POST-CONSTRUCTION PERFORMANCE EVALUATION REPORT – YEAR 10 (2002) FOR

ANDALUSIA REFUGE HABITAT REHABILITATION AND ENHANCEMENT PROJECT

UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM

JULY 2003

US Army Corps
of Engineers
Rock Island District

POOL 16
MISSISSIPPI RIVER MILES 462.0-463.0
ROCK ISLAND COUNTY, ILLINOIS

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

CEMVR-PM-M

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ACKNOWLEDGMENT

Many individuals of the Rock Island District, United States Army Corps of Engineers; the United States Fish and Wildlife Service; and the Illinois Department of Natural Resources contributed to the development of this Post-Construction Performance Evaluation Report for the Andalusia Refuge Habitat Rehabilitation and Enhancement Project. These individuals are listed below:

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EXECUTIVE SUMMARY

1. General. As stated in the Definite Project Report, the Andalusia Habitat Rehabilitation and Enhancement Project (HREP) was initiated in response to limited management capability in providing quality habitat for waterfowl due to a lack of water level control. In the refuge south of Dead Slough, little or no water was present during the fall waterfowl migration. Sediments from the Mississippi River and adjacent uplands were decreasing the water volume in the refuge and backwater fisheries. This reduced water volume caused a succession from a dominance of aquatic bed palustrine wetlands to a more emergent plant species as well as decreasing deepwater fish habitat off the main channel.

2. Purpose. The purpose of this report is to provide a summary of the monitoring data and field observations, as well as project operation and maintenance, since completion of the last Performance Evaluation Report in April 2002.

3. Project Goals, Objectives, and Features. The two goals and associated objectives for the Andalusia HREP are as follows:

a. Enhance Migratory Waterfowl Habitat

(1) Increase reliable food production area (moist soil species) through water control provisions

(2) Increase reliable resting and feeding water area through mechanical dredging

b. Enhance Aquatic Habitat

(1) Restore deep aquatic habitat through mechanical dredging

(2) Restore lentic-lotic habitat access cross-sectional area through mechanical dredging

(3) Improve dissolved oxygen concentration during critical stress periods through mechanical dredging and gated inlet structure construction

(4) Reduce sedimentation in refuge through levee construction and tributary diversion

4. Observations and Findings. For the evaluation period of January to December 2002, the objectives to meet each goal had the following observations and conclusions:

a. Enhance Migratory Waterfowl Habitat

(1) Increase Reliable Food Production Area (moist soil species)

- (a) Year 50 Target is to attain a reliable food production area (moist soil species) greater than or equal to 130 acres
- (b) At Year 0 (1992), moist-soil species within the MSMU were minimal
- (c) Based on results from the August 1997 PER, Year 4 (1996) reported qualitatively 40 acres of reliable food production area
- (d) Field observations within the MSMU since then indicate good progress toward meeting the Year 50 Target acreage for moist-soil species

(2) Increase Reliable Resting and Feeding Water Area

- (a) Year 50 Target is to maintain a reliable resting and feeding water area greater than or equal to 50 acres

(b) Based on results from the August 1997 PER, Year 5 (1997) reported 49.3 acres of resting and feeding water area
(c) Based on results from the hydrographic soundings, Year 10 (2002) reported 99.0 acres of reliable resting and feeding water area
(d) This substantial increase is due to the lowering of the existing ground adjacent to the interior drainage channels from Year 5 (1997) to Year 10 (1992)

b. Enhance Aquatic Habitat

(1) Restore Deep Aquatic Habitat

(a) Year 50 Target is to maintain greater than or equal to 40 acre-feet of deep aquatic habitat (depth $\geq$ 6 feet) in Dead Slough
(b) Based on water quality data in lieu of sedimentation transects, Year 9 (2001) reported an average water depth of 4.07 feet
(c) Based on water quality data in lieu of sedimentation transects, Year 10 (2002) reported an average water depth of 4.41 feet
(d) The sedimentation rate from 2001 to 2002 was -4.08 inches per year, which suggests that the slough has deepened
(e) From Year 8 (2000) to Year 9 (2001), the average sedimentation rate was approximately 10.56 inches per year, more than likely a result of the 2001 Flood, while in 2002 the channel reversed and became deeper, possibly re-stabilizing

(2) Restore Lentic-Lotic Habitat Access Cross-Sectional Area

(a) Year 50 Target is to maintain a lentic-lotic habitat access cross-sectional area (depth $\geq$ 2') greater than or equal to 180 square feet
(b) Based on results from the August 1997 PER, Year 5 (1997) reported 177.5 square feet of lentic-lotic habitat access cross-sectional area
(c) Based on results from the hydrographic soundings, Year 10 (2002) reported 135 square feet of lentic-lotic habitat access cross-sectional area
(d) While the cross-sectional area has fallen below the Year 50 Target, the flat pool depth is still greater than 2 feet, approximately 3 feet in Year 10 (2002), which is adequate for fish to access Dead Slough
(e) Sediment probes were installed by CRREL within the access channel and Scisco Chute that collected data during the winters of 1999-2000 and 2000-2001, a paper was prepared to summarize these data and is included in Appendix F
(f) If the flat pool depth falls below 2 feet and a remedy is not implemented, such as additional dredging or relocation of the channel, it would effectively isolate the project from the navigation channel, thus stranding fish during severe winter ice conditions, representing the critical ending for this objective

(3) Improve Dissolved Oxygen Concentrations During Critical Stress Periods

(a) Year 50 Target is to maintain a DO concentration greater than or equal to 4 milligrams per Liter (mg/L)
(b) Based on water quality data, Year 10 (2002) reported a minimum, maximum, and average DO concentration of 5.89, 19.66, and 10.61 mg/L, respectively

(c) During 2002, the DO concentration did not fall below 4 mg/L for any of the 12 grab samples

(d) According to the Illinois Department of Natural Resources (ILDNR), no fish kills were reported during the monitoring period

(4) Reduce Sedimentation in Refuge

(a) Year 50 Target is to maintain less than 4.2 acre-feet per year of sedimentation

(b) Based on results from the hydrographic soundings in Year 5 (1997) and Year 10 (2002), an overall average rate of 1.2 acre-feet per year of sedimentation

(c) The pre-project sedimentation rate was estimated to be 17 acre-feet per year while post-project, this rate is 1.2 acre-feet per year, which shows that the diversion drainage ditch feature has significantly reduced sedimentation within the refuge

5. Conclusions and Recommendations. Data and observations collected since the last PER suggest that half of the goals and objectives evaluated for the Andalusia HREP are being met (see Tables 8-1 and 8-2). Continued data collection should better define sedimentation rates and project utilization by migratory waterfowl and other wildlife. Monitoring efforts for the Andalusia HREP have been performed according to the Post-Construction Performance Evaluation Plan in Appendix B, Table B-1, and the Resource Monitoring and Data Collection Summary in Appendix C, Table C-2. The next PER will be a detailed report completed in March of 2008 following collection of field data from January 1, 2003, through December 31, 2007.

Project O&M for the Andalusia HREP has been conducted in accordance with the O&M Manual. The operational requirements have been performed according to Table 2-2. The maintenance of project features has been adequate. Annual project inspections by the ILDNR Site Manager have resulted in proper corrective maintenance actions.

A recommendation for the Andalusia HREP is to complete hydrographic soundings within Dead Slough based on the monitoring plan, thus providing more adequate data to better define deep aquatic habitat depths throughout the entire area. Current analysis is based on data collected at the water quality station. It could be assumed that these depths are representative of the entire Dead Slough area but it is not known for sure if this is indeed the case. In addition, the location of the water quality station is determined through use of landmarks rather than coordinates, so channel depths are not necessarily recorded in the exact same spot each time. While the data from the water quality station may provide some idea of deep aquatic habitat depths, this is not its intended purpose.

A recommendation for future HREPs is to perform sedimentation transects more frequently in the first 10 years and less often in later years rather than every 5 years as typically seen for constructed HREPs.

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POOL 16, MISSISSIPPI RIVER MILES 462.0-463.0 ROCK ISLAND COUNTY, ILLINOIS

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1. INTRODUCTION

The Andalusia Refuge Habitat Rehabilitation and Enhancement Project (HREP), hereafter referred to as the "Andalusia HREP," is a part of the Upper Mississippi River System (UMRS) Environmental Management Program (EMP). The Andalusia HREP is located in Pool 16 on the Illinois side of the Mississippi River navigation channel between River Miles (RM) 462.0 and 463.0. Plate 1 in Appendix M contains a site plan and vicinity map. The Andalusia HREP is operated and maintained by the Illinois Department of Natural Resources (ILDNR) under the terms of a Cooperative Agreement with the United States Fish and Wildlife Service (USFWS).

a. Purpose. The purposes of this Performance Evaluation Report (PER) are as follows:

(1) Supplement monitoring results and project operation and maintenance discussed in the April 2002 Post-Construction PER;

(2) Summarize the performance of the Andalusia HREP, based on the project goals and objectives;

(3) Review the monitoring plan for possible revision;

(4) Summarize project operation and maintenance efforts to date; and

(5) Review engineering performance criteria to aid in the design of future HREPs.

b. Scope. This report summarizes available project monitoring data, inspection records, and field observations made by the United States Army Corps of Engineers (Corps), the USFWS, and the ILDNR for the period from 1992 through 2002, including new data collected during January 1 to December 31, 2002.

2. PROJECT GOALS AND OBJECTIVES

a. General. As stated in the Definite Project Report (DPR), the Andalusia HREP was initiated in response to limited management capability in providing quality habitat for waterfowl due to a lack of water level control. In the refuge south of Dead Slough, little or no water was present during the fall waterfowl migration. Sediments from the Mississippi River and adjacent uplands were decreasing the water volume in the refuge and backwater fisheries. This reduced water volume caused a succession from a dominance of aquatic bed palustrine wetlands to a more emergent plant species as well as decreasing deepwater fish habitat off the main channel.

b. Goals and Objectives. Goals and objectives, formulated during the project design phase, are summarized in Table 2-1.

TABLE 2-1. Project Goals and Objectives

Goals	Objectives	Project Features
Enhance Migratory Waterfowl Habitat	Increase reliable food production area (moist soil species)	Provide water control
	Increase reliable resting and feeding water area	Mechanical dredging
Enhance Aquatic Habitat	Restore deep aquatic habitat (Depth $\geq$ 6')	Mechanical dredging
	Restore lentic-lotic habitat access cross-sectional area	Mechanical dredging
	Improve dissolved oxygen concentration during critical stress periods	Mechanical dredging and gated inlet structure
	Reduce sedimentation in refuge	Construct levee and divert tributary

c. Management Plan. A formal Annual Management Plan has been developed for the Andalusia HREP. This plan was developed by the Corps, in coordination with the ILDNR, as shown in Table 2-2. The Andalusia HREP is managed by the ILDNR under authority of Cooperative Agreements with the Corps and USFWS.

TABLE 2-2. Annual Management Plan

Month	Action	Purpose
May to July	Dewater Moist Soil Management Unit (MSMU) by pumping capability or gravity drainage to the draw down elevation of 542 feet MSL [1/]	Expose mudflats to allow revegetation
August to November	Gradually increase MSMU water levels to correspond with growth of marsh plant community [2/]	Provide access to food plants for migratory waterfowl
December to April	Maintain MSMU water levels to maximum extent possible (elevation 547 feet MSL) primarily by use of the pump station [3/]	Control excessive plant growth, if necessary, and provide stable, deeper water to prevent complete ice-up (a critical concern for resident furbearers)

[1/] Some adjustment shall be made to the drawdown elevation so that fisheries benefits are maximized without adversely impacting moist soil plant production

[2/] Elevations higher than 547 feet MSL must be coordinated with adjacent property owners during the non-crop season

[3/] Dewatering during February through April may be required to accomplish vegetation changes within the MSMU

Flat pool elevation is 545 feet MSL
Channel width is 40 feet
Channel elevation at Station 0+00 is 542 feet MSL. Slope is 0.0005
Channel elevation at water control structure (Station 5+40) is 541.73 feet MSL
Channel elevation at pump station (Station 50+00) is 536 feet MSL
Channel width parallel to levee at pump station is 20 to 40 feet
Ditch elevation at Station 49+45 is 539.67 feet MSL

3. PROJECT DESCRIPTION

a. Project Features. The Andalusia HREP consists of a moist soil management unit, deep aquatic habitat, lentic-lotic access channel, diversion drainage ditch, and project access road. The project features can be seen in Appendix M, Plate 2, and are summarized below in Table 3-1.

TABLE 3-1. Summary of Project Features

Project Feature	Measurement or Quantity	Units of Measure
Perimeter Levee		
Length	8,600	Feet
Crown Width	12/60	Feet
Side Slopes	4:1	Horizontal:Vertical
Design Top Elevation	551.8-552.8	Feet MSL
Embankment Volume	92,000	Cubic Yards
Overflow Section		
Length	600	Feet
Level of Protection	2	Year Event
Design Top Elevation	550.8	Feet MSL
Riprap	5,200	Tons
Pump Station		
Sump Elevation	539.5	Feet MSL
Equipment Elevation	560	Feet MSL
Sluice Gate	3	Square Feet
Trash Racks	2	Each
Fence Screen	2	Each
Submersible Pumps	2	Each
Capacity Rating	6,775	Gallons per Minute
Total Dynamic Head	8.5	Feet
Water Control Structure	1	Each
Sluice Gate	3	Square Feet
Invert Elevation	542	Feet MSL
Interior/Side Drainage		
Length	10,900	Feet
Bottom Width	20/40	Feet
Bottom Elevation	536-542	Feet MSL
Bottom Slope	0.0005	Foot per Foot
Islands	27	Each
Area (above 545 feet MSL)	9	Acres
Deep Aquatic Habitat		
Length	4,500	Feet
Bottom Width	60	Feet
Bottom Elevation	536	Feet MSL
Excavation Volume	87,000	Cubic Yards

TABLE 3-1 (Continued) Summary of Project Features		
Project Feature	**Measurement or Quantity**	**Units of Measure**
Lentic-Lotic Access Channel		
Length	1,100	Feet
Bottom Width	30	Feet
Bottom Elevation	538-541	Feet MSL
Excavation Volume	23,000	Cubic Yards
Diversion Drainage Ditch		
Length	2,430	Feet
Side Slopes	3:1	Horizontal:Vertical
Bottom Width	30	Feet
Bottom Elevation	544-550	Feet MSL
Bottom Slope	0.0025	Foot per Foot
Watershed Area	1.152	Acres
Channel Capacity	340	CFS
Level of Protection	2	Year Event
Project Access Road		
Length	3,600	Feet
Crown Width	12	Feet
Side Slopes	2:1	Horizontal:Vertical

(1) Moist Soil Management Unit (MSMU). The main feature is the perimeter levee, constructed to protect the 130-acre MSMU. Other MSMU features include a pump station, water control structure, and interior/side drainage channels with associated islands.

(a) Perimeter Levee. The MSMU is surrounded by a perimeter levee approximately 8,600 feet in length with a 12-foot crown (60-foot crown parallel to Dead Slough) and 4 horizontal on 1 vertical side slopes. The top elevation of the perimeter levee varies from 551.8 to 552.8 feet MSL. The perimeter levee at the downstream end consists of a 600-foot-long armored overflow section from Station 24+17CE to Station 30+17CE. The overflow section has a crown width of 12 feet and the side slopes are protected with 6 inches of bedding overlain by 24 inches of riprap. The top elevation of this section is 550.8 feet MSL, equivalent to a 2-year frequency flood event.

(b) Pump Station. The location of the pump station is near the downstream end of the perimeter levee within the overflow section at Station 28+70CE. The pump station is equipped with two pumps that provide the capability to dewater the MSMU during drawdown times and to add water from the Mississippi River into the MSMU if rainfall is insufficient to maintain desired water levels. The pump station was sized to evacuate the MSMU in approximately 14 days. However, actual performance exceeds design requirements. The pump station has dewatered the MSMU in about 7 to

10 days. The rated capacity of both pumps is 6,775 gallons per minute at a Total Dynamic Head (TDH) of 8.5 feet. The pump station includes trash racks on both the MSMU and riversides. A sedimentation zone was provided on the MSMU side, which consists of an overflow weir protecting the entrance to the pump station to minimize the input of sediment during drawdown periods. The pump station also has two fence screens on the riverside to provide additional protection. The pump station houses an electrically driven 3-foot by 3-foot sluice gate to allow passage of gravity flows. This gate is used only when gravity discharge through the water control structure alone does not have sufficient capacity to drain the refuge as quickly as required, or when access to the water control structure is difficult due to wet conditions that would cause damage to the levee surface.

(c) Water Control Structure. The water control structure consists of a 36-inch-diameter concrete conduit controlled by a 3-foot by 3-foot sluice gate and is located within the perimeter levee section near the eastern edge of Dead Slough at approximately Station 22+00. The invert of the conduit is at elevation 542 feet MSL.

