to draw any conclusions regarding the success or failure of the tree planting in the dredge material placement site. The pin oak seeding immediately adjacent to the upstream containment levee was somewhat successful. Approximately 5 percent of the acorns dropped produced seedlings after the first year. No conclusions can be drawn regarding general project impacts on aquatic and wetland vegetation within the complex due to unavailability of the FWS/LTRM data.

b. Forestry Research on Dredged Deposits

In addition to the objective of increasing bottomland hardwood diversity this project has the secondary objective of developing valuable data regarding the planting of mast production trees on dredged material deposits. Iowa State University has been contracted to plant the trees and monitor their survival with the following objectives in mind:

- To evaluate species suitability based on growth survival.
- To evaluate the use of nurse crop species on early growth survival of trees.
- To evaluate the use of different kinds of seedling stock types on early growth and survival of trees.
- To evaluate the use of applications of sewage sludge and fertilizer on early growth and survival of trees.

Only species native to the region were selected for planting. Species known for their value as wildlife food were given priority for planting. Two kinds of plots have been established on the study site. The first consists of smaller 16-tree plots that will test the suitability of 13 different mast producing species for planting on this site. The second kind of plot is large and in total covers most of the area. These plots were planted with 3 mast-producing species (Black Walnut or Shellbark Hickory, Red Oak and Bur Oak). Nested within these plots are subplots to test the use of sludge as an organic amendment, the use of nurse crops to control competition, and the use of fertilizer to increase growth rates.

Phase I of this research effort has been budgeted for and is anticipated to be completed in September 1995.

7. OPERATION AND MAINTENANCE SUMMARY

a. Operation

Project Operations are detailed in the O&M Manual and generally consist of: 1) Inspection of the sediment deflection levee during flood periods; 2) Closing of the water control structure during high water periods; 3) Opening of the water control structure during periods of low dissolved oxygen conditions in Brown's Lake; 4) Inspection of the inlet channel and side channel following each flood event for removal of flood carried debris, repair of sloughing banks, etc.; and 5) Management of the re-forested

dredge placement site emphasizing wildlife production as a goal.

The project has been operated successfully in this manner since it's completion in the Fall of 1989. As recommended in Reference 4, one gate of the water control structure should be opened approximately 6 inches two weeks after ice over of Brown's Lake. This will allow water to thermally stratify under the ice before the colder main channel water enters the system later in the winter. This stratification is beneficial as it allows fish to select optimal zones of oxygen, temperature and current by moving 4 to 6 feet vertically in the water column.

b. Maintenance

Inspections of the Brown's Lake Project are to be made by the USFWS Site Manager at least annually. Other site inspections should be scheduled by the manager following high water events. These inspections are necessary to determine maintenance needs. Project Inspections were made by the Site Manager in September 1991, May 1992, and August 1992. These inspections resulted in a variety of maintenance activities including removal of flood debris, levee mowing, flushing of the water control structure, greasing of the water control structure gates, spraying of weeds growing up in riprap, re-sloping of the inside slope of the deflection levee and excavation of a drainage ditch to provide improved drainage for the dredged material containment cells.

Joint inspections of the Brown's Lake Project are to be conducted periodically by the USFWS and the COE. The first joint inspection of the project is scheduled for Fall 1992. The results of this and subsequent joint inspections will be summarized in future Post Construction Performance Evaluation Reports.

No changes in project maintenance strategies are recommended at this time. The Site Manager Inspections appear to be adequate for flagging the periodic maintenance needs of the project.

8. CONCLUSIONS AND RECOMMENDATIONS

a. Goals, Objectives and Management Plan

Based on data and observations collected since project completion, it appears that the stated goals and objectives are being met. Further data collection will better define the degree of sedimentation rate reduction, water quality improvement, fish habitat and diversity improvement and bottomland hardwood diversity being created by the project.

It is recommended that a formal Management Plan be developed for the Brown's Lake Project as have been developed for other more recently developed EMP projects.

b. Performance Evaluation and Monitoring

In general, project monitoring efforts have been performed according to the Performance Evaluation Plan and the Resource Monitoring and Data Collection Schedule presented in Appendix B and C respectively. No changes in these schedules is recommended at this time. The next Post Construction Performance Evaluation Report will be completed in 1995 following collection of data for the first 5 year interval.

c. Operation and Maintenance

Project operation and maintenance has been conducted in accordance with the Operation and Maintenance Manual. Annual Site inspections by the Refuge Manager have resulted in proper corrective maintenance actions. It is recommended that the refuge manager modify the project operating plan to include opening one gate of the water control structure 6 inches after Brown's Lakes have been under ice cover approximately 2 weeks.

Operation of the project under low dissolved oxygen conditions ave resulted in a recognition that the water control structure could have more flow capacity than that required to re-oxygenate Brown's Lake. Further monitoring during harsh winter conditions will provide additional data for evaluation of inlet structure design. Future project design should consider this experience when sizing inlet structures to backwater areas.

d. Project Design Enhancement

Discussions with U.S. Fish and Wildlife Service Personnel closely involved with operation, maintenance and monitoring activities at the Brown's Lake Project have resulted in the following general conclusions regarding project features which may effect future project design:

(1). Lainsville Slough - There is concern that the banks of Lainsville Slough could erode due to potentially high velocities caused by river backup through Lainsville Slough during high Mississippi River Conditions. These velocities could carry sediments that would drop out into Lower Brown's Lake at its confluence with Lainsville Slough. Reverse flow in Lainsville Slough has been observed during high Mississippi River Conditions. However, observed velocities have been low resulting in undetectable amounts of bank erosion and sediment deposition. There has been no evidence of bank erosion to date.

(2). Dredged Channels - In general the dredged channels appear to be adequately sized. The deep holes which were dredged have shown thermal stratification resulting in anoxic conditions during both summer and winter seasons. Therefore, the benefit of the deep holes for overwintering habitat is questionable.

There was discussion during project design whether or not to directly connect the Lower Brown's Lake channel to the entrance channel to create more efficient diffusion of oxygen. It appears that the decision not to make this direct connection was appropriate. Oxygen diffuses into the most far reaching end of the Lower Brown's Lake channels as a result of opening the control structure.

(3). Water Control Structure - The size of water control structure required to provide re-oxygenation of water in the Brown's Lake Complex was difficult to determine during design. The design was based on oxygen balance analysis using all known oxygen sources and sinks. It now appears that the water control structure is oversized. Oxygenated water can be provided to the Brown's Lake Complex by partially opening one of the four gates. However, a minimum of two gates should be provided for future projects to allow for reliability should one of the gates become inoperable. The oxygen balance method used for design is still correct but less conservative values should be reflected.

(4). Entrance Channel - The entrance channel into the Brown's Lake Complex was re-oriented to reduce debris and sediment accumulation problems. Debris still drifts into the entrance channel with its new downstream orientation requiring removal at least once per year. Sediment has deposited at the mouth of the entrance channel. This sediment will require periodic removal in order to keep the entrance channel open. In general the magnitude of the debris problem has been reduced by the re-orientation of the entrance channel.

(5). Dredged Material Placement Site - The dredged material placement site has been re-vegetated with mast production trees. The process of reforestation of this area was severely hindered due to the lack of drainage in the dredged material placement site. This problem was resolved by construction of a relatively deep drainage ditch through the site. Future projects which consider dredged material placement sites for reforestation should include design of a drainage system for the placement site.

A P P E N D I X A

REFERENCES

REFERENCES

1. **"Definite Project Report with Environmental Assessment, Brown's Lake Rehabilitation and Enhancement"**, Rock Island District Corps of Engineers, November 1987.

2. **"Operation and Maintenance Manual, Browns Lake Rehabilitation and Enhancement"**, Rock Island District Corps of Engineers, January 1991.

3. **"An evaluation of the Brown's Lake EMP Backwater Rehabilitation and Enhancement Project"**, A draft scope of work submitted to the Environmental Management Technical Center, LaCrosse, WI, by the Iowa Department of Natural Resources, Bellevue Fisheries, December 1988.

4. **"Largemouth Bass Use of Newly Dredged Canals and Response to Change in Water Quality During the Winter Period in Upper and Lower Brown's Lakes, Pool 13 Upper Mississippi River"**, by John Pitlo Jr., Iowa Department of Natural Resources, Bellevue Research Station, July 1991.

5. **"Federal Aid to Fish Restoration, Annual Performance Report, Mississippi River Investigations, Project No. F-109-R-6"**, Iowa Department of Natural Resources, March 1991.

6. **"Site Manager's Project Inspection and Monitoring Results"** - 9/11/91, 9/19/91, 9/26/91, 5/19/92, 5/20/92, 8/11/92, by Matt deRosier and Larry Wargowsky, U.S. Fish and Wildlife Service, Region 3, Savanna District.

A P P E N D I X B

PERFORMANCE EVALUATION PLAN

TABLE B-1

BROWN'S LAKE REHABILITATION AND ENHANCEMENT

February 1993

PERFORMANCE EVALUATION PLAN

Goal	Objective	Alternative	Enhancement Feature	Enhancement Potential: Unit	Year 0 Without Alternative	Year X With Alternative[1]	Year 50 Target With Alternative	Feature Measurement Reference Table C-1	Annual Field Observations by Site Manager
Enhance Aquatic Habitat	Retard loss of fish and wildlife by reducing sedimentation	Basic Development	Deflection Levee	Acre feet of annual sediment reduction	0	--	20	Evaluate data per Notes 5 and 6. Perform transects per Note 7.	Observe by pole soundings or depth gauges sedimentation in excavated channel
	Improve water quality by decreasing suspended solid concentrations and increasing winter dissolved oxygen concentrations	Basic Development	Water Control Structure and Inlet Channel Improvement	mg/l Suspended Solids	300	--	50	Evaluate water quality per Note 2.	Observe water clarity differences between blocked river flows and lake water
				mg/l dissolved oxygen	<5.0	--	>5.0	Evaluate water quality per Note 2.	Observe effects of low dissolved oxygen (fish kills)
				cubic feet per second of desired water inflow	0	--	350	Perform water quality tests per Note 3.	Observe effects of opening and closing gates
	Increase fish habitat	Basic development	Dredging	Acre-feet of additional lake volume	0	--	8	Evaluate data per Notes 5, 6, and 7	Observe/Record fish changes
	Increase fish diversity by providing varied water depths	Basic development	Dredging	Acre-feet of additional lake volume	0	--	8	Evaluate data per Notes 5, 6, and 7	Observe/Record fish changes

TABLE B-1 (Cont'd)

BROWN'S LAKE REHABILITATION AND ENHANCEMENT

Goal	Objective	Alternative	Enhancement Feature	Enhancement Potential: Unit	Year 0 Without Alternative	Year X With Alternative[1]	Year 50 Target With Alternative	Feature Measurement Reference Table C-1	Annual Field Observations by Site Manager
	Increase habitat available for wintering fish by providing deeper water areas	Basic development	Dredging	Acre-feet of additional lake volume	0	--	8	Evaluate data per Notes 5, 6, and 7	Observe/Record fish changes
Enhance Wetland habitat	Increase bottomland hardwood diversity	Basic development	Mast tree plantings on dredged material placement site	Acres of Mast trees	0	--	35	Evaluate data per Note 8. Perform vegetation transect per Note 9.	Observe/record planted mast survivability

1/ This column is completed for the year the enhancement feature is monitored.

TABLE B-1 (Cont'd)

BROWN'S LAKE REHABILITATION AND ENHANCEMENT

1/ See Plate 1 of this report for locations of post-construction phase sampling points, transects, and area measurements. See DPR for locations of design phase sampling locations.

2/ FWS/LTRM Water Quality Stations	Remarks
W-M545.8 F	COE measures pH, chlorophyll, suspended solids
W-M545.5 B	COE measures pH, chlorophyll, suspended solids
W-M545.5 C	COE measures pH, chlorophyll, suspended solids
W-M545.1 H	All parameters measured weekly during Apr-Sep. Site of Vallisneria study.
W-M544.5 F	
W-M544.7 F	
W-M544.6 F	
W-M544.1 D	
W-M544.2 C	COE measures pH, chlorophyll, suspended solids
W-M544.2 D	

3/ COE Water Quality Station	
W-M546.0A	Smith's Creek

4/ IDNR Fish Stations
F-M545.5 C
F-M545.4 B
F-M545.1 J
F-M544.3 C

5/ FWS/LTRM Sedimentation Transects	
S-M544.2 C	DPR Transect E
S-M545.5 A	DPR Transect B
S-M545.4 C	

6/ IDNR Sedimentation Transects	
S-M545.2 I	IDNR Number 11
S-M544.9 E	IDNR Number 9
S-M545.0 C	IDNR Number 1
S-M545.6 B	IDNR Number 10
S-M545.8 E	IDNR Number 6

7/ COE Sedimentation Transects	
S-M545.8 H	DPR Transect A
S-M545.7 H	DPR Transect B
S-M545.3 H	DPR Transect C
S-M544.3 H	DPR Transect D
S-M544.1 E	DPR Transect E
S-M545.9 H	DPR Transect H
S-M546.3 H	DPR Transect I
S-M544.6 H	DPR Transect N
S-M545.6 B	DPR Transect F (Smith's Creek Thalweg)

8/ FWS/LTRM Vegetation Transect
V-M545.0 B

9/ COE Vegetation Transects	
V-M545.8 H	DPR Transect K
V-M545.5 H	DPR Transect L

A P P E N D I X C

RESOURCE MONITORING AND DATA COLLECTION SCHEDULE

CENCR

TABLE C-1

February 1993

BROWN'S LAKE REHABILITATION AND ENHANCEMENT

Resource Monitoring and Data Collection Schedule 1/

	WATER QUALITY DATA						ENGINEERING DATA			NATURAL RESOURCE DATA				
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
Type Measurement	APR-SEP	OCT-MAR	APR-SEP	OCT-MAR	APR-SEP	OCT-MAR							Sampling Agency	Remarks
POINT MEASUREMENTS	-		-		-	2W								
Water Quality Stations 2/	-		-		-	2W								
Turbidity	-		-		-	2W							FWS/LTRM	
Secchi Disk Transparency	-		-		-	2W								
Dissolved Oxygen	-		-		2W	2W								
Specific Conductance	-		-		2W	2W								
Water Temperature	-		-		2W	2W								
Velocity	-		-		2W	2W								
Water Depth	-		-		2W	2W								
Water Elevation	-		-		2W	2W								
Percent Ice Cover	-		-		-	2W								
Ice Depth	-		-		-	2W								
Percent Snow Cover	-		-		-	2W								
Snow Depth	-		-		-	2W								
Substrate Hardness	-		-		2W	2W								
pH	-		-		2W	2W								
Chlorophyll	-		-		2W	2W								
Suspended Solids	-		-		2W	M								
Wind Direction	-		-		2W	M								
Wind Velocity	-		-		2W	M								
Wave Height	-		-		2W	M								

TABLE C-1 (continued)
BROWN'S LAKE REHABILITATION AND ENHANCEMENT
Resource Monitoring and Data Collection Schedule 1/

	WATER QUALITY DATA						ENGINEERING DATA			NATURAL RESOURCE DATA				
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const Phase	Sampling Agency	Remarks
Type Measurement	APR-SEP	OCT-MAR	APR-SEP	OCT-MAR	APR-SEP	OCT-MAR								
Water Quality Stations 1,2,3,4														
Dissolved Oxygen		-		1		-							COE	
Water Quality Stations B-2, B-4, B-5														
Sediment Oxygen Demand		-		1		-							COE	
Fish Stations 4/													IDNR	
Creel Survey										1	1	6M		
Electrofish/netting										1	1	4M		
Radio Telemetry										-	1	Y		
Water Quality Station														
Column Settling Analyses at Boring B-87-15							-	-	1				COE	
Geotechnical Boring Stations														
Soil Borings. See Construction Drawings.							-	1	-				COE	
TRANSECT MEASUREMENTS														
Sedimentation Transects 5/													FWS/LTRM	
Hydrographic Soundings							-	-	Y					
Sedimentation Transects 6/													IDNR	
Hydrographic Soundings								1	Y					
Sedimentation Transects 7/													COE	
Hydrographic Soundings							-	1	5Y	-	1	-		
Sedimentation Transects B, E, G, I													COE	
Hydrographic Soundings							-	1	-					

TABLE C-1 (Cont'd)