(d) Interior/Side Drainage Channels with Associated Islands. Interior drainage within the MSMU is provided through excavated fish access channels. Two types of typical sections were constructed—Type I and Type II. A Type I section consists of drainage channels constructed on both sides of an island. The excavated material produces an approximate 45-foot-wide island with a top elevation of 551 feet MSL. A Type II section consists of a drainage channel constructed on one side of an island. The excavated material produces an approximate 10-foot-wide island with a top elevation of 551 feet MSL. The overall length of the refuge drainage channels is close to 8,600 feet. The MSMU was designed to provide a reliable resting and feeding area for migrating waterfowl in existing open areas, as well as an additional food source within the inundated “green tree” portion of the unit.

(2) Deep Aquatic Habitat. The Contractor excavated approximately 85,000 cubic yards from Dead Slough for deep aquatic habitat improvement. Upon completion, a channel approximately 4,500 feet in length was excavated to 9 feet below flat pool (elevation 545 feet MSL) with an average bottom width of 60 feet. The excavated material was placed in the levee section adjacent to Dead Slough.

(3) Lentic-Lotic Access Channel. A 1,100-foot lentic-lotic access channel connects Scisco Chute to Dead Slough. Originally, the access channel was constructed to have a bottom width of approximately 30 feet with a depth that varied from 4 feet to 9 feet below flat pool (elevation 545 feet MSL). However, the access channel experienced greater than estimated sedimentation rates as a result of the Great Flood of 1993. It was subsequently re-excavated in March 1994 to 7 feet below flat pool to match existing river bottom elevations. The access channel was again excavated in 1998 to 5 feet below flat pool following the Flood of 1997.

(4) Diversion Drainage Ditch. Drainage from the watershed along the upstream or eastern edge of the project area is routed through the diversion drainage ditch to Scisco Chute. The bottom width of the excavated ditch is approximately 30 feet, with

an average depth of 3 feet. The drainage ditch was sized to pass a 2-year frequency flood event within the banks. The outlet of the diversion drainage ditch into Scisco Chute was placed near flat pool (elevation 545 feet MSL) in order to reflect the previous drainage outlet and minimize maintenance. The diversion drainage ditch was designed to reduce the present sediment load in the watershed by approximately 25 percent as discussed in the DPR, Appendix K. This reduction should improve the water quality in Dead Slough by reducing suspended solids and chemicals associated with agricultural runoff.

(5) Project Access Road. The approximately 3,600-foot-long project access road follows the Government property line from the pump station to the county road just outside the project limits. The top width of the access road is 12 feet. Crushed stone was placed to a depth of approximately 6 inches.

b. Project Construction. Following award of the construction contract on August 24, 1989, dredging began during late summer. Deep aquatic habitat excavation was finished in the summer of 1992. The Great Flood of 1993 caused minor erosion along the access road and some silting of the ditches. These areas were restored by contract modification. Re-excavation of the access channel to remove sediment deposited as a result of the Great Flood of 1993 was completed in March 1994 by the Corps' labor forces. The Andalusia HREP was essentially complete in September 1994. A low water crossing was installed to improve access road drainage and reduce sedimentation buildup in August 1997. The access channel was re-excavated in 1998 following the Flood of 1997.

c. Project Operation and Maintenance. Operation and maintenance (O&M) of the Andalusia HREP is the responsibility of the ILDNR in accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580. These functions are further defined in the O&M Manual. The project features were designed and constructed to minimize the operation and maintenance requirements. Project operation and maintenance generally consists of the following:

(1) Mowing and maintaining the perimeter levee to ensure serviceability during times of flood;

(2) Operating the pump station and water control structure to achieve desired water levels consistent with vegetative growth, and opening the gates to minimize overtopping erosion when the river reaches elevation 550 feet MSL on the Fairport gage with predicted stage to increase;

(3) Maintaining the interior/side drainage channels with associated islands as determined by the ILDNR Site Manager; and

(4) Removing snags and other debris from Dead Slough, the access channel, and the diversion drainage ditch.

4. PROJECT MONITORING

a. General. Appendix B presents the Post-Construction Evaluation Plan (Table B-1), along with the Sedimentation Transect Project Objectives Evaluation (Table B-2). These references were developed during the design phase and serve as a guide for measuring and documenting project performance. The Post-Construction Evaluation Plan also outlines the monitoring responsibilities for each agency. Appendix C contains the Monitoring and Performance Evaluation Matrix (Table C-1) and Resource Monitoring and Data Collection Summary (Table C-2). The Monitoring and Performance Evaluation Matrix outlines the monitoring responsibilities for each agency. The Resource Monitoring and Data Collection Summary presents the types and frequency of data needed to meet the requirements of the Post-Construction Evaluation Plan. Plate 3 in Appendix M contains the monitoring plan for the Andalusia HREP.

b. U.S. Army Corps of Engineers. The success of the project relative to original project objectives shall be measured by the Corps, USFWS, and ILDNR through data collection and field observations. The Corps has overall responsibility to evaluate and document project performance.

The Corps is responsible for collecting field data as outlined in the Post-Construction Evaluation Plan at the specified time intervals. The Corps shall also perform joint inspections with the USFWS and ILDNR in accordance with ER 1130-2-339. The purpose of these inspections is to assure that adequate maintenance is being performed as presented in the DPR and O&M Manual. Joint inspections should also occur after any event that causes damage in excess of annual operation and maintenance costs.

c. U.S. Fish and Wildlife Service. The USFWS does not have project-specific monitoring responsibilities. However, the USFWS should be present at the joint inspections with the Corps and ILDNR as described in the previous paragraph.

d. Illinois Department of Natural Resources. The ILDNR is responsible for O&M, as well as monitoring the project through field observations during inspections. Project inspections should be performed on an annual basis following the guidance presented in the O&M Manual. It is recommended that the inspections be conducted in May or June, which is representative of conditions after spring floods. Joint inspections with the Corps and USFWS shall also be conducted as mentioned above. During all inspections, the ILDNR should complete the checklist form as provided in the O&M Manual. This form should also include a brief summary of the overall condition of the project and any maintenance work completed since the last inspection. Once completed, a copy of the form shall be sent to the Corps.

5. EVALUATION OF MIGRATORY WATERFOWL HABITAT OBJECTIVES

a. Increase Reliable Food Production Area.

(1) Monitoring Results. One of the objectives for enhancing migratory waterfowl habitat is to increase the reliable food production area through water level control. As shown in Appendix B, Table B-1, the Year 50 Target is to attain more than 130 acres of reliable food production area (moist-soil species). At Year 0 (1992), moist-soil species within the MSMU were minimal. The August 1997 PER reported qualitatively 40 acres of reliable food production area in Year 4 (1996). Corps personnel conducted informal vegetation surveys on three occasions in 1996. These field observations at several locations in the MSMU revealed good growth of moist-soil vegetation, particularly in the downstream portion of the project. Moist-soil plants representing four genera, namely pigweeds (*Amaranthus*), nutsedges (*Cyperus*), wild millet or barnyard grass (*Echinochloa*), and smartweeds (*Polygonum*), were observed in the drawdown areas of the MSMU. Additional discussion was included in the August 1997 PER. Since then, additional surveys have not been conducted. According to Table C-2 in Appendix C, informal vegetation surveys are required every 5 years by the Corps.

ILDNR personnel performed an inventory of moist-soil vegetation on August 28, 1996. Twenty-five plots (each 2 feet in size) were sampled to determine species composition, height, and percentage of ground coverage for each species present. A total of nine species occurred in sample plots (listed by percentage of occurrence); pigweed (68%), nutsedge (40%), bulrush-live (36%), bulrush-dead (36%), smartweed (32%), barnyard grass (28%), reed canary grass (12%), American lotus (8%), cattail (4%), and cucumber vine (4%). Pigweed was the most dominant species within the sampled plots, comprising 24.6% of the ground cover. Other dominant species included bulrush-dead (21.4%), bulrush-live (12.8%), and nutsedge (10.2%).

Although willows within the MSMU were sprayed during construction, the inundation of the islands during flood events has not been sufficient to kill the willows that have started to take over since project completion. To control encroachment of bulrush, lotus, and willow, the ILDNR Site Manager had the MSMU aerially sprayed with herbicide in the spring of 1996. This was the last time the MSMU was treated in this manner. Field observations and examination of photographs taken during an aerial survey of the project in the fall of 1996 indicated that some remnants of this less desirable growth were still present in the upstream portion of the MSMU and on top of the islands. As a result, approximately half of the islands were burned in the spring of 1997 with the remaining islands burned in 1998 to once again attack the undesirable woody vegetation.

(2) Conclusions. Field observations and vegetation surveys within the MSMU in addition to corrective maintenance actions indicate good progress toward meeting the Year 50 Target acreage for moist-soil production. The acreage increased from a minimal amount in Year 0 (1992) to 40 acres in Year 4 (1996) and appears to be increasing. Water level control appears to be successful in promoting the growth of natural waterfowl food sources such as smartweeds, wild millet, pigweeds, and nutsedges. Continued

management of the MSMU is in accordance with the plan outlined in Table 2-2. In addition, burning and herbicide application as performed by the ILDNR Site Manager when necessary, should allow for the target acreage to be met in future years.

b. Increase Reliable Resting and Feeding Water Area.

(1) Monitoring Results. The other objective for enhancing migratory waterfowl habitat is to increase the reliable resting and feeding water area through mechanical dredging. As presented in the DPR, the Year 50 Target was to maintain 200 acres of reliable resting and feeding water area. This acreage was based on a MSMU configuration that included Dead Slough. However, the larger MSMU configuration is not accurate for this objective, as it would have greatly diminished the fishery benefits gained from dredging Dead Slough. Therefore, in the August 1997 PER, the Year 50 Target was revised based on an MSMU configuration that does not include Dead Slough using hydrographic soundings conducted in January 1997. Since then, the objective is to maintain 50 acres of reliable resting and feeding water area as shown in Appendix B, Table B-1. This acreage is the water surface area inside the perimeter levee during the winter months when the MSMU is maintained at a maximum water elevation or approximately 547 feet MSL. A discussion of this revision was included in the August 1997 PER.

TABLE 5-1. Increase Reliable Resting and Feeding Water Area

Transect	Average Channel Width (feet)	Channel Length (feet)	2002 Water Surface Area (acres)	1997 Water Surface Area (acres)
A	1128	600	15.5	
C	462	1200	12.7	
E	650	1600	23.9	
I	1317	1100	33.3	
K	847	700	13.6	
Total		5200	**99.0**	49.3
Target			**50.0**	

According to Appendix C, Table C-2, hydrographic soundings are required every 5 years by the Corps. Hence, additional soundings were completed in July 2002. Using these data, the average channel width could be calculated by measuring the distances along each transect at the maximum water elevation of 547 feet MSL. The channel length was determined using a distance representative of the average channel width for each individual transect. Once these two values were known, the water surface area could be estimated. The water surface area in 2002 was found to be approximately 99.0 acres, generously exceeding the Year 50 Target of 50 acres. These data are summarized in Table 5-1, while the hydrographic soundings can be seen on Plates 4 and 6 in Appendix M.

(2) Conclusions. The Andalusia HREP is meeting the objective of providing reliable resting and feeding water area. In 1997, the water surface was documented at 49.3 acres. Therefore, the amount of reliable resting and feeding water area has doubled in the last 5 years. The reason for this can be clearly seen by looking at Transect A on Plate 4. It appears that the existing ground adjacent to the interior drainage channels has lowered in elevation from Year 5 (1997) to Year 10 (1992). In 1997, this area was near the maximum water elevation of 547 feet MSL. In 2002, this same area was below 547 feet MSL. Hence, the surface area for the existing ground adjacent to the interior drainage channels was not included in the acreage for reliable resting and feeding water area in 1997 but was in 2002, resulting in a substantial increase.

Additional hydrographic soundings or aerial photography will provide the continual data needed to determine the future amount of reliable resting and feeding area. Hydrographic soundings inside the perimeter levee should be performed early in the year (January or February) when the MSMU is at increased water levels.

6. EVALUATION OF AQUATIC HABITAT OBJECTIVES

a. Restore Deep Aquatic Habitat (Depth $\geq$ 6').

(1) Monitoring Results. One of the objectives for enhancing aquatic habitat is to restore the deep aquatic habitat through mechanical dredging to a depth greater than or equal to 6 feet. As shown in Appendix B, Table B-1, the Year 50 Target is to maintain more than 40 acre-feet of deep aquatic habitat. Hydrographic soundings for Dead Slough were conducted at project completion to reflect as-built conditions and again in 1996. A discussion of that data was included in the August 1997 PER. Additional soundings were completed in July 2002, but that data did not include Dead Slough. According to Table C-2 in Appendix C, hydrographic soundings are required every 5 years by the Corps.

However, channel depths were recorded during water quality monitoring. Station W-M462.5O is located adjacent to sedimentation transect "C". This portion of the channel was designed to have an ideal water depth of greater than or equal to 6 feet at Year 50. As seen in Table 6-1, Station W-M462.5O or transect "C" has an average flat pool depth of 4.41 feet at Year 10, which is less than the ideal water depth of 6 feet.

TABLE 6-1. Restore Deep Aquatic Habitat

Year	W-M462.5O Flat Pool Depth (Feet)	W-M462.5O Sedimentation Rate (In/Yr)
0 (1992)	7.31	
0-2		1.44
2 (1994)	7.12	
2-3		0.6
3 (1995)	7.07	
3-4		7.92
4 (1996)	6.41	
4-6		6.42
6 (1998)	5.34	
6-7		4.32
7 (1999)	4.98	
7-8		0.36
8 (2000)	4.95	
8-9		10.56
9 (2001)	4.07	
9-10		-4.08
10 (2002)	**4.41**	
0-10		4.17
50 (Target)	**6.00**	

The flat pool depths were determined by adjusting the water depths recorded during site visits in 2002. Using historical water profiles, the pool elevation at the Andalusia HREP could be determined by interpolating between two stream gages on the Mississippi River. To view individual water depths for each site visit and the steps taken to adjust these values to depths relative to flat pool, refer to Appendix E, Table E-2.

Sedimentation within the Andalusia HREP as stated in the DPR is due to the combination of two sources, namely the Mississippi River and adjacent uplands. Based on 1936 through 1987 data, the DPR estimated an overall average sedimentation rate for the entire area of 0.5 inch per year. The DPR estimate of the sedimentation rate in Dead Slough, or near Transect C, was greater than the estimated overall average. This rate was estimated to be about 0.8 inch per year. In 2002 or Year 10, an overall average sedimentation rate of 4.17 inches per year was determined as shown in Table 6-1. This rate was determined by taking the best-fit line of channel depth versus time (see Figure E-3 in Appendix E).

It should be noted that the average sedimentation rates from 1995 to 2000 steadily decreased from year to year. This decline may have suggested that the slough was approaching a stable condition. From Year 7 to Year 8, the average sedimentation rate was approximately 0.36 inch per year. This rate closely resembles the determined value in the DPR. However, from Year 8 to Year 9, the average sedimentation rate was approximately 10.56 inches per year. This high rate is more than likely a result of the 2001 Flood. Then in 2002, the channel reversed and became deeper, possibly re-stabilizing.

(2) Conclusions. It appears that the Andalusia HREP may or may not be meeting the objective of restoring deep aquatic habitat by maintaining an average flat pool depth of greater than or equal to 6 feet. It could be assumed that these depths are representative of the entire project area, but since the monitoring results were based solely on data collected at the water quality station, it is not known for sure if this is indeed the case. In addition, the location of the water quality station is determined through use of landmarks rather than coordinates, so channel depths are not necessarily recorded in the exact same spot each time. While the data from the water quality station may provide some idea of deep aquatic habitat depths, this is not its intended purpose. Therefore, future hydrographic soundings based on the monitoring plan should result in more adequate data to better define deep aquatic habitat depths throughout the entire project area.

The design bottom elevation of 536 feet MSL for deep aquatic habitat was based on an ideal water depth of 6 feet, a low-flow regulation of 1 foot below flat pool, and sediment deposition of 2 feet over a project life of 50 years. The 2 feet of sediment accumulation is equivalent to an annual sedimentation rate of 0.5 inch per year. The average sedimentation rate was found to be more than 4 inches per year. This high rate of sediment deposition may be the result of the area being inundated during the 2001 Flood. However, in Year 10 (2002), the slough was actually deeper than the previous year, which could mean re-stabilization of the channel following the flood. However, this theory will not be known for sure until additional data are collected in future years.

b. Restore Lentic-Lotic Habitat Access Cross-Sectional Area.

(1) Monitoring Results. Another objective for enhancing aquatic habitat is to restore the lentic-lotic habitat access through mechanical dredging. As shown in Appendix B, Table B-1, the Year 50 Target is to maintain more than 180 square feet of lentic-lotic habitat access cross-sectional area. Hydrographic soundings were conducted at project completion to reflect as-built conditions. In the 1993 Flood Damage Assessment Report, it was noted that the lentic-lotic habitat access channel had silted in considerably, from a post-construction range of elevation 536 through 541 feet MSL to 544 feet MSL in some places. In response to this report, the channel was re-excavated in March 1994 to elevation 538 feet MSL by Corps labor forces.