BROWN'S LAKE REHABILITATION AND ENHANCEMENT

Resource Monitoring and Data Collection Schedule 1/

	WATER QUALITY DATA						ENGINEERING DATA			NATURAL RESOURCE DATA				
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
Type Measurement	APR-SEP	OCT-MAR	APR-SEP	OCT-MAR	APR-SEP	OCT-MAR							Sampling Agency	Remarks
Water Quality Stations 3/													COE	
Suspended Solids	-		-	D	W									
Water Depth	-		-	D	W									
Discharge Measurement	-		-	6M	6M									
Water Quality Stations B-1, B-4 B-5, B-7.5													COE	
Dissolved Oxygen	-		1	-										
Specific Conductance	-		1	-										
Water Temperature	-		1	-										
PH	-		1	-										
Elutriate	-		1	-										
Grain Size Analyses	-		1	-										

TABLE C-1 (Cont'd)
BROWN'S LAKE REHABILITATION AND ENHANCEMENT

Resource Monitoring and Data Collection Schedule 1/

	WATER QUALITY DATA						ENGINEERING DATA			NATURAL RESOURCE DATA				
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
Type Measurement	APR-SEP	OCT-MAR	APR-SEP	OCT-MAR	APR-SEP	OCT-MAR							Sampling Agency	Remarks
Transects at Select Intervals Topographic Mapping										-	1	-	COE	
Vegetation Transects 8/ Vegetation Survey										-	1	Y	FWS/LTRM	
Vegetation Transects 9/ Vegetation (timber) Survey										-	1	Y	COE COE	
AREAL MEASUREMENTS Vertical Stereo Areal Photographs (1=15,000)										-	1	5Y	COE	

Legend

W = Weekly
M = Monthly
Y = Yearly
nW = n-Week interval
nY = n-Year interval
1, 2, 3 --- = number of times data is collected within designated project phase

TABLE C-1 (Cont'd)

BROWN'S LAKE REHABILITATION AND ENHANCEMENT

1/ See Plate 1 of this report for locations of post-construction phase sampling points, transects, and area measurements. See DPR for locations of design phase sampling locations.

2/ FWS/LTRM Water Quality Stations	Remarks
W-M545.8 F	COE measures pH, chlorophyll, suspended solids
W-M545.5 B	COE measures pH, chlorophyll, suspended solids
W-M545.5 C	COE measures pH, chlorophyll, suspended solids
W-M545.1 H	All parameters measured weekly during Apr-Sep. Site of Vallisneria study.
W-M544.5 F	
W-M544.7 F	
W-M544.6 F	
W-M544.1 D	
W-M544.2 C	COE measures pH, chlorophyll, suspended solids
W-M544.2 D	

3/ COE Water Quality Station	
W-M546.0A	Smith's Creek

4/ IDNR Fish Stations
F-M545.5 C
F-M545.4 B
F-M545.1 J
F-M544.3 C

5/ FWS/LTRM Sedimentation Transects	
S-M544.2 C	DPR Transect E
S-M545.5 A	DPR Transect B
S-M545.4 C	

6/ IDNR Sedimentation Transects	
S-M545.2 I	IDNR Number 11
S-M544.9 E	IDNR Number 9
S-M545.0 C	IDNR Number 1
S-M545.6 B	IDNR Number 10
S-M545.8 E	IDNR Number 6

7/ COE Sedimentation Transects	
S-M545.8 H	DPR Transect A
S-M545.7 H	DPR Transect B
S-M545.3 H	DPR Transect C
S-M544.3 H	DPR Transect D
S-M544.1 E	DPR Transect E
S-M545.9 H	DPR Transect H
S-M546.3 H	DPR Transect I
S-M544.6 H	DPR Transect N
S-M545.6 B	DPR Transect F (Smith's Creek Thalweg)

8/ FWS/LTRM Vegetation Transect
V-M545.0 B

9/ COE Vegetation Transects	
V-M545.8 H	DPR Transect K
V-M545.5 H	DPR Transect L

A P P E N D I X D

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Chicago, IL 60605-1592

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Clock Tower Building - P.O. Box 2004
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CENCR-ED-H CENCR-PD-W
CENCR-ED-D CENCR-OD-S

1/ All addresses receive one copy to the document except where noted in parentheses.

PLATES

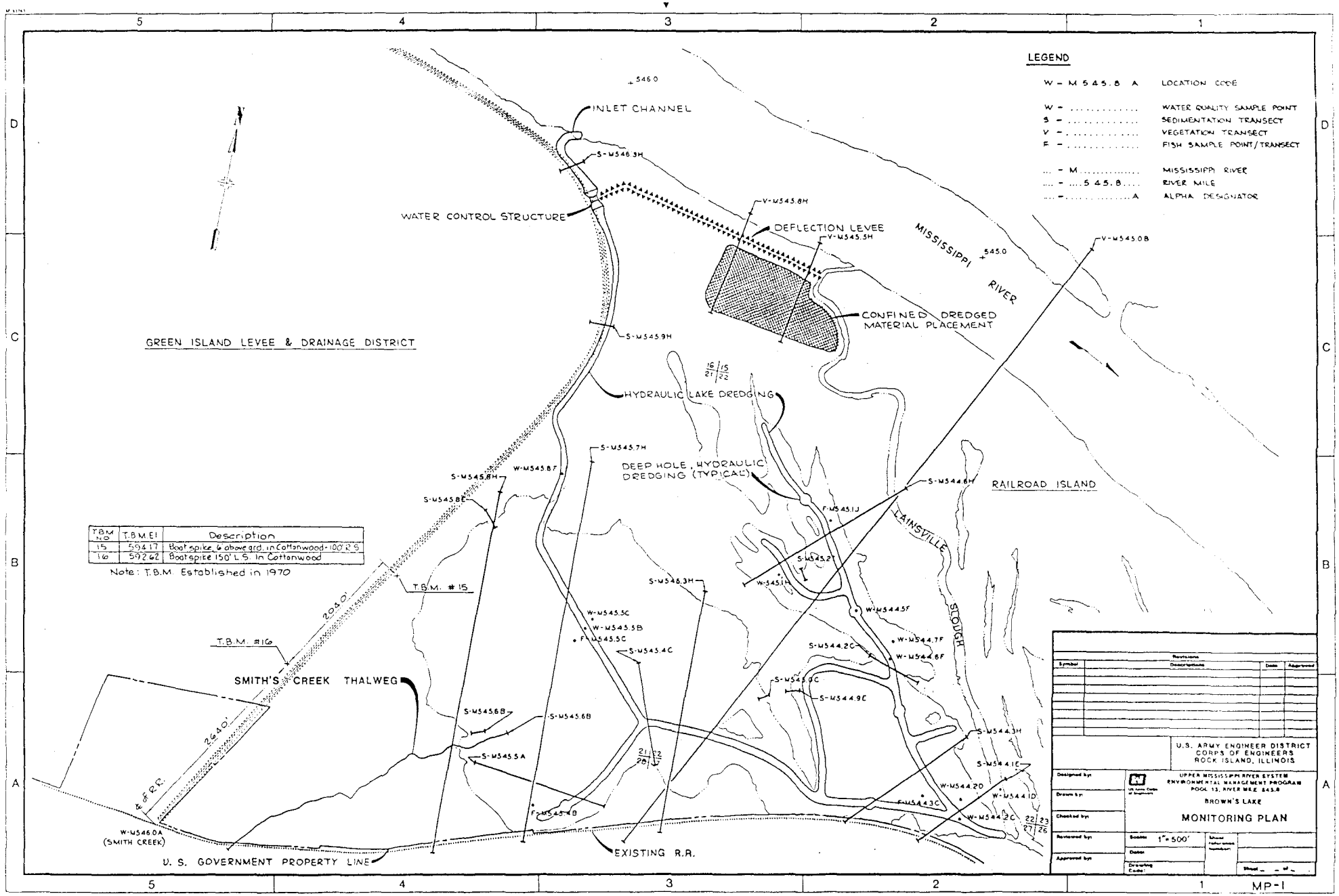

LEGEND
W - M 545.8 A LOCATION CODE
W - ..... WATER QUALITY SAMPLE POINT
S - ..... SEDIMENTATION TRANSECT
V - ..... VEGETATION TRANSECT
F - ..... FISH SAMPLE POINT/TRANSECT
... - M ..... MISSISSIPPI RIVER
.... - ....545.8..... RIVER MILE
.... - ..... A ALPHA DESIGNATOR
INLET CHANNEL
WATER CONTROL STRUCTURE
DEFLECTION LEVEE
CONFINED DREDGED MATERIAL PLACEMENT
MISSISSIPPI RIVER
GREEN ISLAND LEVEE & DRAINAGE DISTRICT
HYDRAULIC LAKE DREDGING
DEEP HOLE, HYDRAULIC DREDGING (TYPICAL)
RAILROAD ISLAND
LAINSVILLE SLOUGH
T.B.M. #15
T.B.M. #16
SMITH'S CREEK THALWEG
EXISTING R.R.
U. S. GOVERNMENT PROPERTY LINE
W-M546.0A (SMITH CREEK)
T.B.M. No. | T.B.M. El | Description
15 | 594.17 | Boat spike, 6 above grd. in Cottonwood - 100' S
16 | 592.62 | Boat spike 150' L.S. in Cottonwood
Note: T.B.M. Established in 1970
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 13, RIVER MILE 545.8
BROWN'S LAKE
MONITORING PLAN
Scales 1"=500'
MP-1

PLATE 1

M545.5A

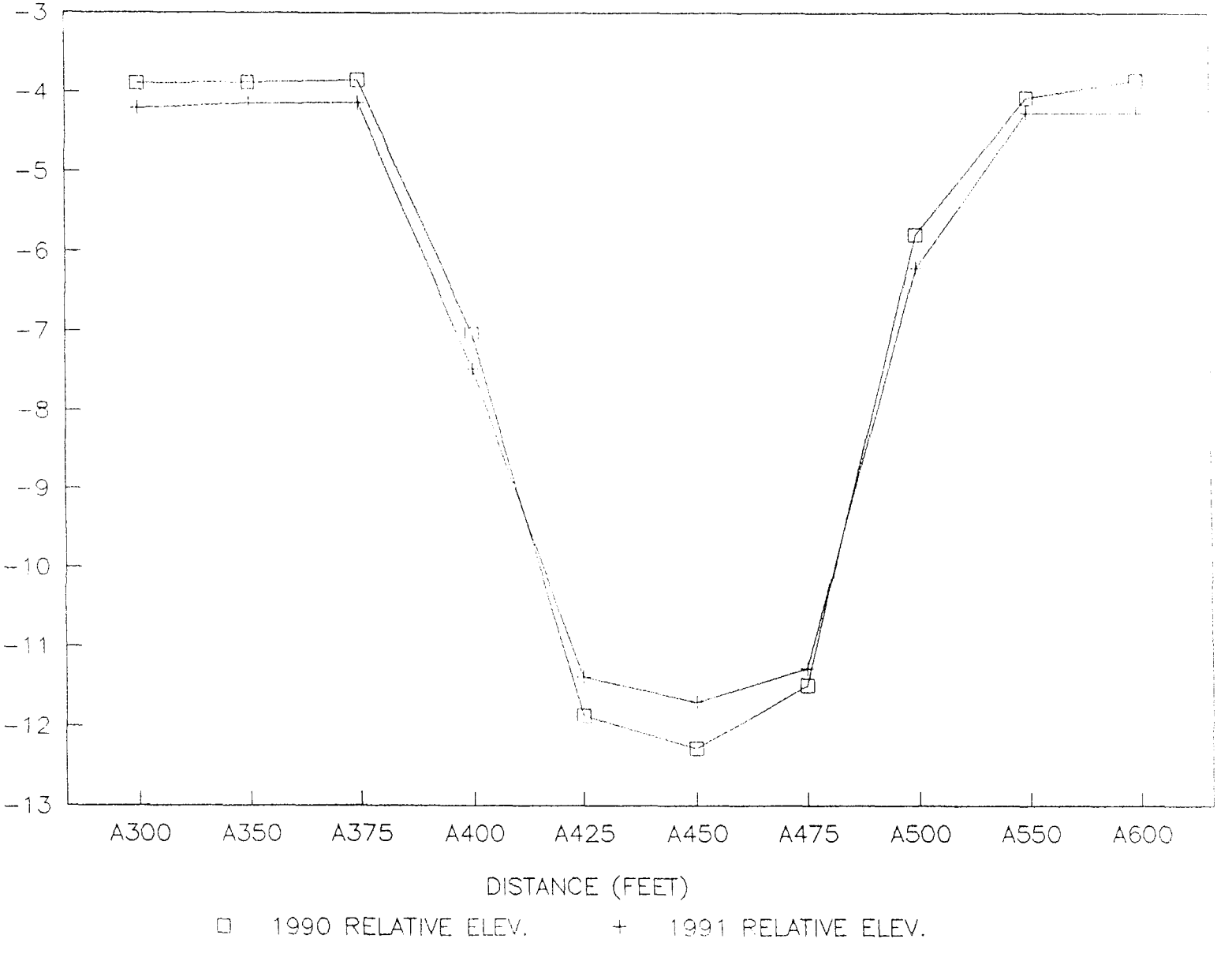


PLATE 2

M545.4C

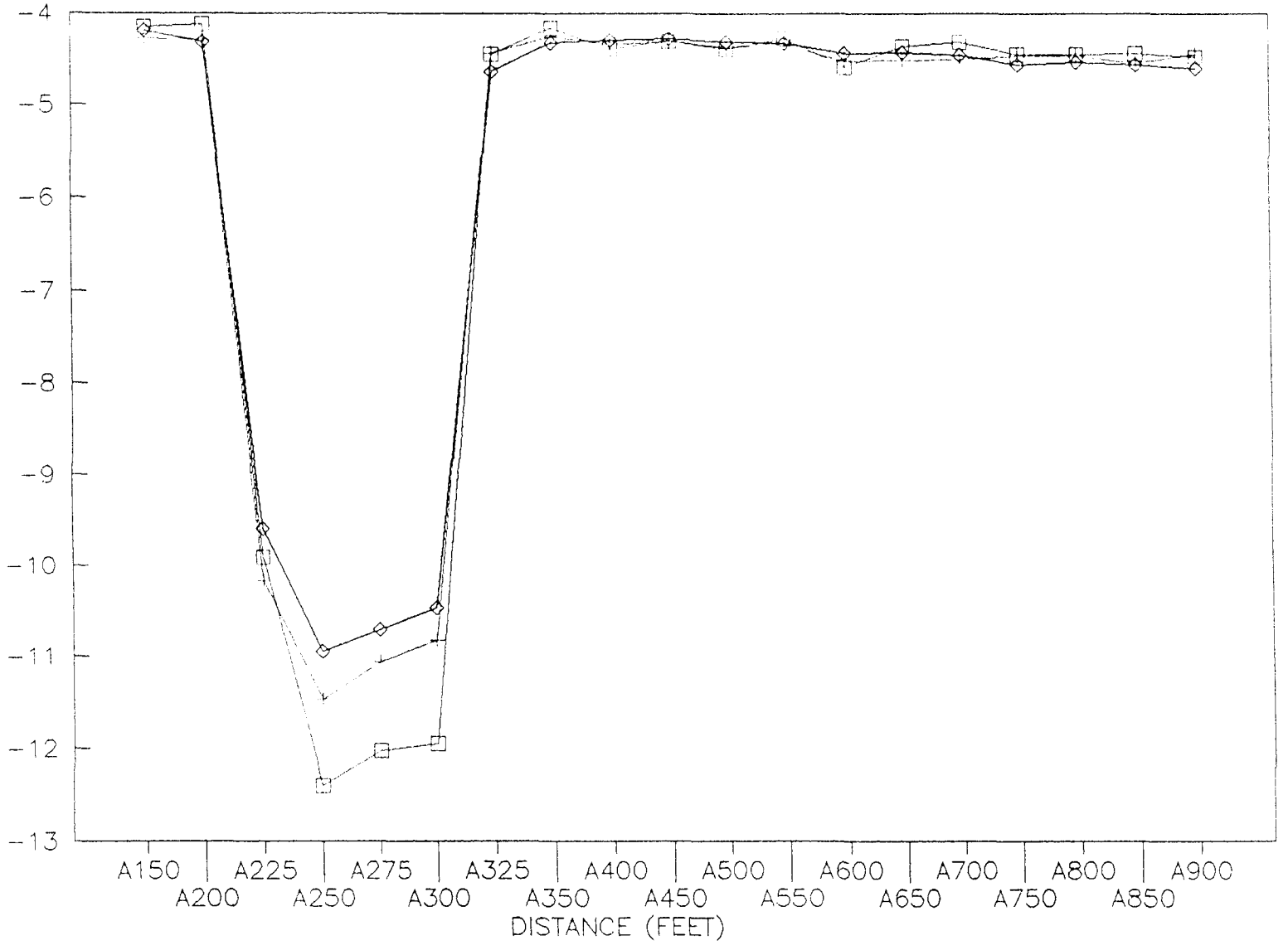
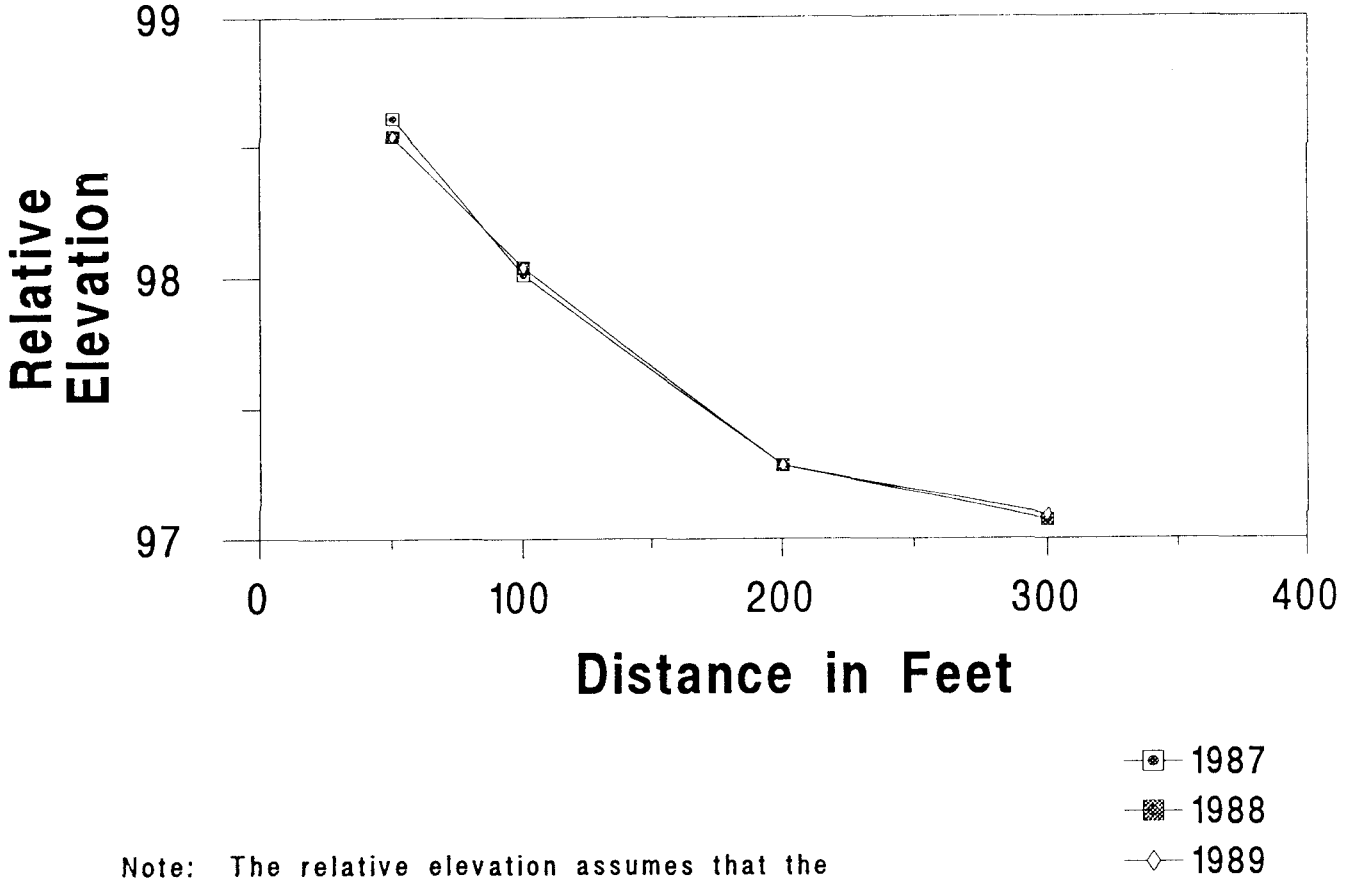