Hydrographic soundings were conducted again in 1997. A discussion of these data was included in the August 1997 PER. It was found that the average elevation near the mouth of the channel was approximately 543 feet MSL. This elevation was only 2 feet below flat pool. It was determined nearly 178 square feet of lentic-lotic habitat access cross-sectional area existed, which was essentially the same as the Year 50 Target. Following this report, a hydraulic study was conducted in October 1997 to determine the cause of the high sedimentation rate at the entrance to the lentic-lotic habitat access channel. The results of the study indicated that bank sloughing was the primary cause of excessive sedimentation near the channel entrance. Field reconnaissance revealed unstable banks with numerous slope failures. Existing bank slopes of 1H:1V and steeper were observed where the design slope was 2H:1V.

The 1997 hydraulic study proposed remedial solutions to alleviate the high sedimentation rate. In order to maintain an access depth of 3.5 feet, it was recommended that the bank slopes near the entrance to the lentic-lotic habitat access channel be graded to the design slope of 2H:1V (preferably 3H:1V) and then protected with vegetation. In addition, it was recommended that the access channel be excavated to a depth of 3.5 feet below flat pool with the dredged material placed at least 50 feet beyond the crest of the downstream bank. Placement of dredged material on the downstream shore of Scisco Island was also stated as being acceptable. The other option was to relocate the access channel. The current entrance to the access channel is located near the downstream end of Scisco Island where sediment deposition is greatest. The lowest bottom elevation within Scisco Chute (elevation 536 feet MSL) is located approximately 2,400 feet upstream of the existing channel entrance. This would be the ideal location for the access channel. The report from this study is located in Appendix F of the June 2001 PER.

In response to these recommendations, Corps labor forces excavated a portion of Scisco Chute and the access channel in 1998 to elevation 540 feet MSL or 5 feet below flat pool. Also, the banks were sloped back and vegetation was planted. After additional sediment deposition occurred, the access channel was visited in the summer of 1999. At this time, a second channel connecting the navigation channel to Dead Slough was discovered farther downstream. More than likely, flow is entering Dead Slough through the access channel and exiting through the second channel. If this is the case, then the access channel is unable to naturally “flush” itself out.

In December 1999, the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) initiated a study on the effects of ice cover on the rate of erosion/deposition of riverbed sediments. As part of this study, robust scour probes were installed in Scisco Chute and the access channel to monitor conditions throughout the area. These probes are capable of real-time monitoring of a full scour cycle that is independent of water velocity and water temperature. The field observations along with a discussion of these observations are documented in the paragraphs below. The complete paper prepared by CRREL is included in Appendix F.

> “Bed elevations were monitored at six locations using the TDR [time-domain reflectometry] probes during the winters of 1999-2000 and 2000-01 (Zabilansky, in prep.). Probes were installed in the side channel [Scisco Chute] and the dredged [access] channel for the reserve; channel depths were 3 and 1.5 m, respectively. Water velocities within the pool were relatively low, and a thermally grown ice cover formed in place with a relatively smooth bottom surface. Being a regulated pool, the stage was not allowed to increase as the ice cover formed. The maximum ice thickness in the confluence area was on the order of 22 cm, and ice completely covered the width of the river. There was no appreciable change in bed elevation in the side channel during the winter, but material was deposited in the dredged channel. Ice melted in place starting in the navigation channel. As the ice melted in the navigation channel, material started to deposit in the side channel and continued to deposit in the dredged channel. Deposition continued until the side channel was ice-free.”
>
> “…when the entire river was ice covered, the velocity profiles across the river were similar, with comparable near-bed velocities. As the navigation channel melted out, it was able to accommodate a larger portion of the flow, reducing the discharge and water velocity in the side channel. The lower velocity cannot carry the suspended sediment, and it precipitated out, detected by the increase in bed elevation at the monitoring points in the side channel.”

According to Appendix C, Table C-2, the Corps requires hydrographic soundings every 5 years. Hence, additional soundings were completed in July 2002. Using these data, the lentic-lotic habitat access cross-sectional area could be calculated by determining the area below flat pool (elevation 545 feet MSL) for Transects D1 and D2. Transect D1 is located at the north end of the channel near Scisco Chute. Transect D2 is located at the south end of the channel near Dead Slough. The cross-sectional area in 2002 was found to be 90 square feet for Transect D1 and 180 square feet for D2. It makes sense that Transect D1 is filling in more quickly than Transect D2 as it is more directly impacted by flows from the river due to its location. The average cross-sectional area in Year 10 (2002) is 135 square feet. Therefore, the amount of lentic-lotic habitat access cross-sectional area has decreased by 43 square feet in the last 5 years and falls farther below the Year 50 Target of 180 square feet. A summary of these data is displayed in Table 6-2, while the hydrographic soundings can be seen on Plate 5 in Appendix M.

The channel needs to maintain an ideal water depth of greater than or equal to 2 feet at Year 50 in order to provide adequate access for fish. This depth was based on an estimated maximum ice thickness of 14 inches during the harshest of winters. The data CRREL collected from the sediment probes determined a maximum ice thickness between 8 and 9 inches during the winters of 1999-2000 and 2000-2001. Therefore, the 2-foot ideal water depth for adequate fish access is conservative. As seen in Table 6-2, Transects D1 and D2 have flat pool depths of 3.0 and 3.1 feet at Year 10, respectively, which are greater than the ideal water depth of 2 feet. When comparing the 1997 and 2002 data, it appears that the depths have balanced out. In 1997, Transect D1 was 1 foot shallower, while Transect D2 was 1 foot deeper and now they are pretty much the same depth.

TABLE 6-2. Restore Lentic-Lotic Habitat Access

	Cross-Sectional Area (SF)			Channel Depth (Feet)		
Year	**Transect D1**	**Transect D2**	**Average**	**Transect D1**	**Transect D2**	**Average**
0 (1992)	308	308	308	4 to 7	4 to 7	4 to 7
5 (1997)	105	250	177.5	2.0	4.4	3.2
10 (2002)	**90**	**180**	**135**	3.0	3.1	3.05
50 (Target)	**180**	**180**	**180**	2.0	2.0	2.0

(2) Conclusions. The Andalusia HREP may or may not be meeting the objective of restoring the lentic-lotic habitat access channel. While the cross-sectional area has fallen below the Year 50 Target, the flat pool depth is still greater than 2 feet, approximately 3 feet in Year 10 (2002), which is adequate for fish to access Dead Slough.

Since the depths in the access channel have been significantly low in the past, the remaining life of this objective is cause for concern and continued monitoring efforts are warranted. If the flat pool depth falls below 2 feet and a remedy is not implemented, such as additional dredging or relocation of the channel, it could be said that lentic-lotic habitat has been lost. Should this loss of depth occur, it would effectively isolate the project from the navigation channel, thus stranding fish during severe winter ice conditions. This point would represent the critical ending for the objective of providing lentic-lotic habitat access. By Year 10 (2002), this critical point has been reached and corrected through dredging on more than one occasion. Although lentic-lotic habitat access may diminish, the water areas shall continue to have significant long-term benefits for waterfowl and other wildlife, even with portions of the project maintaining depths greater than 2 feet.

c. Improve Dissolved Oxygen Concentration During Critical Stress Periods.

(1) Monitoring Results. The water quality objective of the Andalusia Refuge project is to improve dissolved oxygen (DO) concentrations in Dead Slough during critical

seasonal stress periods. As shown in Appendix B, Table B-1, the goal of the project is to maintain a DO concentration greater than 4 milligrams per liter (mg/l) most of the time. Prior to project completion, severe summer and winter fish kills in Dead Slough were reported by local residents and ILDNR personnel. It is presumed these fish kills were due to low DO concentrations coupled with thermal stresses. In an effort to avoid future fish kills, dredging was utilized to create deep aquatic habitat within Dead Slough and an access channel from the slough to the Mississippi River.

Post-project water quality monitoring in Dead Slough has been ongoing since April 7, 1992, at site W-M462.5O. This site is located in a dredged channel as shown in Appendix M, Plate 3. The initial post-evaluation report for this project covered the period April 7, 1992, through February 25, 1997. Subsequent performance evaluation reports covered the periods June 18, 1997, through September 19, 2000, and January 3, 2001, through September 18, 2001. Reported herein are water quality data collected from January 8, 2002, through December 17, 2002. Data were obtained through a combination of periodic grab samples and the use of in-situ continuous monitors.

Grab samples were collected just below the surface on 11 occasions. The site was visited approximately twice per month from June through September and monthly from December through March. Sampling was not performed during April, May, October, and November. The following variables were typically measured: water depth, velocity, wave height, air and water temperature, cloud cover, wind speed and direction, DO, pH, total alkalinity, specific conductance, Secchi disk depth, turbidity, suspended solids, chlorophyll (a, b, and c) and pheophytin a.

In-situ water quality monitors (YSI model 6000UPG or 6600UPG sondes) were deployed on 8 occasions. Sondes were positioned 3 feet above the bottom and were typically deployed for a period of 2 weeks during the summer months and 7 weeks during the winter months. The sondes were normally equipped to measure DO, temperature, pH, specific conductance, depth, and turbidity.

The results from periodic grab samples collected at site W-M462.5O are found in Appendix E, Table E-1. This table includes the results from DO and ancillary parameters that are useful in the interpretation of DO data. DO concentrations ranged from 5.89 mg/l to 19.66 mg/l. None of the DO measurements were below the 4 mg/l target level. The average DO concentration (10.61 mg/l) at the site was more than twice the target value. Supersaturated DO concentrations were observed during the three winter sampling events.

In-situ continuous monitors were deployed at site W-M462.5O on 8 occasions (1 during the winter and 7 during the summer). Unfortunately, the monitor deployed during the winter failed and no data were collected. However, DO measurements taken when the monitor was deployed (January 8, 2002) and retrieved (February 28, 2002) showed supersaturated conditions. DO data from two of the seven summer deployments also were unusable. Data from the remaining five summer deployments showed that DO concentrations occasionally fell below the 4 mg/l target level (usually at night); however, this condition never persisted for more than one day. Daytime DO concentrations usually exceeded 4 mg/l as a result of plant photosynthesis. Figures E-1 and E-2 in Appendix E display the range of DO concentrations measured with a continuous monitor during the summer. No DO concentrations were below 4 mg/l during the August 29 to September 10 deployment (see Figure E-1), while the longest period that DO concentrations remained below 4 mg/l (about 22 hours) was seen during the August 1 to August 14 deployment (see Figure E-2). The typical diel pattern of rising pH and DO values during the day and falling pH and DO values during the night is exhibited in both figures.

(2) Conclusions. The goal of the Andalusia Refuge EMP project is to maintain a DO concentration greater than 4 mg/l most of the time. The project was successful in attaining this goal during the 2002 monitoring period. During the critical winter months, the DO concentration remained well above 4 mg/l. During the summer, DO concentrations occasionally fell below 4 mg/l during the night; however, values usually recovered during the day. Another indication of the project's success is the fact that several fish kills were reported prior to project completion; however, according to Ed Walsh, Rivers Biologist with the ILDNR, no fish kills were reported during 2002.

Essentially no pre-project water quality samples were collected from site W-M462.5O, as it was difficult to access. Therefore, it is impossible to make comparisons between pre- and post-project water quality data. Comparisons of DO data from surface samples collected at site W-M462.5O during the previous and current post-project evaluation periods are summarized in the table below.

TABLE 6-3. Improve DO Concentration During Critical Stress Periods				
Water Quality Station W-M462.5O	Post-Project 04/07/92 to 02/25/97	Post-Project 06/18/97 to 09/19/00	Post-Project 01/03/01 to 09/18/01	Post-Project 01/08/02 to 12/17/02
Total Number of Samples	42	41	12	11
Winter (Oct-Mar) Samples	17	10	4	3
Summer (Apr-Sep) Samples	25	31	8	8
Total DO Samples ≤ 4 mg/L	2 (4.8%)	1 (2.4%)	0	0
Winter DO Samples ≤ 4 mg/L	0	0	0	0
Summer DO Samples ≤ 4 mg/L	2 (8.0%)	1 (3.2%)	0	0
Minimum DO (mg/L)	3.04	3.86	5.47	*5.89*
Maximum DO (mg/L)	24.00	25.99	14.37	*19.66*
Average DO (mg/L)	10.69	9.96	10.15	*10.61*

The average DO concentration for the current evaluation period (10.61 mg/l) is nearly identical to that observed during the initial evaluation period (10.69 mg/l). Post-project surface water samples collected during the fall/winter have never fallen below the target level, while those collected during the spring/summer have fallen below the target level on only three occasions.

d. Reduce Sedimentation in Refuge.

(1) Monitoring Results. The final objective for enhancing aquatic habitat is to reduce sedimentation in the refuge. As shown in Appendix B, Table B-1, the Year 50 Target is to maintain less than 4.2 acre-feet per year of sedimentation in the refuge. In order to achieve this objective, a drainage ditch was constructed to divert adjacent watershed erosion and sediment deposition around the Andalusia HREP to Scisco Chute. Although the MSMU is protected from a 2-year flood event by the perimeter levee, this project feature is not considered to contribute towards sediment reduction and therefore was not a factor when the target sedimentation rate was estimated. A sedimentation study conducted during the design phase, which is documented in the DPR, estimated a pre-

project sedimentation rate of 17 acre-feet per year, with the navigation channel contributing 6 acre-feet per year and adjacent watersheds contributing 11 acre-feet per year. This estimated rate was based upon the pre-project hydrographic soundings, a sediment deposition of 1 inch per year, and a project area of 200 acres (includes both Dead Slough and the MSMU).

Hydrographic soundings within the MSMU were conducted again after project completion to reflect as-built conditions and again in 1997. A discussion of these data was included in the August 1997 PER. It was determined that the channel volume was approximately 106.7 acre-feet. According to Appendix C, Table C-2, hydrographic soundings are required every 5 years by the Corps. Hence, additional soundings were completed in July 2002. These soundings are illustrated on Plates 4 and 6 in Appendix M. Using these data, the channel volume could be calculated by taking the cross-sectional areas of Transects A, C, E, I, and K and multiplying them by the respective channel lengths.

TABLE 6-4. Reduce Sedimentation in Refuge
Summary of Hydrographic Soundings

Year	Channel Volume (Ft^3)	Channel Volume (Ac-Ft)	Sedimentation Rate (Ac-Ft/Yr)
0 (1992)	4,948,000	113.6	
0-5			1.4
5 (1997)	4,645,500	106.7	
5-10			**1.2**
10 (2002)	4,385,600	100.7	
50 (Target)			**4.2**

As shown in Table 6-4, the channel volume was found to be approximately 100.7 acre-feet. The sedimentation rate could then be determined by subtracting the 2002 channel volume from the 1997 channel volume and dividing by the elapsed time of 5 years. Using this formula, the sedimentation rate was found to be approximately 1.2 acre-feet per year.

Another way to evaluate this objective would be to assume that the sedimentation rates determined for Dead Slough (Table 6-1) are similar to those observed within the MSMU. In order to accomplish this task, the slough sedimentation rates were determined in inches per year using the channel depths recorded during water quality monitoring and next converted to acre-feet per year using a Dead Slough area of 150 acres and then divided by three to estimate the refuge sedimentation rates (since the MSMU is comprised of approximately 50 acres). The results are summarized in Table 6-5.

TABLE 6-5. Reduce Sedimentation in Refuge Summary of Water Quality Data				
Year	W-M462.5O Flat Pool Depth (Feet)	W-M462.5O Sediment Rate (In/Yr)	W-M462.5O Sediment Rate (Ac-Ft/Yr)	Refuge Sediment Rate (Ac-Ft/Yr)
0 (1992)	7.31			
0-2		1.44	18	6
2 (1994)	7.12			
2-3		0.6	7.5	2.5
3 (1995)	7.07			
3-4		7.92	99	33
4 (1996)	6.41			
4-6		6.42	80	27
6 (1998)	5.34			
6-7		4.32	54	18
7 (1999)	4.98			
7-8		0.36	4.5	1.5
8 (2000)	4.95			
8-9		10.56	132	44
9 (2001)	4.07			
9-10		-4.08	-51	-17
10 (2002)	4.41			
0-10		3.48	43.5	**14.5**
50 (Target)	6.00			
0-50		1	12.5	**4.2**

When comparing Tables 6-4 and 6-5, it can be seen that the assumption made for the second analysis is not valid. The estimated sedimentation rate of 1.2 acre-feet per year is significantly less than the sedimentation rate of 14.5 acre-feet per year based on data collected in the slough rather than the refuge. Therefore, future PERs will not include the second analysis for this objective.

(2) Conclusions. The Andalusia HREP appears to be meeting the objective of reducing sedimentation in the refuge through construction of a diversion drainage ditch. The refuge sedimentation rate from 1997 to 2002 was determined to be 1.2 acre-feet per year, which is well below the Year 50 Target of 4.2 acre-feet per year. The pre-project sedimentation rate was estimated to be 17 acre-feet per year, while post-project, this rate is 1.2 acre-feet per year, which proves that the construction of the diversion drainage ditch has significantly reduced sedimentation within the refuge. It is also apparent when comparing Tables 6-4 and 6-5 that the slough sedimentation rates are quite a bit higher than that found within in the refuge, with an estimated average of 40 acre-feet per year between 1997 and 2002.

7. OPERATION AND MAINTENANCE SUMMARY

a. Operation. Project operations are detailed in the O&M Manual. The Andalusia HREP has been operating successfully in this manner since completion. As described in the Annual Management Plan (Table 2-2), the MSMU is dewatered from May through July to expose mudflats and allow revegetation of moist-soil species. The MSMU water levels are gradually increased from August through November to correspond with the growth of the moist-soil species and to provide migratory waterfowl access to food. A high water level is maintained in the MSMU from December through April to control excessive plant growth and to prevent complete freeze out conditions.

b. Maintenance.

(1) Inspections. A project inspection of the Andalusia HREP was performed in October 2002. The ILDNR Site Manager's project inspection and monitoring results completed at this time can be found in Appendix D. In addition, the Corps and ILDNR conducted a joint inspection of the Andalusia HREP in November 2000. At this time, the Corps completed a pump station inspection report, which is illustrated in Appendix G.

(2) Maintenance Based on Inspections. The pump station and ILDNR Site Manager's project inspection and monitoring results are summarized below with respect to each project feature. Information from past inspection reports is also included.

(a) Perimeter Levee. The ILDNR inspection reports noted that the perimeter levee had been mowed three times each in 2002 and 2001. At the joint inspection in November 2000, the ILDNR Site Manager stated that the levee is typically mowed three to four times per year. Burrowing animals were not reported, more than likely due to trapping that began a few years ago. ATV use along the perimeter levee continues to be a concern. Overtopping occurred during the 2001 flood, which resulted in slight erosion but nothing significant. The condition of the levee as observed during the joint inspection in November 2000 can be seen in Appendix H. At that time, the levee was rated as acceptable. The only item rated marginally acceptable was "encroachment," where it was suggested that a 10-foot buffer zone be maintained between the toe of the levee and the tree line.

(b) Water Control Structure. The inspection report documented some surface damage to the riprap in April and June of 2002. The concrete, pipes, gates, and operating mechanisms were documented to be in good condition. There was not any blockage at the inlet and outlet channels and no erosion adjacent to the structure was reported. The last maintenance issue was when the inlet gate was repaired in 1999.

(c) Diversion Drainage Ditch. Debris was removed from the diversion drainage ditch in July 2002 and June 2001. In 2002, bank erosion was reported as undercutting slightly on the Dead Slough perimeter. This same erosion was documented as minor in 2001. There were not any waste materials or unauthorized structures found in the ditch.

(d) Dead Slough Excavation. There was not any debris, waste materials, unauthorized structures, or bank erosion reported in Dead Slough in 2002.

(e) Refuge Drainage/Islands. There was not any debris, waste materials, unauthorized structures, or bank erosion reported on the islands or within the refuge drainage areas in 2002.

(f) Pump Station. In 2002, the building, gates, pumps, control panel, and trash racks were reported as being in good condition. In August 2001, the low level float was replaced. It was documented that the rubber edging on the sluice gates will also need to be replaced. Annual maintenance of the fence systems should continue prior to freezing conditions. The pump station water level control form is located in Appendix D.

The pump station maintenance inspection guide provides an overall rating of the facility. Within this guide, there are two sections. The first section is for internal use and evaluation, while the second section is for local sponsor use. Within section one there is only one item to critique. In section two there are 15 items to critique. Each item has an evaluation and remarks column.

Overall, the pump station report passed with an acceptable rating during the joint inspection in November 2000. There was only one item that fell below the acceptable rating. This was item number 12 - Pump Control System. This item was given a minimal acceptable rating. This means that the pump control system is operational but with minor discrepancies. Some general comments were included in the report as well. The first comment noticed gaskets detaching from the aluminum stoplogs. The second comment explained the problem the ILDNR Site Manager had while attempting to maintain the MSMU between elevation 543 and 543.5 feet MSL. The "pump out" pump could not be operated in the "manual" or "auto" mode. The cause of the operational flaw was not investigated or corrected.

(g) Dredged Material Placement Site. In July of 2001 and 2002, the riprap at the dredged material placement site was cleared of woody vegetation and sprayed with herbicide.

(h) Access Road. In 2002, the culverts along the access road were cleaned and the woody vegetation in the riprap was cut and sprayed. The ditches, stone surface, and entrance gate were reported to be in good condition. The ditches and culverts along the access road were cleaned in June 2001. The granular surfacing on the access road and overflow spillway was displaced during the 2001 flood. Approximately 600 tons of rock was placed in September 2001 to fix these areas.

8. CONCLUSIONS AND RECOMMENDATIONS

a. Project Goals, Objectives, and Management Plan. Data and observations collected since the last PER suggest that half of the goals and objectives evaluated for the Andalusia HREP are being met, as illustrated in Table 8-1. Further data collection should better define sedimentation rates and project utilization by migratory waterfowl and other wildlife.

TABLE 8-1. Project Goals and Objectives

Goals	Objectives	Project Features	Unit	Year 10 (2002)	Year 50 (2042) Target	Status
Enhance Migratory Waterfowl Habitat	Increase reliable food production area (moist soil species)	Provide water control	Acres	40 [1/]	130	Not Met
	Increase reliable resting and feeding water area	Mechanical dredging	Acres	99	50	Met
Enhance Aquatic Habitat	Restore deep aquatic habitat (Depth $\geq$ 6')	Mechanical dredging	Ac-ft	34 [2/]	40	Not Met
	Restore lentic-lotic habitat access cross-sectional area	Mechanical dredging	Ft^2	135	180	Not Met
	Improve dissolved oxygen concentration during critical stress periods	Mechanical dredging and gated inlet structure	Mg/L (min) (max) (avg)	 5.89 19.66 10.61	4	Met
	Reduce sedimentation in refuge	Construct levee and divert tributary	Ac-ft year	1.2	4.2	Met

[1/] This number reflects a qualitative estimate summarized in the August 1997 PER.
[2/] This number reflects that summarized in the August 1997 PER since the hydrographic soundings completed in 2002 did not include Dead Slough.

b. Post-Construction Evaluation and Monitoring Schedules. Monitoring efforts for the Andalusia HREP have been performed according to the Post-Construction Performance Evaluation Plan in Appendix B and the Resource Monitoring and Data Collection Summary in Appendix C. The next PER will be a detailed report completed in March of 2008 following collection of field data from January 1, 2003, through December 31, 2007.

For this PER only, a revised table was developed in order to quantify and evaluate certain project objectives. Since the hydrographic soundings completed in 2002 did not include Dead Slough, the restore deep aquatic habitat objective was evaluated based on depth in feet rather than volume in acre-feet. As a result, the "Unit" and "Year 50 Target" columns were modified. These modified performance parameters are highlighted in Table 8-2.

TABLE 8-2. Project Goals and Objectives (revised for this PER only)

Goals	Objectives	Project Features	Unit	Year 10 (2002)	Year 50 (2042) Target	Status
Enhance Migratory Waterfowl Habitat	Increase reliable food production area (moist soil species)	Provide water control	Acres	40 [1/]	130	Not Met
	Increase reliable resting and feeding water area	Mechanical dredging	Acres	99	50	Met
Enhance Aquatic Habitat	Restore deep aquatic habitat (Depth ≥ 6')	Mechanical dredging	**Feet**	4.41	**6**	Not Met
	Restore lentic-lotic habitat access cross-sectional area	Mechanical dredging	Ft^2	135	180	Not Met
	Improve dissolved oxygen concentration during critical stress periods	Mechanical dredging and gated inlet structure	Mg/L (min) (max) (aver)	 5.89 19.66 10.61	4	Met
	Reduce sedimentation in refuge	Construct levee and divert tributary	Ac-ft / year	1.2	4.2	Met

[1/] This number reflects a qualitative estimate summarized in the August 1997 PER.

(1) Increase reliable food production area (moist-soil species). Earlier evaluations have indicated project success in promoting moist-soil species and increasing the natural waterfowl food production. Some active measures, such as burning or herbicide application, should be continued to control encroachment of less desirable plant species within the MSMU to meet the Year 50 Target acreage. In the future, this acreage should be revised based on a more accurate quantification of the maximum potential food production area within the MSMU if the opportunity arises. Formal vegetation transects were not established within the MSMU prior to project completion and are not included in the Post-Construction Evaluation Plan. Informal vegetation surveys by Corps personnel

and field observations by the ILDNR Site Manager shall be utilized to monitor performance of reliable food production area.

(2) Restore Deep Aquatic Habitat and Reduce Sedimentation in Refuge. It is not only apparent for the Andalusia HREP, but for other HREPs as well that the annual sedimentation rates are consistently underestimated. This may be due to the fact that many of the existing HREPs are still in the younger years of their design life and that sediment deposition is not linear, but rather logarithmic. The result is higher sedimentation rates in the earlier years of the project until the channel becomes stabilized and sedimentation rates begin to level off. If this is indeed the case, then it seems practical to conduct hydrographic soundings on a similar scale. Transects should be performed more frequently in the first 10 years and less often in later years. This, in turn, would closely follow the implementation schedule for PERs. More importantly, a better relationship between sedimentation rates versus project life could be determined and incorporated in the design of future HREPs.

HREP design, evaluation, and measurement of project features have evolved since the EMP program began. Measuring acre-feet of deep aquatic habitat, acre-feet per year of sedimentation, or cross-sectional area of lentic-lotic habitat access, are objectives easily calculated during design. However, after project completion, these objectives may not provide the necessary information for a proper evaluation. For example, dredged or excavated channel side slopes may have sloughed, thus widening the channel and decreasing depth, but the cross-sectional area may not reflect this loss of depth. As a result, the flat pool depth may be inadequate to support deep aquatic habitat when the cross-sectional area shows the objective being met. Perhaps simpler measurements coupled with biological monitoring are warranted. For aquatic habitat, this may simply be depth in combination with fish surveys. Younger HREPs are incorporating this idea by utilizing electrofishing as a feature measurement.

(3) Restore Lentic-Lotic Habitat Access Cross-Sectional Area. Scisco Chute and the lentic-lotic habitat access channel have experienced excessive sediment deposition since project completion. The flat pool depths in the access channel are currently around 3 feet. If these depths exceed the critical point of 2 feet, the criteria for lentic-lotic habitat would no longer be met. Therefore, the remaining life of this objective is cause for concern. It is recommended that hydrographic soundings based on the monitoring plan in combination with an evaluation of data from the sediment probes be conducted during the next performance period to better define habitat depths and sedimentation rates in the channel. In order to meet the Year 50 Target for lentic-lotic habitat access, continual dredging of the channel seems likely in the future.

(4) Improve Dissolved Oxygen Concentration During Critical Stress Periods. When the Resource Monitoring and Data Collection Summary (Appendix C, Table C-2) was prepared for the DPR, it was determined that point measurements at the water quality stations would be performed twice per week during the summer months (April through September) and monthly during the winter months (October through March). This sampling would be similar for all phases of the Andalusia HREP: pre-project, design, and

post-construction. However, due to the increasing number of HREPs and weather constraints, post-construction water quality sampling has been generally conducted twice per month from June through September and monthly from December through March. Typically, sampling has not been performed during April, May, October, and November. Therefore, Table C-2 in Appendix C was modified to reflect current water quality sampling frequencies.

c. Project Operation and Maintenance. Project O&M for the Andalusia HREP has been conducted in accordance with the O&M Manual. The operational requirements have been performed according to Table 2-2. The maintenance of project features has been adequate. Annual project inspections by the ILDNR Site Manager have resulted in proper corrective maintenance actions.

d. Project Design Enhancement. Discussions with those involved with operation, maintenance, and monitoring activities at the Andalusia HREP have resulted in the following general conclusions regarding project features that may affect future HREP design:

The primary dredging project design and evaluation criteria in apparent need of review is feature life expectancy. For this project, a 50-year life does not appear to be a realistic restoration goal. A programmatic review of engineering design criteria for a 50-year project life and sponsor O&M requirements for constructed features should be accomplished. Additionally, future PERs should consider O&M expenditures versus estimated costs. Program reauthorization might consider the ability to return to a project post-construction and fund additional work to simplify or correct O&M difficulties. The benefits of restoring habitat through maintenance activities and the habitat disruptions that may accompany such activities need to be assessed on a project-by-project basis.

APPENDIX A

ACRONYMS

ACRONYMS

CEMVR	Corps of Engineers, Mississippi Valley Division, Rock Island District
DO	Dissolved Oxygen
DPR	Definite Project Report
EMP	Environmental Management Program
ER	Engineer Regulation
HREP	Habitat Rehabilitation and Enhancement Project
ILDNR	Illinois Department of Natural Resources
LTRMP	Long-Term Resource Monitoring Program
MSL	Mean Sea Level
MSMU	Moist Soil Management Unit
O&M	Operation and Maintenance
PER	Performance Evaluation Report
RM	River Mile
TDH	Total Dynamic Head
UMRS	Upper Mississippi River System
USFWS	United States Fish and Wildlife Service

APPENDIX B

POST-CONSTRUCTION EVALUATION PLAN
AND
SEDIMENTATION TRANSECT PROJECT OBJECTIVES EVALUATION

TABLE B-1. Post-Construction Evaluation Plan

Goal	Objective	Enhancement Feature	Unit	Year 0 (1992) Without Project	Year 0 (1992) With Project	Year 10 (2002) With Project	Year 50 (2042) Target With Project	Feature Measurement	Annual Field Observations by ILDNR Site Manager
nhance igratory aterfowl abitat	Increase reliable food production area (moist soil species)	Provide water control	Acres	0	--	40 [1/]	130	Informal vegetation surveys	Development of emergent vegetation
	Increase reliable resting & feeding water area	Mechanical dredging	Acres	0	--	99	50	Perform hydrographic soundings of transects	Waterfowl presence or absence
nhance quatic abitat	Restore deep aquatic habitat (depth ≥ 6')	Mechanical dredging	Ac-ft	0	55.8	34 [2/]	40	Perform hydrographic soundings of transects	Development of emergent vegetation within deep dredged area
	Restore lentic-lotic habitat access cross-sectional area	Mechanical dredging	Ft^2	0	308	135	180	Perform hydrographic soundings of transects	Development of emergent vegetation within access area
	Improve dissolved oxygen concentration during critical stress periods	Mechanical dredging & gated inlet structure	Mg/L (min) (max) (avg)	< 4	> 4	5.89 19.66 10.61	4	Perform water quality testing at stations	Fish stress or fish kills
	Reduce sedimentation in refuge	Construct levee & divert tributary	Ac-ft year	11	--	1.2	4.2	Perform hydrographic soundings of transects	Shoaling in shallows areas

This number reflects a qualitative estimate summarized in the August 1997 PER.
This number reflects that summarized in the August 1997 PER since the hydrographic soundings completed in 2002 did not include Dead Slough.