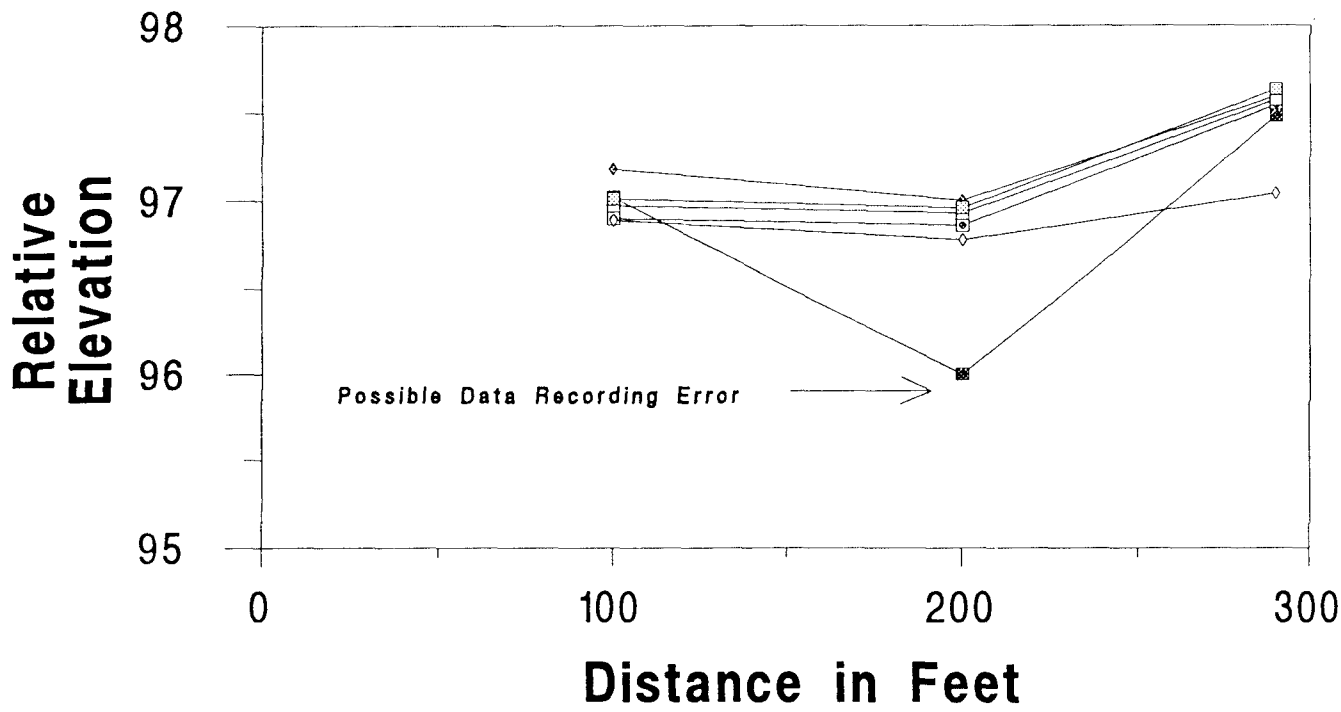
PLATE 3

Sediment Transect S-M544.9E



Note: The relative elevation assumes that the bench mark which the soundings are referenced to is at an elevation of 100.

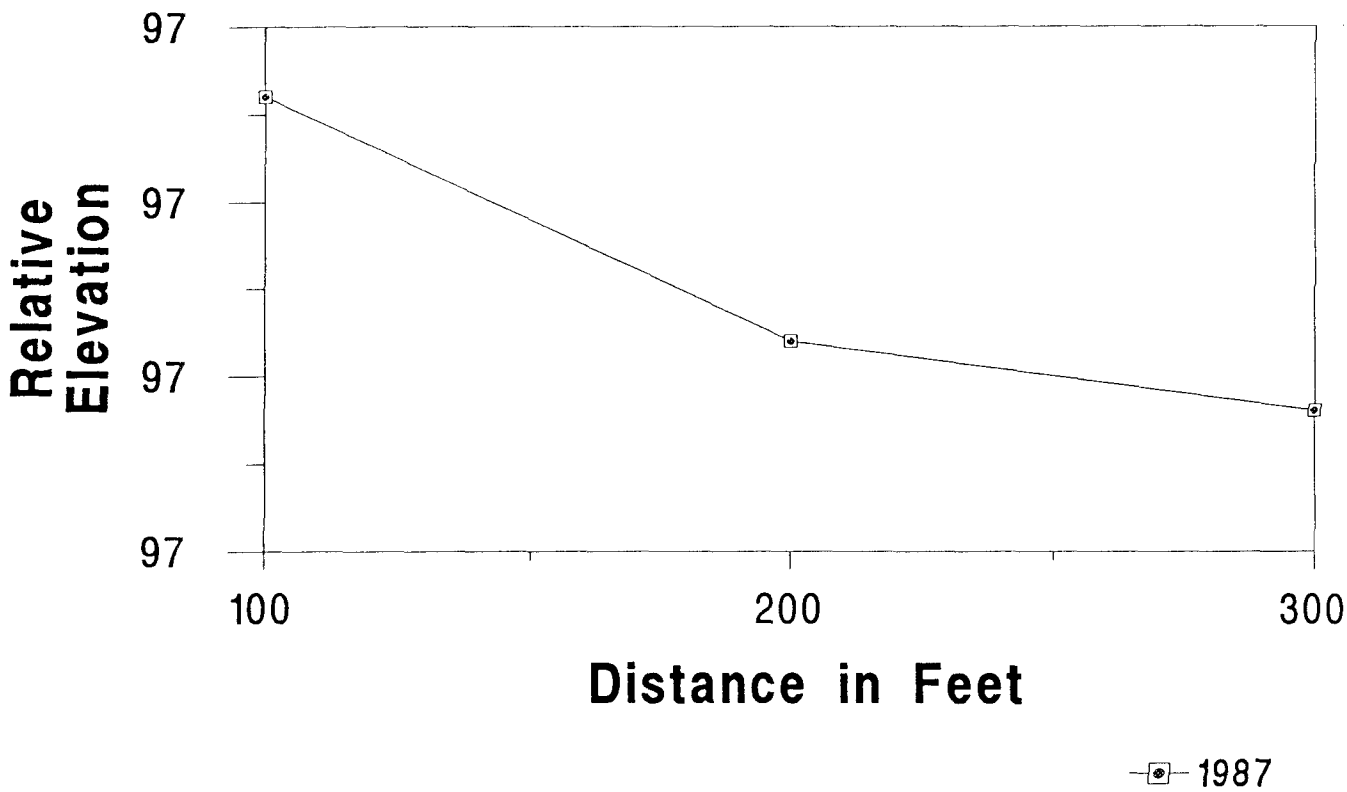
Sediment Transect S-M545.0C



Note: The relative elevation assumes that the bench mark which the soundings are referenced to is at an elevation of 100.

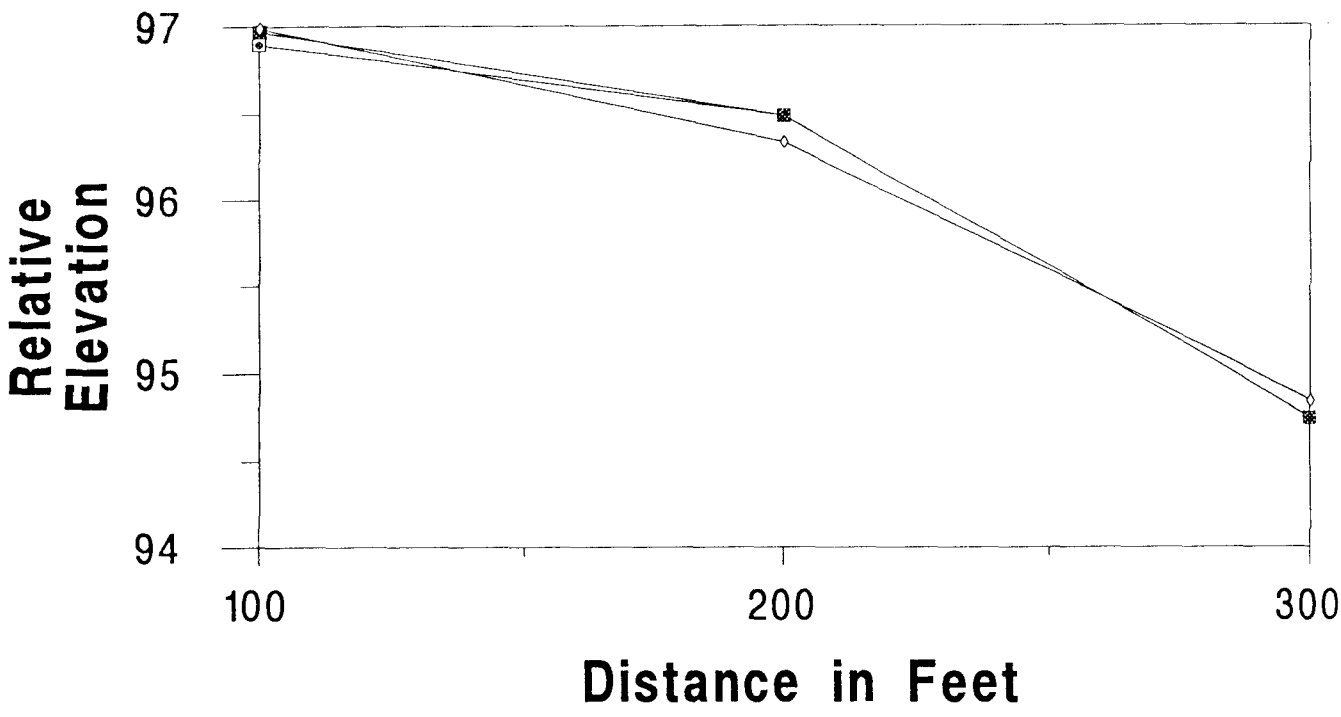
PLATE 5

Sediment Transect S-M545.2I



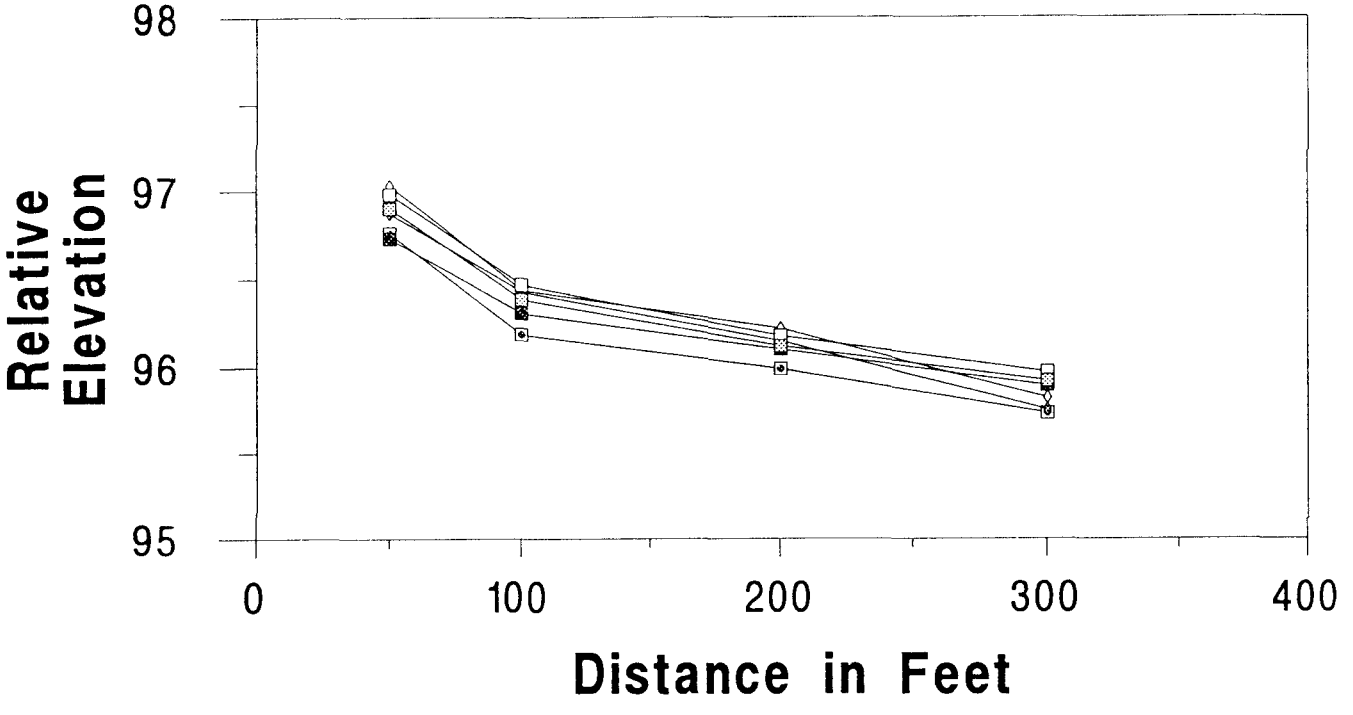
Note: The relative elevation assumes that the bench mark which the soundings are referenced to is at an elevation of 100.