TABLE B-2. Sedimentation Transect Project Objectives Evaluation				
Transect	**Project Objectives to Be Evaluated**			
	Increase Reliable Resting & Feeding Water Area	**Restore Deep Aquatic Habitat**	**Restore Lentic-Lotic Habitat Access Cross-Sectional Area**	**Reduce Sedimentation in Refuge**
Dead Slough				
A	X	X		X
C	X	X		X
D [1/]			X	
D1 [1/]			X	
D2 [1/]			X	
E	X	X		X
I	X			X
K	X			X
L [2/]				
M [2/]				
P [2/]				

[1/] Transects added during post-construction phase
[2/] Transects undisturbed by project construction

APPENDIX C

MONITORING AND PERFORMANCE EVALUATION MATRIX
AND
RESOURCE MONITORING AND DATA COLLECTION SUMMARY

TABLE C-1. Monitoring and Performance Evaluation Matrix

Project Phase	Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Implementation Instructions
Pre-Project	Sedimentation Problem Analysis	System-wide problem definition; evaluates planning assumptions	USGS	USGS	LTRMP	--
	Pre-Project Monitoring	Identifies and defines problems at HREP site; establishes need of proposed project features	USFWS	USFWS	USFWS	--
	Baseline Monitoring	Establishes baselines for performance evaluation	Corps	Corps	HREP	See Table C-2
Design	Data Collection for Design	Includes quantification of project objectives, design of project, and development of performance evaluation plan	Corps	Corps	HREP	See Table C-2
Construction	Construction Monitoring	Assesses construction impacts; assures permit conditions are met	Corps	Corps	HREP	See State Section 401 Stipulations
Post-Construction	Performance Evaluation Monitoring	Determines success of project as related to objectives	Corps/ ILDNR	Corps/ ILDNR	HREP	See Table C-2
	Analysis of Biological Responses to Projects	Evaluates predictions and assumptions of habitat unit analysis; studies beyond scope of performance evaluation, or if projects do not have desired biological results	Corps	Corps	HREP	--

TABLE C-2. Resource Monitoring and Data Collection Summary [1/]

Type Measurement	Water Quality Data						Engineering Data			Natural Resource Data			Sampling Agency	Remarks
	Pre-Project Phase		Design Phase		Post-Const Phase		Pre-Project Phase	Design Phase	Post-Const Phase	Pre-Project Phase	Design Phase	Post-Const Phase		
	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Jun-Sep	Dec-Mar								
POINT MEASUREMENTS														
Water Quality Stations [2/]													Corps	
Turbidity					2M	M								
Secchi Disk Depth	2W				2M	M								
Suspended Solids	2W				2M	M								
Dissolved Oxygen	2W				2M	M								
Specific Conductance	2W				2M	M								
Water Temperature	2W				2M	M								
PH	2W				2M	M								
Total Alkalinity					2M	M								
Chlorophyll (a,b,c)	2W				2M	M								
Velocity					2M	M								
Water Depth	2W				2M	M								
Pheophytin (a)	2W				2M	M								
Percent Ice Cover						M								
Ice Depth						M								
Percent Snow Cover						M								
Snow Depth						M								
Wind Direction					2M	M								
Wind Speed					2M	M								
Wave Height					2M	M								
Air Temperature					2M	M								
Percent Cloud Cover					2M	M								
Sediment Test Stations [3/]													Corps	
Bulk Sediment			1											
Elutriate			1											

TABLE C-2. Resource Monitoring and Data Collection Summary [1/] (Continued)

Type Measurement	Water Quality Data						Engineering Data			Natural Resource Data			Sampling Agency	Remarks
	Pre-Project Phase		Design Phase		Post-Const Phase		Pre-Project Phase	Design Phase	Post-Const Phase	Pre-Project Phase	Design Phase	Post-Const Phase		
	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Jun-Sep	Dec-Mar								
POINT MEASUREMENTS														
Boring Stations													Corps	
Geotechnical Borings [4/]								1						
Column Settling Analysis [5/]								1						
Waterfowl Numbers													ILDNR	
Aerial Survey												Y		
Fish Stations													ILDNR	
Electrofishing/Netting												M		
TRANSECT MEASUREMENTS														
Hydrographic Soundings [6/]													Corps	
Hydrographic Soundings							1		5Y					
Vegetation Transects													Corps	
Moist Soil Plant Survey												5Y		
AREA MEASUREMENTS														
Mapping [7/]													Corps	
Aerial Photos/Remote Sensing										1		5Y		

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

TABLE C-2 (Continued)
Resource Monitoring and Data Collection Summary [1/]

[1/] Resource Monitoring and Data Collection Summary-See Appendix M, Plate 3 for Monitoring Plan

[2/] Water Quality Stations

W-M462.5O

[3/] Sediment Test Stations (Design Phase)

DPR-R-1	DPR-L-1
DPR-R-2	DPR-L-2
DPR-R-3	DPR-L-3

[4/] Boring Stations (Design Phase)

DPR-A-87-1	DPR-A-87-8
DPR-A-87-2	DPR-A-87-9
DPR-A-87-3	DPR-A-87-10
DPR-A-87-4	DPR-A-87-11
DPR-A-87-5	DPR-A-87-12
DPR-A-87-6	DPR-A-87-13
DPR-A-87-7	DPR-A-87-14

[5/] Column Settling Stations (Design Phase)

(50# Settlement Analysis)
DPR-Sample 1
DPR-Sample 2

[6/] Hydrographic Soundings

PER	O&M Manual	DPR
A	S-M462.6X to S-M462.9Q	Range A
C	S-M462.5U to S-M462.8L	Range C
D	None	None
D1	None	None
D2	None	None
E	S-M462.3U to S-M462.5M	Range E
I	S-M462.1W to S-M462.2N	Range I
K	S-M462.0Q to S-M462.1N	Range K
L	S-M461.8O to S-M461.8V	Range L
M	S-M461.7X to S-M461.7O	Range M
P	S-M461.3Y to S-M461.2S	Range P

[7/] Mapping (Post-Construction Phase) – aerial survey shall be performed of the project area to determine the amount of waterfowl resting and feeding in project water areas

July 12, 1993 – color aerial photos (1" = 1000')
April 17, 1994 – color aerial photos (1" = 1000')
November 21, 1995 – black & white photos (1" = 1400')
November 24, 1995 – black & white photos (1" = 2800')
September 26, 1996 – color oblique aerial photos

APPENDIX D

COOPERATING AGENCY CORRESPONDENCE

ANDALUSIA REFUGE REHABILITATION AND ENHANCEMENT
OPERATION AND MAINTENANCE MANUAL

UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 16, RIVER MILES 462 THROUGH 463
ROCK ISLAND, ILLINOIS

SITE MANAGER'S PROJECT INSPECTION AND MONITORING RESULTS

Inspected by JAY FINN Date 10-25-02
Type of Inspection (annual) (emergency-disaster) (other)

1. PROJECT INSPECTION.

Item | Comment/Condition

a. Perimeter Levee.

(✓) Settlement, sloughs, or loss of section. OK
(✓) Seepage, saturated areas, sand boils. NONE
(✓) Wave-wash, scouring. OK
(✓) Overtopping erosion. NONE
(✓) Vegetative cover (mowing). MOWED 3 times DURING 2002
(✓) Displaced/missing riprap. NONE - OK
(✓) Burrowing animals. NONE OBSERVED
(✓) Unauthorized grazing or traffic. NONE - grazing - SOME ATV TRACKS
(✓) Encroachments. NONE ON BOUNDARIES

b. Water Control Structure.

(✓) Pipes, gates, and operating mechanisms. OK
(✓) Concrete. OK
(✓) Displaced/missing riprap. RIPRAP OK SOME SURFACE DAMAGE IN April & JUNE
(✓) Blockage of inlet and outlet channels. NONE
(✓) Erosion adjacent to structure. NONE

c. Diversion Drainage Ditch.

(✓) Debris. REMOVED IN July
(✓) Waste materials/unauthorized structures. NONE
( ) Bank Erosion. UNDERCUTTING SLIGHTLY ON DEAD Slough perimeter

d. Dead Slough Excavation.

(✓) Debris. NONE
(✓) Waste materials/unauthorized structures. NONE
(✓) Bank Erosion. NONE

e. Refuge Drainage/Islands.

(✓) Debris. NONE
(✓) Waste materials/unauthorized structures. NONE
(✓) Bank Erosion. NONE

f. Pump Station.

(✓) Building. OK
(✓) Gates. OK
(✓) Pumps. OK
(✓) Control Panel. OK
(✓) Trash Racks. OK

g. Dredge Material Placement Site.

(✓) Mowing/herbicide treatment. SPRAYED TREES after cutting July 8 - RIPRAP AREAS

h. Access Road.

(✓) Ditches. OK
(✓) Culverts. OK - CLEANED
( ) Stone Surface. OK
(✓) Riprap. CUT + SPRAYED
(✓) Entrance gate. OK

i. Additional Comments.

LEVEE ON North SIDE of pumphouse slightly eroDed IN April Due to highwater AND WINDACTION - RIVERSIDE. Levee ON North SIDE of pumphouse overtopped slightly ON 6-8-2002. Minor DAMAGE to CAG EDGES ON both SIDES.

Jay Finn
Site Manager

Andalusia Refuge Water Level Control Form

		Water Level Readings			Water Level Control Management Phase	Pump Station Status (Condition/ water direction)			Dead Slough Gate (Condition water direction)	Comment
Date	Time	Inside MSMU	Outside MSMU	Fairport		Pumps	Hour Meter	Gate	Gate	
23-Apr-2002	08:30 AM	547.60	548.10	548.76	Flood Management			Open	Closed	Open gates for pressure equalization due to flooding
24-Apr-2002	02:00 PM	547.50	549.50	549.35	Flood Management			Open	Closed	
28-Apr-2002	02:00 PM	549.00	550.20	550.95	Flood Management			Open	Closed	Slight damage to west side of Levee from wind action but water did not top levee at pumphouse
11-May-2002	02:00 PM	547.00	546.70	547.16				Closed	Closed	
7-Jun-2002	02:00 PM			550.90				Closed	Closed	Friday
8-Jun-2002				551.79				Closed	Closed	Saturday - slightly topped levee and caused some erosion but minor
9-Jun-2002				550.70						Sunday - water below levee
2-Jul-2002	09:15 AM	547.60	546.00		Gravity Drawdown			Open	Open	Vegetation management drawdown
5-Jul-2002	01:45 PM	546.00	545.80					Open	Closed	Dead Slough Gate equalized with River level
8-Jul-2002	11:50 AM	545.80	545.80		Pump down	On	1378.5	Closed	Closed	Cut Brush and Sprayed Rip-Rap
10-Jul-2002	09:00 AM	545.00	545.80		Pump down	On	1423.6	Closed	Closed	
12-Jul-2002	09:30 AM	544.80	545.50		Pump down	Off	1470.7	Closed	Closed	Off for weekend
15-Jul-2002	11:00 AM	544.80	545.80		Pump down	On	1470.7	Closed	Closed	
17-Jul-02	02:30 PM	543.00	545.80		Pump down	Off	1501.10	Closed	Closed	Pump Shut off normally on Float system
29-Jul-02	02:00 PM	546.00			Pump down	On	1501.10	Closed	Closed	Rain Event - Tom Vandemore
30-Jul-02		545.80			Pump down			Closed	Closed	

Andalusia Refuge Water Level Control Form

		Water Level Readings			Water Level Control Management Phase	Pump Station Status (Condition/ water direction)			Dead Slough Gate (Condition water direction)	Comment
Date	Time	Inside MSMU	Outside MSMU	Fairport		Pumps	Hour Meter	Gate	Gate	
31-Jul-02		545.50			Pump down			Closed	Closed	
01-Aug-02		544.90			Pump down			Closed	Closed	
02-Aug-02		544.00			Pump down	Off	1613.50	Closed	Closed	Shut Off Manually
13-Aug-02	08:30 AM	546.00	545.80		Pump down	On	1613.50	Closed	Closed	Rain Event
15-Aug-02	09:00 AM	545.00			Pump down	On				
16-Aug-02	02:30 PM	544.20			Pump down	On				
19-Aug-02	01:00 PM	543.20	545.80			Off	1714.20	Closed	Closed	Pump shut off by Float
23-Aug-02	01:30 PM	545.00			Pump down	On	1714.40	Closed	Closed	Rain Event
26-Aug-02	11:30 AM	543.20	545.80		Pump down	Off	1767.00	Closed	Closed	Pump shut off by Float
20-Sep-02	11:00 AM	543.60	545.60		Rewater			Open	Closed	
24-Sep-02	08:30 AM	545.50	545.50		Rewater	On	827.60	Closed	Closed	
25-Sep-02	08:30 AM	545.80								
26-Sep-02	10:45 AM	546.00	545.50		Rewater	Off	875.20	Closed	Closed	Target level reached
21-Oct-02	11:00 AM	545.80	545.80		Rewater	On	875.20	Closed	Closed	
25-Oct-02	10:20 AM	546.80	545.80		Rewater	Off	970.40	Closed	Closed	Target Level reached

APPENDIX E

WATER QUALITY DATA

TABLE E-1. Post-Project Monitoring Results at Station W-M462.5O

Date	Water Depth (m)	Velocity (ft/s)	Water Temp (°C)	DO (mg/L)	pH (SU)	Chlorophyll a (mg/m^3)
04/07/92	2.865	--	14.8	18.80	8.97	120
05/05/92	3.170	0.120	17.5	15.40	8.94	84
11/24/92	2.423	0.078	5.2	--	7.66	7.6
01/25/93	2.591	0.000	1.0	11.30	8.22	25.9
11/10/93	2.271	0.051	4.8	13.73	8.82	5.4
01/10/94	2.850	0.063	0.3	15.74	8.60	18.3
02/24/94	3.155	0.042	-0.3	11.87	7.75	14
03/09/94	2.057	0.000	2.2	10.27	7.79	--
04/19/94	2.560	0.059	15.3	7.88	7.97	13
05/10/94	3.383	0.336	14.7	11.13	8.26	80
05/24/94	2.850	0.067	22.5	3.58	7.83	18
06/14/94	1.753	0.105	27.1	5.70	7.99	35
07/07/94	2.804	0.000	28.1	10.52	8.28	44
07/19/94	2.835	0.032	27.4	10.76	8.49	38
08/09/94	2.591	0.000	25.0	6.44	8.46	71
08/31/94	2.530	0.155	23.1	5.24	8.05	43
09/13/94	2.484	0.042	24.8	8.32	8.20	60
10/04/94	2.896	0.043	15.8	9.00	8.37	56
10/25/94	2.835	0.139	11.5	11.86	8.74	128
12/06/94	1.859	0.101	4.7	18.28	8.51	89
02/14/95	2.774	0.000	0.8	24.00	7.90	24
03/14/95	2.743	0.000	8.7	17.74	8.18	--
04/11/95	2.896	0.095	6.6	10.66	8.56	27
05/02/95	3.658	0.120	11.2	9.31	8.22	35
05/16/95	2.286	0.138	17.0	6.68	7.79	6.7
06/13/95	2.713	0.074	22.1	7.21	8.10	24
06/27/95	2.667	0.062	26.7	3.04	7.86	24
07/11/95	2.560	0.000	27.4	9.50	8.40	85
07/25/95	2.591	0.000	27.9	9.00	8.40	94
08/29/95	2.408	0.000	29.2	4.55	8.24	45
09/12/95	2.499	0.000	20.2	7.78	8.27	54
09/27/95	2.469	0.000	16.1	11.12	8.72	64
10/10/95	2.606	0.000	14.8	11.48	8.81	64
10/24/95	2.149	--	8.3	10.00	8.80	55
11/07/95	2.210	0.131	3.6	15.40	8.78	16
12/13/95	1.448	0.039	--	--	--	--
06/19/96	2.438	0.159	23.1	5.58	--	16
07/10/96	2.210	0.000	26.4	9.07	8.14	84
08/13/96	1.829	0.243	--	--	--	--
08/27/96	2.195	0.380	24.9	6.60	--	40
09/19/96	2.393	0.000	18.8	11.53	8.66	81
12/23/96	1.981	0.000	0.9	13.78	7.83	4.8
01/07/97	2.103	0.000	1.3	18.70	--	56
02/11/97	1.768	0.000	0.8	11.17	7.59	5.6
02/25/97	2.697	0.000	0.5	9.30	7.25	<1
06/18/97	2.134	0.039	24.3	4.68	7.78	68
07/02/97	2.301	0.201	28.9	4.85	7.91	75
07/17/97	2.286	0.041	28.0	7.86	8.31	66
07/31/97	2.164	0.000	25.2	7.12	8.27	63

TABLE E-1. (Continued)
Post-Project Monitoring Results at Station W-M462.5O

Date	Water Depth (m)	Velocity (ft/s)	Water Temp (°C)	DO (mg/L)	pH (SU)	Chlorophyll a (mg/m^3)
08/19/97	2.088	0.000	24.0	6.00	8.26	69
09/03/97	1.524	0.129	23.0	6.42	8.36	64
09/25/97	2.012	--	17.8	9.23	8.54	69
12/23/97	1.676	0.000	2.1	18.50	--	28
01/27/98	1.829	0.000	0.4	15.38	8.25	61
02/24/98	1.966	--	6.5	19.98	8.77	120
03/24/98	2.103	0.000	6.2	17.80	7.80	160
06/03/98	1.661	0.106	22.5	4.32	7.89	34
07/02/98	2.499	0.000	24.9	5.52	7.56	9.6
07/14/98	2.347	0.000	26.3	7.44	7.96	25
07/28/98	1.798	0.027	26.8	8.92	8.37	110
08/13/98	1.951	0.000	25.9	6.27	7.97	77
08/25/98	1.524	0.000	27.2	3.86	7.53	68
09/10/98	1.661	0.000	22.6	7.82	8.24	100
09/28/98	1.631	0.000	25.7	11.65	8.43	95
12/29/98	1.814	0.000	0.4	23.13	8.50	30
01/28/99	1.951	0.000	-0.1	13.00	7.80	2.6
02/25/99	1.722	0.000	1.9	25.99	8.80	97
03/23/99	1.585	0.000	7.2	22.20	8.70	140
05/27/99	3.353	0.848	17.5	7.73	7.24	16
06/22/99	1.737	0.067	22.8	6.50	7.90	15
07/08/99	1.707	0.000	27.4	7.08	8.30	34
07/27/99	1.981	0.000	28.7	5.11	7.90	53
08/10/99	1.768	0.075	24.7	7.70	8.40	120
08/24/99	1.890	0.000	22.3	6.54	8.40	100
09/08/99	1.646	0.000	23.6	6.60	8.30	78
09/21/99	1.500	0.000	17.3	8.72	8.50	100
02/08/00	1.580	0.000	0.2	15.22	7.90	17
03/07/00	1.810	0.040	10.5	14.90	8.40	67
05/31/00	1.730	0.000	19.6	7.40	8.00	17
06/15/00	3.100	--	20.4	4.59	7.60	7.8
07/06/00	1.788	--	22.7	4.01	7.60	7
07/25/00	1.705	--	24.6	11.86	8.50	88
08/08/00	1.720	--	28.8	17.06	8.80	23
08/22/00	1.655	--	23.5	7.43	8.20	83
09/05/00	1.520	--	22.1	5.20	7.80	52
09/19/00	1.700	--	20.8	6.88	8.10	48
01/03/01	0.980	--	-0.1	14.14	7.90	2.4
02/13/01	1.020	--	-0.1	12.41	7.70	3.1
03/06/01	1.300	0.000	0.4	14.14	7.90	17
03/20/01	1.540	0.000	3.5	14.37	8.40	34
06/05/01	2.350	0.060	17.8	11.56	8.20	36
06/19/01	2.040	--	24.6	6.34	7.90	29
07/03/01	2.280	0.000	26.8	10.73	8.50	36
07/18/01	1.710	0.000	27.2	9.52	8.30	97
07/31/01	1.600	0.000	27.9	8.93	8.40	84
08/14/01	1.460	0.000	25.0	7.27	8.50	98
08/28/01	1.250	0.000	24.9	6.88	8.40	75
09/18/01	1.340	0.00	18.4	5.47	7.90	--

TABLE E-1. (Continued)
Post-Project Monitoring Results at Station W-M462.5O

Date	Water Depth (m)	Velocity (ft/s)	Water Temp (°C)	DO (mg/L)	pH (SU)	Chlorophyll a (mg/m^3)
01/08/02	1.640	0.000	-0.1	19.66	8.20	75.0
02/28/02	1.690	0.000	1.6	17.08	8.10	22.0
06/18/02	1.700	--	21.9	7.42	7.90	43.0
07/02/02	1.610	--	27.3	7.37	8.10	67.0
07/18/02	1.540	0.000	27.5	9.30	8.10	114.0
08/01/02	1.500	--	28.0	8.38	8.10	115.0
08/14/02	1.630	0.000	24.7	7.36	8.10	151.0
08/29/02	1.510	0.000	24.6	5.89	7.70	51.0
09/10/02	1.540	0.095	25.8	8.90	8.30	100.0
09/24/02	1.480	--	17.3	9.47	8.30	94.0
12/17/02	1.390	0.030	0.1	15.83	8.26	--
MIN	0.980	0.000	-0.3	3.04	7.24	2.4
MAX	3.658	0.848	29.2	25.99	8.97	160.0
AVG	2.085	0.051	16.8	10.34	--	56.3

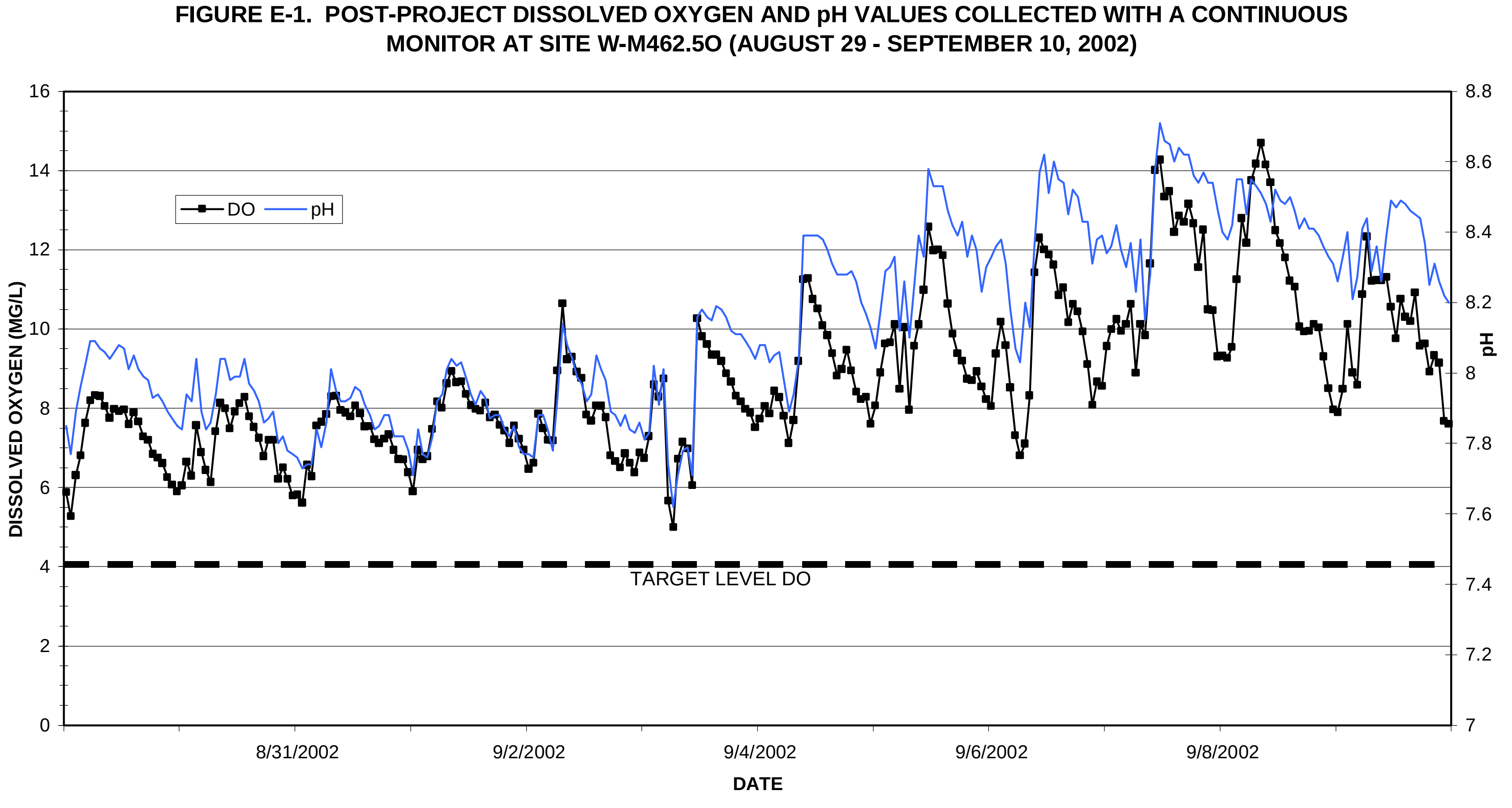


FIGURE E-1. POST-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M462.5O (AUGUST 29 - SEPTEMBER 10, 2002)
DISSOLVED OXYGEN (MG/L)
pH
DO
pH
TARGET LEVEL DO
DATE
8/31/2002
9/2/2002
9/4/2002
9/6/2002
9/8/2002
0
2
4
6
8
10
12
14
16
7
7.2
7.4
7.6
7.8
8
8.2
8.4
8.6
8.8

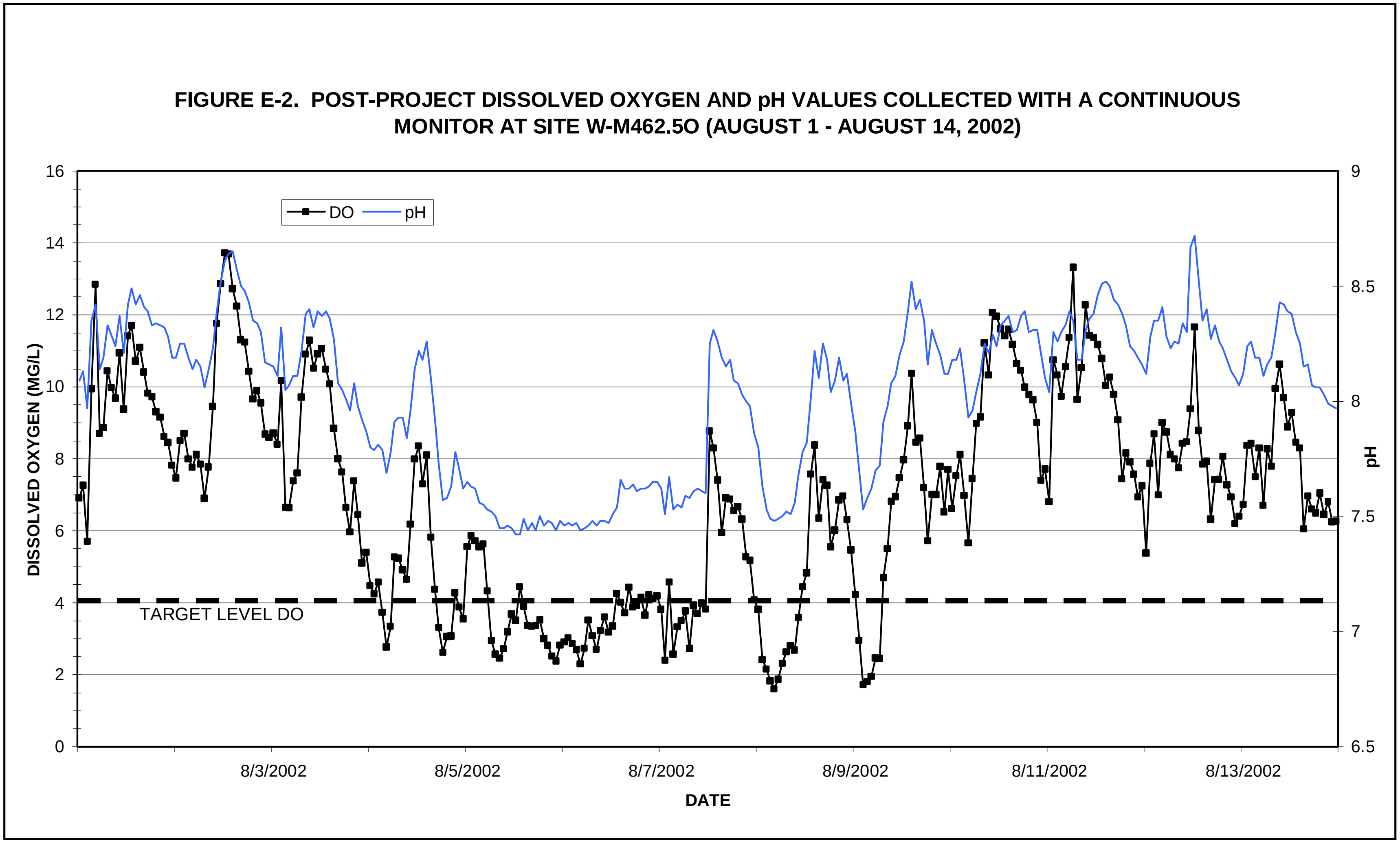


FIGURE E-2. POST-PROJECT DISSOLVED OXYGEN AND pH VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M462.5O (AUGUST 1 - AUGUST 14, 2002)
DO
pH
DISSOLVED OXYGEN (MG/L)
pH
TARGET LEVEL DO
DATE
0
2
4
6
8
10
12
14
16
6.5
7
7.5
8
8.5
9
8/3/2002
8/5/2002
8/7/2002
8/9/2002
8/11/2002
8/13/2002

TABLE E-2. Summary of Channel Depths at Station W-M462.5O

Date	W-M 462.5O Channel Depth (feet)	FAII4 463.5 Gage Reading (feet)	FAII4 463.5 Pool Elevation (feet) [1/]	MI16 457.2 Gage Reading (feet)	MI16 457.2 Pool Elevation (feet) [2/]	W-M 462.5O Pool Elevation (feet)	W-M 462.5O Bottom Elevation (feet) [3/]	W-M 462.5O Flat Pool Depth (feet) [4/]
04/07/92	9.40	11.04	546.20	10.52	544.31	545.90	536.50	8.50
05/05/92	10.40	13.70	548.86	12.85	546.64	548.51	538.11	6.89
11/24/92	7.95	11.62	546.78	10.57	544.36	546.40	538.45	6.55
01/25/93	8.50	11.29	546.45	11.36	545.15	546.24	537.75	7.25
11/10/93	7.45	10.56	545.72	11.15	544.94	545.60	538.15	6.85
01/10/94	9.35	11.99	547.15	11.59	545.38	546.87	537.52	7.48
02/24/94	10.35	13.27	548.43	11.94	545.73	548.00	537.65	7.35
03/09/94	6.75	12.51	547.67	10.21	544.00	547.09	540.34	4.66
04/19/94	8.40	10.78	545.94	10.68	544.47	545.71	537.31	7.69
05/10/94	11.10	14.37	549.53	13.82	547.61	549.23	538.13	6.87
05/24/94	9.35	10.50	545.66	10.71	544.50	545.48	536.13	8.87
06/14/94	5.75	10.97	546.13	11.68	545.47	546.03	540.28	4.72
07/07/94	9.20	11.10	546.26	11.47	545.26	546.10	536.90	8.10
07/19/94	9.30	11.56	546.72	11.40	545.19	546.48	537.18	7.82
08/09/94	8.50	11.38	546.54	11.31	545.10	546.31	537.81	7.19
08/31/94	8.30	11.02	546.18	11.23	545.02	546.00	537.70	7.30
09/13/94	8.15	11.44	546.60	11.20	544.99	546.34	538.20	6.80
10/04/94	9.50	10.97	546.13	11.33	545.12	545.97	536.47	8.53
10/25/94	9.30	11.27	546.43	11.38	545.17	546.23	536.93	8.07
12/06/94	6.10	10.71	545.87	11.18	544.97	545.73	539.63	5.37
02/14/95	9.10	11.14	546.30	11.61	545.40	546.16	537.06	7.94
03/14/95	9.00	11.22	546.38	11.89	545.68	546.27	537.27	7.73
04/11/95	9.50	11.50	546.66	10.59	544.38	546.30	536.80	8.20
05/02/95	12.00	13.81	548.97	13.50	547.29	548.70	536.71	8.29
05/16/95	7.50	14.30	549.46	12.47	546.26	548.95	541.45	3.55
06/13/95	8.90	11.08	546.24	10.39	544.18	545.91	537.02	7.98
06/27/95	8.75	13.03	548.19	11.42	545.21	547.72	538.97	6.03
07/11/95	8.40	10.16	545.32	11.09	544.88	545.25	536.85	8.15
07/25/95	8.50	11.07	546.23	11.68	545.47	546.11	537.61	7.39
08/29/95	7.90	10.90	546.06	11.03	544.82	545.86	537.97	7.03
09/12/95	8.20	10.16	545.32	11.02	544.81	545.24	537.04	7.96
09/27/95	8.10	10.07	545.23	11.21	545.00	545.19	537.10	7.90
10/10/95	8.55	10.68	545.84	11.50	545.29	545.75	537.20	7.80
10/24/95	7.05	10.68	545.84	11.35	545.14	545.73	538.68	6.32
11/07/95	7.25	10.92	546.08	10.46	544.25	545.79	538.54	6.46
12/13/95	4.75	10.27	545.43	11.37	545.16	545.39	540.64	4.36
06/19/96	8.00	11.30	546.46	10.46	544.25	546.11	538.11	6.89
07/10/96	7.25	10.92	546.08	10.27	544.06	545.76	538.51	6.49
08/13/96	6.00	10.55	545.71	11.33	545.12	545.62	539.62	5.38
08/27/96	7.20	10.18	545.34	11.25	545.04	545.29	538.09	6.91
09/19/96	7.85	10.49	545.65	11.71	545.50	545.63	537.78	7.22
12/23/96	6.50	10.88	546.04	11.62	545.41	545.94	539.44	5.56
01/27/98	6.00	10.85	546.01	11.40	545.19	545.88	539.88	5.12
02/24/98	6.45	10.85	546.01	11.60	545.39	545.91	539.46	5.54
03/24/98	6.90	10.61	545.77	11.06	544.85	545.62	538.73	6.27
06/03/98	5.45	10.62	545.78	11.44	545.23	545.69	540.24	4.76