Sediment Transect S-M545.6B

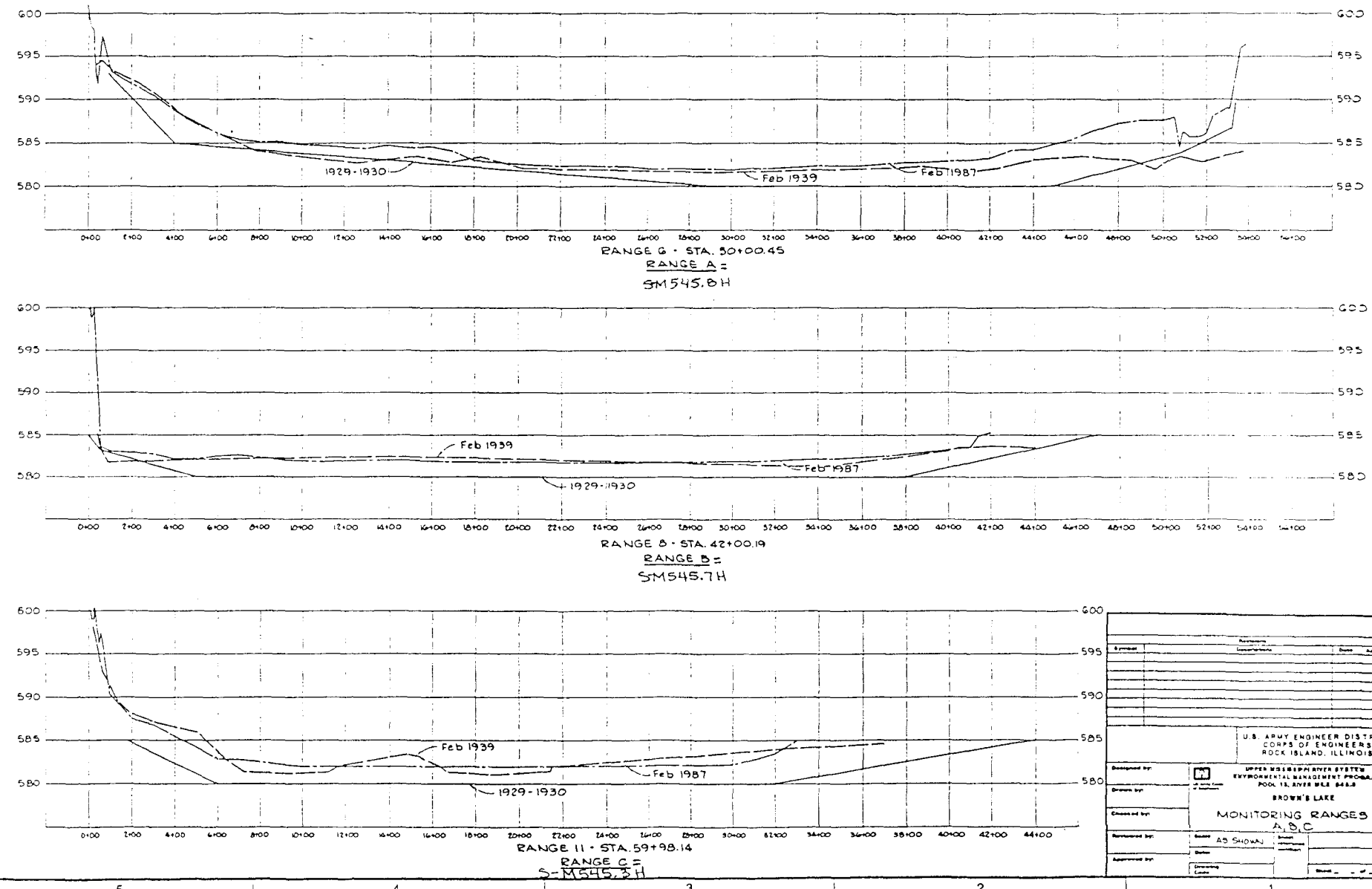


Note: The relative elevation assumes that the bench mark which the soundings are referenced to is at an elevation of 100.

Sediment Transect S-M545.8E



Note: The relative elevation assumes that the bench mark which the soundings are referenced to is at an elevation of 100.



RANGE G - STA. 50+00.45

RANGE A =

SM545.8H

RANGE B - STA. 42+00.19

RANGE B =

SM545.7H

RANGE H - STA. 59+98.14

RANGE C =

S-M545.3H

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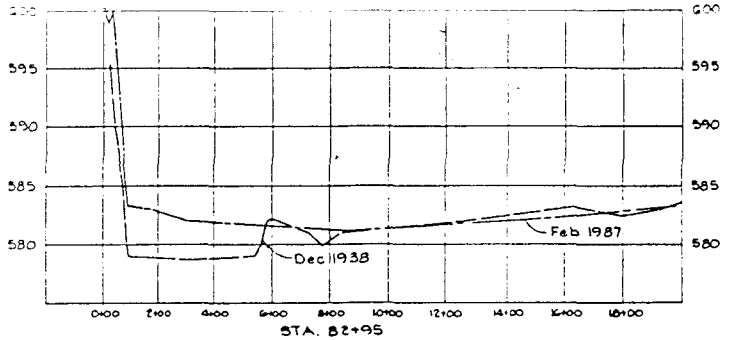
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13, RIVER MILE 544.5