TABLE E-2. (Continued)
Summary of Channel Depths at Station W-M462.5O

Date	W-M 462.5O Channel Depth (feet)	FAII4 463.5 Gage Reading (feet)	FAII4 463.5 Pool Elevation (feet) [1/]	MI16 457.2 Gage Reading (feet)	MI16 457.2 Pool Elevation (feet) [2/]	W-M 462.5O Pool Elevation (feet)	W-M 462.5O Bottom Elevation (feet) [3/]	W-M 462.5O Flat Pool Depth (feet) [4/]
07/02/98	8.20	12.39	547.55	12.18	545.97	547.30	539.10	5.90
07/14/98	7.70	12.46	547.62	10.86	544.65	547.15	539.45	5.55
07/28/98	5.90	10.57	545.73	11.47	545.26	545.66	539.76	5.24
08/13/98	6.40	10.80	545.96	11.75	545.54	545.89	539.49	5.51
08/25/98	5.00	10.24	545.40	11.24	545.03	545.34	540.34	4.66
09/10/98	5.45	10.17	545.33	11.40	545.19	545.31	539.86	5.14
09/28/98	5.35	10.19	545.35	11.40	545.19	545.32	539.98	5.02
12/29/98	5.95	10.49	545.65	11.67	545.46	545.62	539.67	5.33
01/28/99	6.40	10.84	546.00	11.63	545.42	545.91	539.51	5.49
02/25/99	5.65	10.50	545.66	11.03	544.82	545.53	539.88	5.12
03/23/99	5.20	11.19	546.35	11.83	545.62	546.23	541.04	3.96
05/27/99	11.00	15.40	550.56	15.23	549.02	550.32	539.32	5.68
06/22/99	5.70	11.18	546.34	10.48	544.27	546.01	540.31	4.69
07/08/99	5.60	10.81	545.97	10.87	544.66	545.76	540.16	4.84
07/27/99	6.50	11.25	546.41	10.06	543.85	546.00	539.51	5.49
08/10/99	5.80	10.65	545.81	10.95	544.74	545.64	539.84	5.16
08/24/99	6.20	10.91	546.07	11.66	545.45	545.97	539.77	5.23
09/08/99	5.40	10.47	545.63	11.43	545.22	545.56	540.17	4.83
09/21/99	4.92	10.50	545.66	11.56	545.35	545.61	540.69	4.31
02/08/00	5.18	10.13	545.29	11.31	545.10	545.26	540.08	4.92
03/07/00	5.94	10.81	545.97	10.45	544.24	545.70	539.76	5.24
05/31/00	5.67	10.65	545.81	11.17	544.96	545.68	540.00	5.00
07/06/00	5.86	11.23	546.39	10.08	543.87	545.99	540.13	4.87
07/25/00	5.59	10.65	545.81	11.20	544.99	545.68	540.09	4.91
08/08/00	5.64	10.60	545.76	11.66	545.45	545.71	540.07	4.93
08/22/00	5.43	10.54	545.70	11.52	545.31	545.64	540.21	4.79
09/19/00	5.58	10.54	545.70	11.46	545.25	545.63	540.05	4.95
01/03/01	3.21	10.73	545.89	11.28	545.07	545.76	542.55	2.45
02/13/01	3.35	11.09	546.25	11.37	545.16	546.08	542.73	2.27
03/06/01	4.26	10.97	546.13	11.48	545.27	545.99	541.73	3.27
03/20/01	5.05	10.74	545.90	10.85	544.64	545.70	540.65	4.35
06/05/01	7.71	13.41	548.57	12.59	546.38	548.22	540.51	4.49
06/19/01	6.69	11.60	546.76	10.51	544.30	546.37	539.68	5.32
07/03/01	7.48	13.57	548.73	12.57	546.36	548.35	540.88	4.12
07/18/01	5.61	10.44	545.60	11.43	545.22	545.54	539.93	5.07
07/31/01	5.25	10.33	545.49	11.26	545.05	545.42	540.17	4.83
08/14/01	4.79	9.91	545.07	11.13	544.92	545.05	540.26	4.74
08/28/01	4.10	10.17	545.33	11.26	545.05	545.29	541.19	3.81
09/18/01	4.40	10.17	545.33	11.34	545.13	545.30	540.90	4.10
01/08/02	5.38	10.50	545.66	11.51	545.30	545.60	540.22	4.78
02/28/02	5.54	10.70	545.86	11.35	545.14	545.75	540.20	4.80
06/18/02	5.58	11.11	546.27	10.53	544.32	545.96	540.38	4.62
07/02/02	5.28	11.37	546.53	10.52	544.31	546.18	540.90	4.10
07/18/02	5.05	10.77	545.93	11.38	545.17	545.81	540.76	4.24
08/01/02	4.92	10.43	545.59	11.12	544.91	545.48	540.56	4.44
08/14/02	5.35	10.83	545.99	11.63	545.42	545.90	540.55	4.45

TABLE E-2. (Continued)
Summary of Channel Depths at Station W-M462.5O

Date	W-M 462.5O Channel Depth (feet)	FAII4 463.5 Gage Reading (feet)	FAII4 463.5 Pool Elevation (feet) [1/]	MI16 457.2 Gage Reading (feet)	MI16 457.2 Pool Elevation (feet) [2/]	W-M 462.5O Pool Elevation (feet)	W-M 462.5O Bottom Elevation (feet) [3/]	W-M 462.5O Flat Pool Depth (feet) [4/]
08/29/02	4.95	10.65	545.81	10.58	544.37	545.58	540.63	4.37
09/10/02	5.05	10.59	545.75	11.31	545.10	545.65	540.59	4.41
09/24/02	4.86	10.46	545.62	11.48	545.27	545.56	540.71	4.29
12/17/02	4.56	10.46	545.62	11.46	545.25	545.56	541.00	4.00
92 MIN	7.95	11.04	546.20	10.52	544.31	545.90	536.50	6.55
92 MAX	10.40	13.70	548.86	12.85	546.64	548.51	538.45	8.50
92 AVG	9.25	12.12	547.28	11.31	545.10	546.93	537.69	7.31
93 MIN	7.45	10.56	545.72	11.15	544.94	545.60	537.75	6.85
93 MAX	8.50	11.29	546.45	11.36	545.15	546.24	538.15	7.25
93 AVG	7.97	10.93	546.09	11.26	545.05	545.92	537.95	7.05
94 MIN	5.75	10.50	545.66	10.21	544.00	545.48	536.13	4.66
94 MAX	11.10	14.37	549.53	13.82	547.61	549.23	540.34	8.87
94 AVG	8.62	11.59	546.75	11.41	545.20	546.50	537.88	7.12
95 MIN	4.75	10.07	545.23	10.39	544.18	545.19	536.71	3.55
95 MAX	12.00	14.30	549.46	13.50	547.29	548.95	541.45	8.29
95 AVG	8.34	11.31	546.47	11.41	545.20	546.27	537.93	7.07
96 MIN	6.00	10.18	545.34	10.27	544.06	545.29	537.78	5.38
96 MAX	8.00	11.30	546.46	11.71	545.50	546.11	539.62	7.22
96 AVG	7.13	10.72	545.88	11.11	544.90	545.72	538.59	6.41
98 MIN	5.00	10.17	545.33	10.86	544.65	545.31	538.73	4.66
98 MAX	8.20	12.46	547.62	12.18	545.97	547.30	540.34	6.27
98 AVG	6.23	10.85	546.01	11.46	545.25	545.89	539.66	5.34
99 MIN	4.92	10.47	545.63	10.06	543.85	545.53	539.32	3.96
99 MAX	11.00	15.40	550.56	15.23	549.02	550.32	541.04	5.68
99 AVG	6.21	11.25	546.41	11.52	545.31	546.23	540.02	4.98
00 MIN	5.18	10.13	545.29	10.08	543.87	545.26	539.76	4.79
00 MAX	5.94	11.23	546.39	11.66	545.45	545.99	540.21	5.24
00 AVG	5.61	10.64	545.80	11.11	544.90	545.66	540.05	4.95
01 MIN	3.21	9.91	545.07	10.51	544.30	545.05	539.68	2.27
01 MAX	7.71	13.57	548.73	12.59	546.38	548.35	542.73	5.32
01 AVG	5.16	11.09	546.25	11.42	545.21	546.09	540.93	4.07
02 MIN	4.56	10.43	545.59	10.52	544.31	545.48	540.20	4.00
02 MAX	5.58	11.37	546.53	11.63	545.42	546.18	541.00	4.80
02 AVG	5.14	10.72	545.88	11.17	544.96	545.73	540.59	**4.41**
92-02 MIN	3.21	9.91	545.07	10.06	543.85	545.05	536.13	2.27
92-02 MAX	12.00	15.40	550.56	15.23	549.02	550.32	542.73	8.87
92-02 AVG	6.83	11.12	546.28	11.35	545.14	546.10	539.27	5.73

1/ FAII4 463.5 Pool Elevation = FAII4 463.5 Gage Reading + Gage Zero
where Gage Zero = 535.16 feet MSL (1912)

2/ MI16 457.2 Pool Elevation = MI16 457.2 Gage Reading + Gage Zero
where Gage Zero = 533.79 feet MSL (1912)

3/ W-M462.5O Bottom Elevation = W-M462.5O Pool Elevation - W-M462.5O Channel Depth

4/ W-M462.5O Flat Pool Channel Depth = Flat Pool - W-M462.5O Bottom Elevation
where Flat Pool = 545 feet MSL

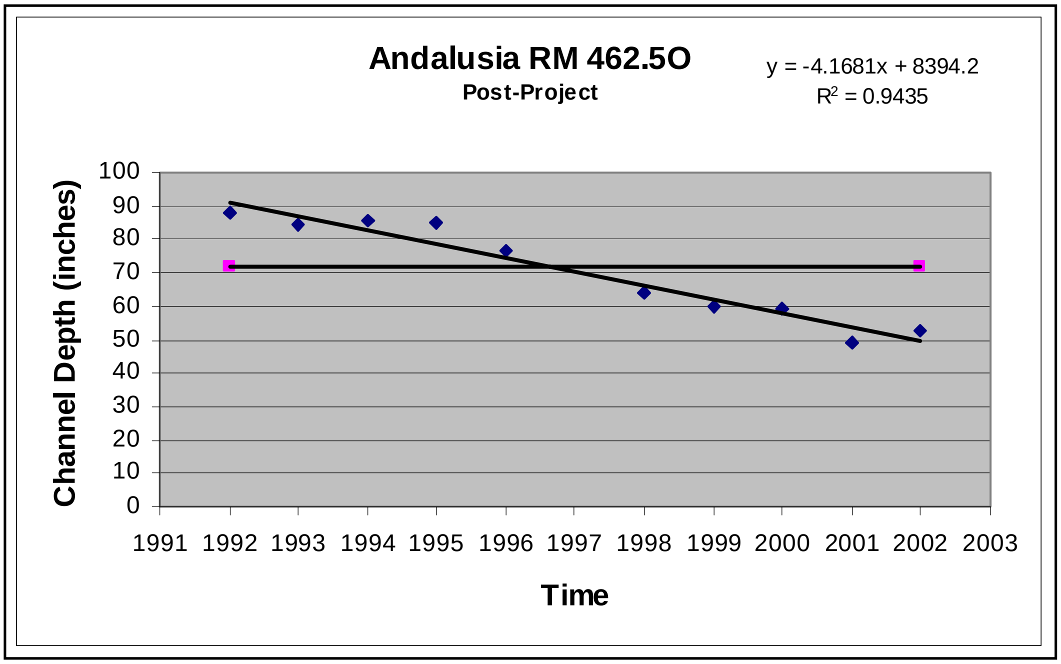
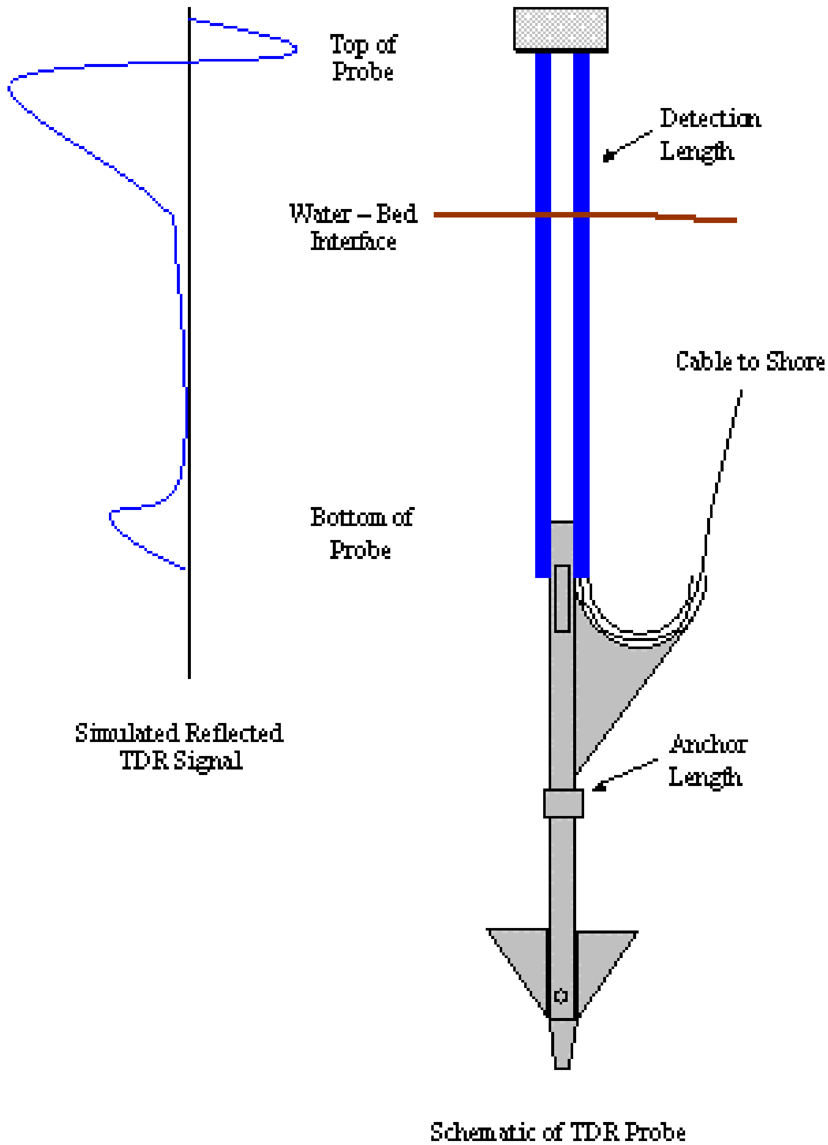


FIGURE E-3. Sedimentation Rates at Station W-M462.5O

APPENDIX F

TECHNICAL COMPUTATIONS

Cold Regions Research and Engineering Laboratory (CRREL)
Time-Domain Reflectometry (TDR) Probe



Time Domain Reflection (TDR) Probe for Bed Scour

Cold Regions Research and Engineering Laboratory
Hanover, NH
Leonard Zabilansky

Ice Cover Effects on Bed Scour: Case Studies

Leonard J. Zabilansky[1]

Abstract

The effect of an ice cover on the rate of erosion and deposition of riverbed sediments has been the subject of much speculation. At the center of the debate is the lack of field measurements correlating the hydraulic and ice conditions with changes in bed elevation. With the recent development of robust scour probes using time-domain reflectometry (TDR) technology, it is now possible to obtain field measurements that are independent of surface conditions. Arrays of TDR probes were installed at three sites to monitor the bed elevation from freeze-up through break-up. The sites were in the Missouri River in eastern Montana, in a navigation pool on the Mississippi River, and upstream of a bridge pier in the White River in Vermont. The probes were connected to a data acquisition system to monitor the scour-fill cycle in real time during the winter, along with temperatures and water pressure. Measurements from the three sites imply that the rate of erosion or deposition of bed material depends on the variation in flow from the discharge at the time the ice cover formed.

Introduction

Sediment movement is driven by the stream hydrograph; erosion or scour usually occurs on the rising limb, whereas redeposition typically occurs on the falling limb. During one scour cycle the bed may be excavated, or a scour hole created, and then refilled. In cold regions the presence of ice adds another dimension to the already complex scour process. An ice cover approximately doubles the wetted perimeter of the river, thereby adding flow resistance. Conveying a similar open-water discharge under ice requires an increase in stage, mean velocity, or both. Typically the stage has to increase two to four times the ice thickness before the ice sheet breaks up (Donchenko 1975). As long as the stage is below this threshold, the ice cover defines the water surface elevation. Therefore, any increases above the freeze-up discharge but below the break-up threshold are reflected in increases in the mean water velocity.

Currently numerical models used to forecast sediment movement are based on extensive laboratory tests with very little field data for validation. Numerical and physical models seldom consider the effects of an ice cover or ice and debris accumulations on the sediment transport process. This is due, in part, to the lack of instrumentation to monitor

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the erosion and deposition of sediments in real time under a variety of conditions, such as flooding, debris accumulation, and ice covers.

Scour Instrumentation

The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) utilized time-domain reflectometry (TDR) technology to develop and patent an instrument capable of real-time monitoring of a full scour cycle that is independent of water velocity and water temperature. Once installed in the riverbed, these robust but non-intrusive cable-based probes can tolerate impact from ice and debris. Because the probes are independent of a structure, they can be deployed to monitor bed elevations around buried utilities, constriction and abutment scour at bridges, and the stability of contaminated sediments.

The development and calibration of the TDR probes is presented in Yankielun and Zabilansky (1998) but briefly reviewed here. TDR operates by propagating an electromagnetic pulse along a transmission line. The pulse travels down the transmission line at a velocity that is a function of the electrical and physical characteristics of the transmission line and the surrounding medium. At any boundary condition along the transmission line (e.g., air/water and water/sediment), a dielectric discontinuity exists. This discontinuity is also an electrical impedance boundary. As a pulse traveling down the transmission line encounters a boundary, a portion of the pulse energy is reflected back to the source; the rest of the energy continues through the boundary until another boundary condition, or the end of the transmission line, causes part or all of that remaining energy to be reflected back towards the source. The time that the pulse takes to propagate down and back a length of the transmission line is called the "round-trip travel time." The travel time is related to the dielectric constants of the surrounding materials.