BROWN'S LAKE

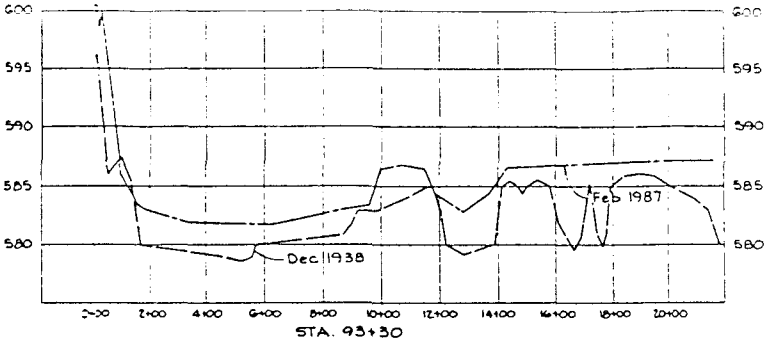
MONITORING RANGES
A, B, C

AS SHOWN

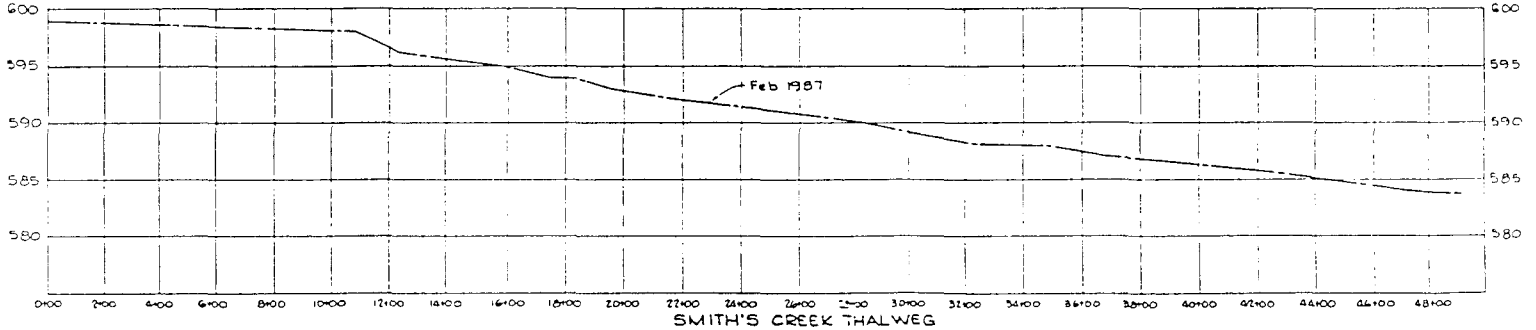
PLATE 9



STA. 82+95
RANGE D=
SM544.3H



STA. 93+30
RANGE E=
S-M544.1E



SMITH'S CREEK THALWEG
RANGE F=
S-M545.6B

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13, RIVER MILE 546.8

BROWN'S LAKE

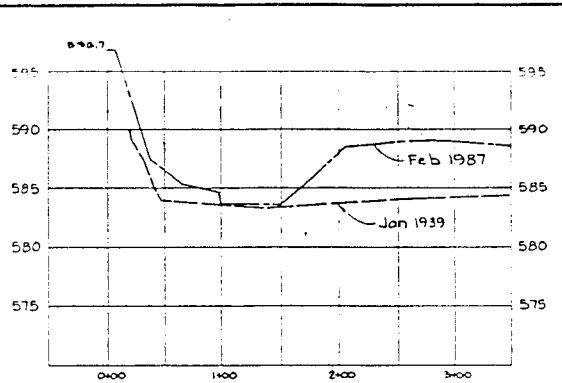
MONITORING RANGES
D, E, F

Scale: AS SHOWN

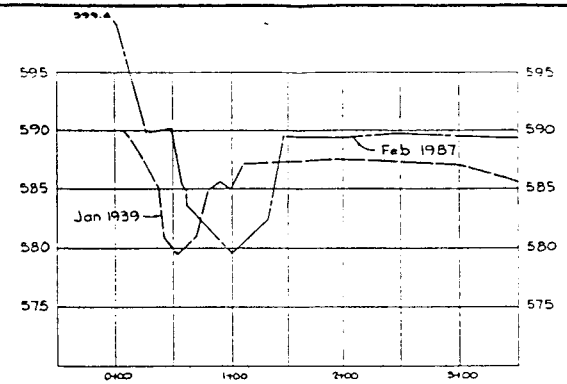
Date:

Drawing Count:

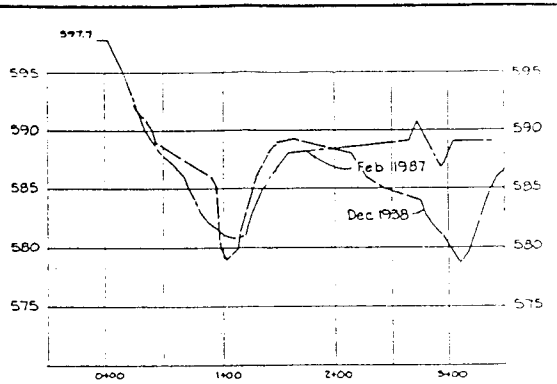
PLATE 10



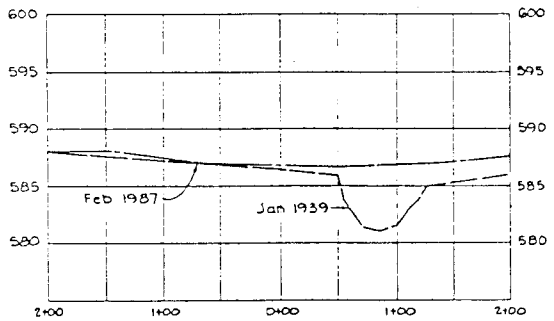
STA. 75+96.17
RANGE G



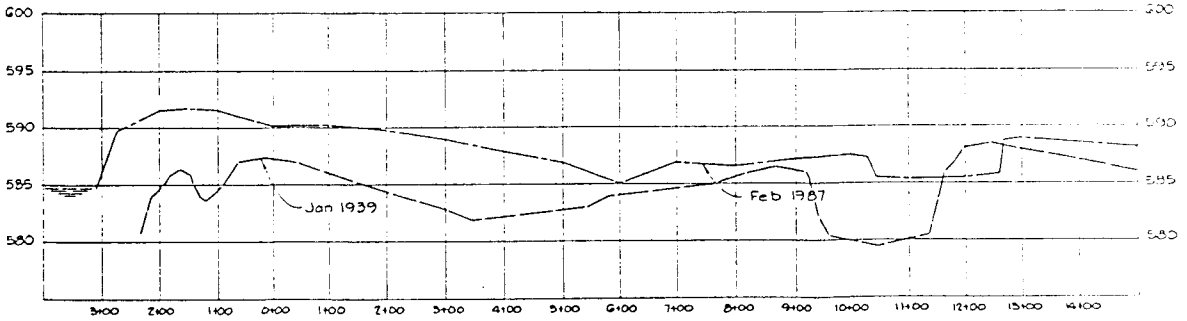
STA. 86+95.40
RANGE H=
S-M545.9H



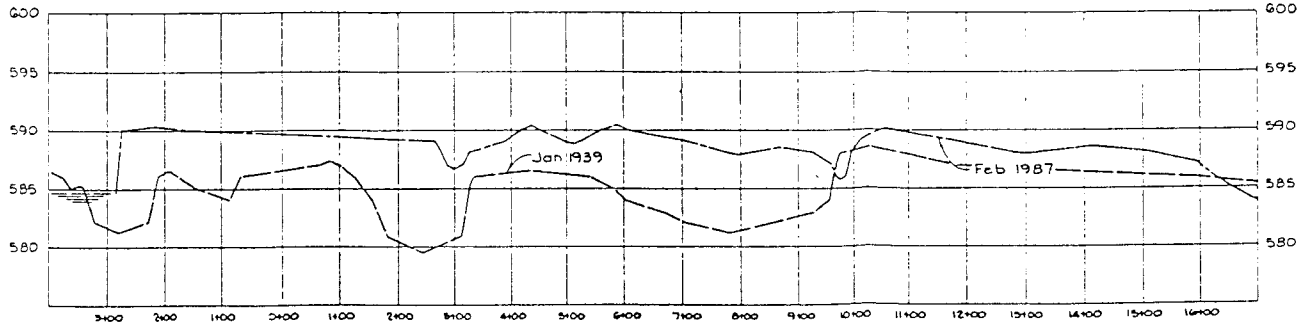
STA. 109+00
RANGE I =
S-M546.3H



STA. 3+50.00
RANGE J



STA 25+00
RANGE K =
V-M545.8H



STA. 38+00
RANGE L =
V-M545.5H

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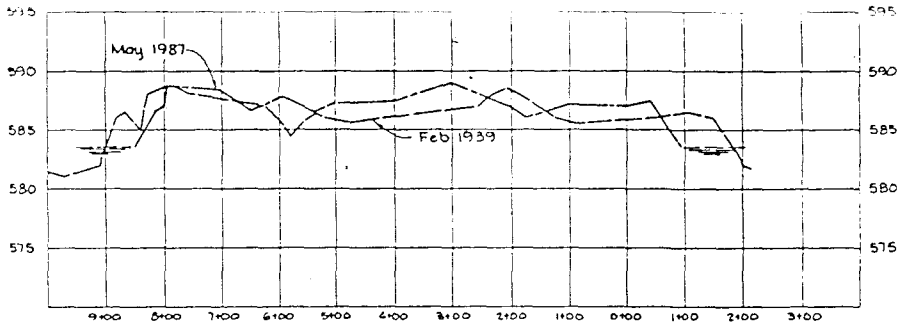
POOL 18, RIVER MILE 544.9

BROWN'S LAKE

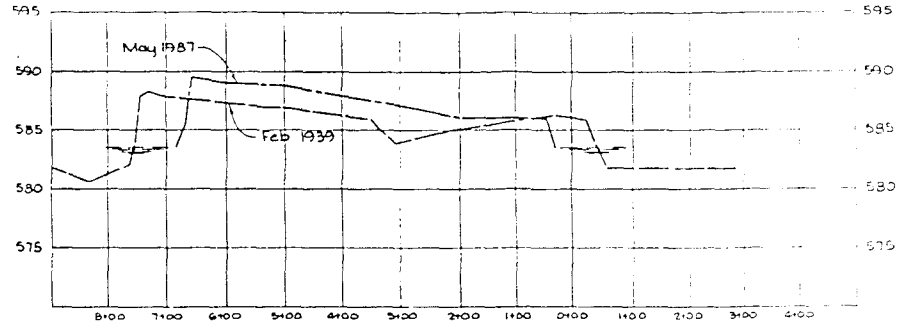
MONITORING RANGES
G, H, I, J, K, L

AS SHOWN

PLATE 11



STA. 25+00
RANGE M



STA. 30+00
RANGE N =
S-M 544.6 H

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ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13, RIVER MILE 544.6

BROWN'S LAKE

MONITORING RANGES M, N

AS SHOWN

PLATE 12