CRREL's TDR probe has two parts: the sensor and the anchoring section. The sensor or transmission section is fabricated from two parallel 3.17-cm- (1.25-in.-) diameter pipes spaced 7.6 cm (3 in.) on center. A plastic block on the top of the probe serves as a junction box for connecting the coax instrumentation cable to the sensor and keeps the pipes parallel but electrically isolated. The length of the sensing section is a compromise between the anticipated scour and the required resolution controlled by the instrumentation; we have used sensing lengths up to 1.5 m with a resolution of 1 cm. The bottoms of the parallel pipes are welded to the lower anchoring section, which provides the lateral support for the sensing section as the bed material is eroded, exposing the pipes to the current. The length of the anchoring section is a function of the lateral resistance of the bed material; it is typically on the order of 2 m. Probes are installed into the river bottom such that the top of the probe just protrudes above the bed (when measuring scour) or at the maximum level of anticipated deposition.

To avoid variations in the propagation velocity associated with the sediment layers surrounding the sensing section, the pulse is introduced at the top of the probe. Calculating the bed elevation with respect to the top of the probe is then a function of propagation velocity in water, which is nearly constant. Basing the travel time on the velocity in water, rather than the soil surrounding the probe, allows the probes to be deployed in conductive soils where the first boundary is the water/soil interface. The conductivity of the soil surrounding the buried portion of the TDR significantly reduces the level of the returned signal, making it difficult to identify subsequent boundaries.

Field Applications

The TDR probes have been deployed at three locations to assist in characterizing the effects of an ice cover on river morphology and scour around bridges. The studies were conducted on the Missouri River in eastern Montana, in a navigation pool on the Mississippi River, and upstream of a bridge pier in White River Junction, Vermont. The sites, conditions, and scour measurements are summarized below.

Missouri River, Culbertson, Montana. The objective of this study was to identify the variables that trigger sediment transport and result in significant changes in the river system between fall and spring. Five sites along the Fort Peck Reach of the Missouri River in eastern Montana were monitored during the winter of 1998-99 (Zabilansky et al., in prep.). To correlate the changes with various ice cover processes (i.e. formation, growth, and break-up), periodic bathymetric and hydraulic surveys were conducted to bracket each phase: during open water in October, following ice formation in January, prior to break-up in February, and during open water in April. To correlate changes in bed elevation with the hydrograph and ice conditions, the bed elevations at seven locations were monitored continuously at the Culbertson, Montana, site using TDRs. This reach of the river can be characterized as a meandering channel with two sub-channels, with nominal channel

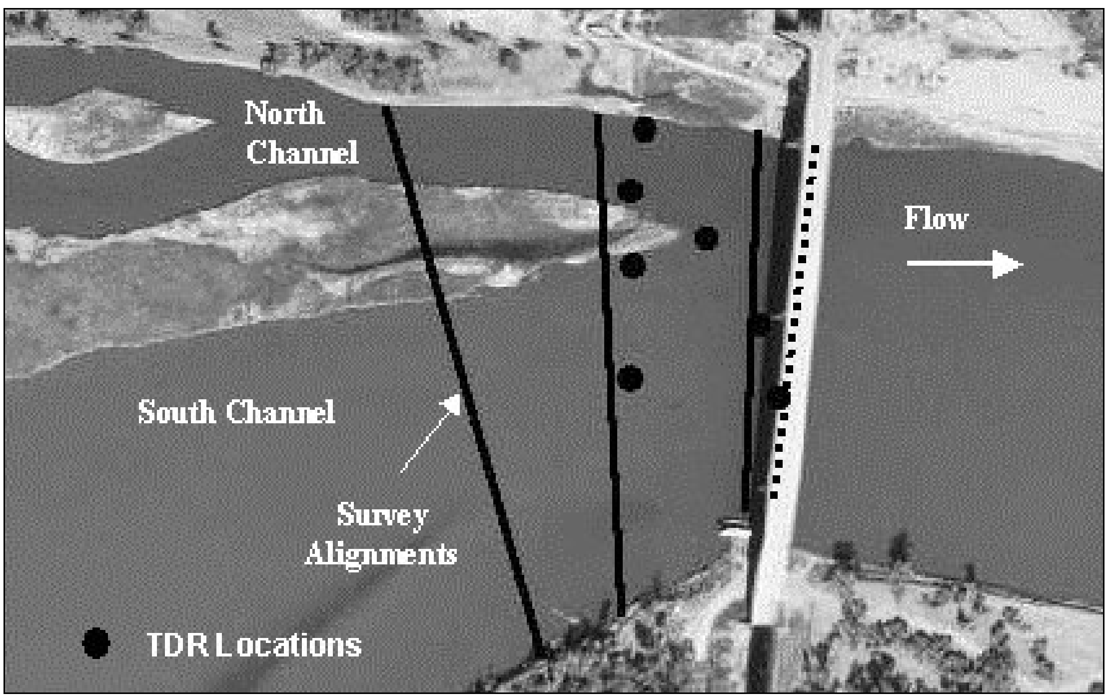

Figure 1. TDR locations and survey alignments, Missouri River.

depths of about 3 m in open water. The channel bed in this reach of the river is primarily sands and silts. Figure 1 shows the survey alignments used for periodic bathymetric measurements and the locations of the TDRs. Prior to freeze-up in December the average daily flow was approximately 280 m^3/s, which increased to 340 m^3/s for January and February following freeze-up and tapered to 250 m^3/s by early March. Superimposed on the average discharge are the hydroelectric releases. Prior to break-up in March the nominal ice thickness was 50 cm.

Ice cover formations occurred by juxtaposition of drifting frazil-ice slush and pans and pieces of skim ice. The ice formation process triggered a shift in the primary channel or thalweg from the south channel to the north channel. Initially the south channel was the thalweg and conveyed the majority of the flow and ice pieces. At one point the ice arched across the entrance to the north channel at the upstream end of the island, forcing the ice to pack and thicken in the south channel. As the ice pieces continued to accumulate in the south channel, a thermally grown ice cover formed downstream of the arch in the north channel. The underside of the ice accumulation in the south channel was hydraulically rougher than the smooth, thermally grown cover in the north channel. These differences in channel roughness biased the flow towards the north channel, which led to enlarging of the northern channel section by erosion of the bed and banks. Bed lowering was also measured by the TDRs along the north channel. The combined process of smoothing of the bottom of the ice, which reduced the resistance to flow, and enlarging of the north channel, which reduced the mean velocity and the rate of bed erosion, re-established equilibrium between discharge and flow area. The TDR readings of the bed elevation in the north channel remained stable until break-up, which occurred in March. As the thalweg shifted to the north channel, the velocity decreased in the south channel and the TDRs in the area measured a slight increase in bed elevation. The bed elevations at all the monitoring locations suddenly decreased in the early stage of ice break-up, even though the ice cover predominantly melted in place.

As the channel melted out upstream, ice blocks broke free from shore and floated down to the upstream edge of the ice cover. The turbulence of transitioning from open-water to ice-covered flow combined with the submergence of ice blocks floating downstream disrupted the velocity profile in the transition zone. Shifting the velocity profile increased the near-bed velocities, with a subsequent increase in erosion of the bed. Once the ice sheet fractured, the stage increased, the water velocity decreased, and the bed elevation started to increase. Although the TDR measurements were localized, the trends correlated with the global periodic bathymetry surveys taken at all the sites.

Mississippi River, Andalusia, IL. The objective of the study was to document the changes in bed elevation during the winter to calibrate a numerical sediment model. The instrumented site is at the confluence of a dredged channel with a side channel in a navigation pool on the Mississippi River downstream of Rock Island, Illinois. The instrumented site is shown in Figure 2, with the dredged channel (which provides water to a wildlife reserve) on the lower right, the side channel in the middle of the figure, and the navigation channel on the opposite side of the island along the top edge of the figure. Bed elevations were monitored at six locations using the TDR probes during the winters of 1999-2000 and 2000-01 (Zabilansky, in prep.). Probes were installed in the side channel and the dredged channel for the reserve; channel depths were 3 and 1.5 m, respectively. Water velocities within the pool were relatively low, and a thermally grown ice cover formed in place with a relatively smooth bottom surface. Being a regulated pool, the stage was not allowed to increase as the ice cover formed. The maximum ice thickness in the confluence area was on the order of 22 cm, and ice completely covered the width of the river. There was no appreciable change in bed elevation in the side channel during the

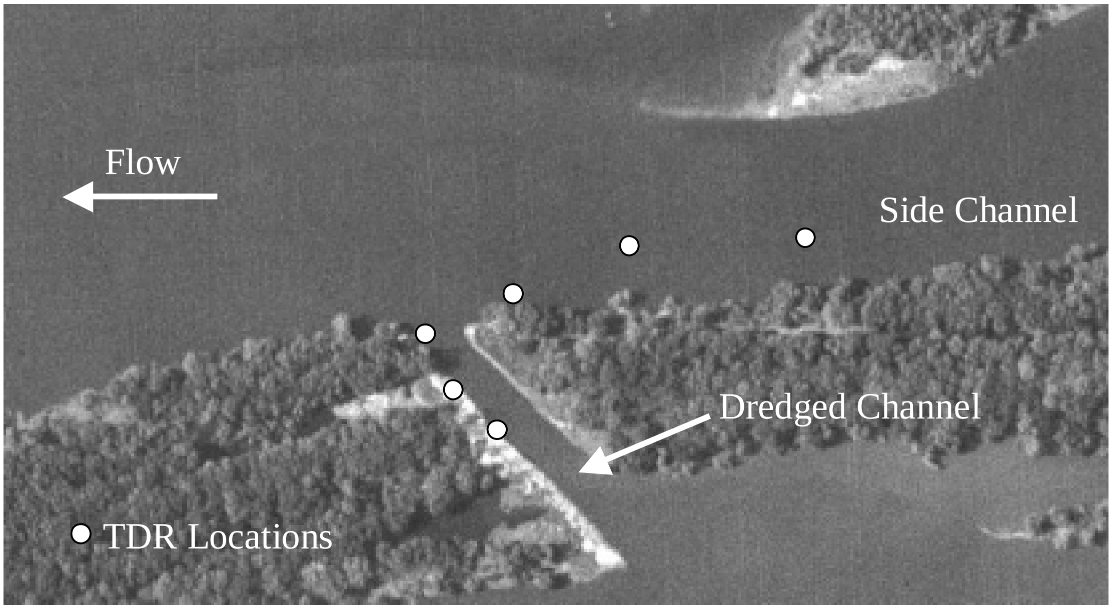

Figure 2. TDR locations, Mississippi River.

winter, but material was deposited in the dredged channel. Ice melted in place starting in the navigation channel. As the ice melted in the navigation channel, material started to deposit in the side channel and continued to deposit in the dredged channel. Deposition continued until the side channel was ice-free.

White River, White River Junction, Vermont. To document the cumulative effect of scour around bridge piers, three TDR probes were installed in the White River immediately upstream of a bridge pier. The river is an unregulated shallow watercourse with a gravel bed. The probes were installed immediately upstream of one of the piers of the Route 5 bridge pier in White River Junction, Vermont, in September 1996 and have been monitored since (Zabilansky and Yankielun, 2000) The initial ice cover is composed primarily of frazil accumulations confined by shore ice growing laterally from the riverbanks. Typical midwinter flows are about 30 m^3/s with a water depth of 0.4 m, but discharge can jump to 110 m^3/s when melting occurs in the basin. Break-up in the White River is triggered by an increase in stage due to rainfall or snowmelt in the basin. As stage rises, the bed recedes as the system tries to maintain equilibrium between the flow area and discharge, with the ice cover fixing the water surface elevation. Scour continues until the ice cover breaks up, at which time deposition starts.

During the summers, scour chains installed in conjunction with the probes were recovered and the maximum depth of scour documented before resetting the chains in preparation for the next winter. Repeatedly, the upper portions of the chains were found in a 4- to 15-cm sand layer covering a very dense layer of armoring rock. The sand layer was capped with a gravel wedge, which is thickest at the pier and tapers upstream. It can be surmised that the once the ice cover breaks up, the stage increases, decreasing the water velocity, and the suspended sediment can no longer be carried through the low-velocity zones associated with the scour holes. As the open-water phase of the spring hydrograph continues, the gravel being transported as a bed load deposits on top of the sand layer, restoring the gravel wedge upstream of the pier by early summer (Fig. 3).

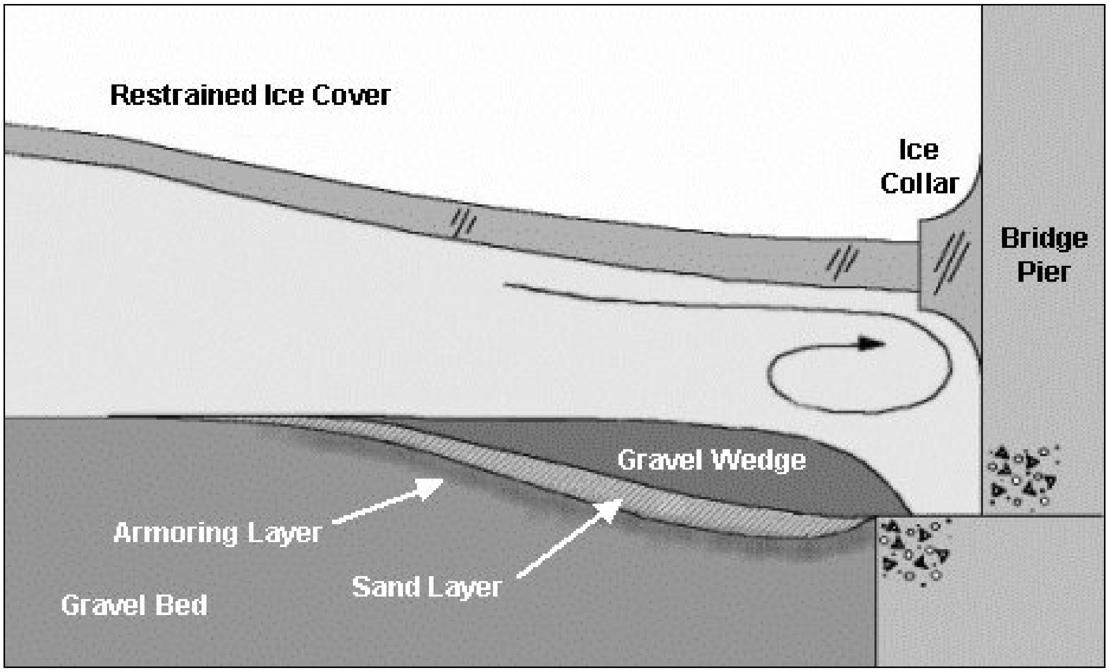

Figure 3. Restrained ice cover and sediment layers.

Discussion

Near-bed water velocity and water depth dictate the fate of suspended sediment. For a particular reach of river in open-water conditions, the maximum water velocity (V_{ow}) occurs at the surface, and the water depth (d_{ow}) is dictated by discharge (Q_{ow}) but depends on the bed roughness and channel slope as well. For a given reach, once a stationary ice cover forms, the velocity at the ice/water interface becomes zero, which shifts the velocity profile and the maximum velocity (V_{ic}) downward. The location of the maximum velocity is controlled by the friction at the ice/water and water/bed interfaces. To convey an equivalent open-water discharge, the water depth (d_{ic}) must increase and the open-water stage-discharge relationship is no longer valid. The increase in stage at freeze-up does decrease the water surface slope and the ability to carry sediment. As the ice cover thickens over the winter, it becomes more rigid and strongly attached to the shoreline and midchannel structures, which impedes the free response of the ice cover to changes in water level. To some extent this controls the flow area, as long as discharge does not increase the stage enough to cause break-up. Any fluctuation in the discharge below this threshold level has to be accommodated by an increase in the mean velocity. If the mean velocity (V) is greater than the velocity at freeze-up (V_{ic}), the increase in the near-bed velocity can trigger bed erosion.

At the Mississippi site, when the entire river was ice covered, the velocity profiles across the river were similar, with comparable near-bed velocities. As the navigation channel melted out, it was able to accommodate a larger portion of the flow, reducing the discharge and water velocity in the side channel. The lower velocity cannot carry the suspended sediment, and it precipitated out, detected by the increase in bed elevation at the monitoring points in the side channel. This observation is in agreement with Al-Abed

(1989), who reported that a free-floating ice cover reduces the bed and suspended load capacity to 34% and 50% of the sediment capacity of an open-water condition, respectively. When the ice cover allows the stage to increase in response to an increase in discharge, the ice cover is classified as “free-floating.”

At the Culbertson site, discharge at the time of freeze-up was 280 m^3/s, and the ice cover that formed at the corresponding stage elevation (datum) defined the cross-sectional flow area for the remainder of the winter. The ice cover remained stationary, and only shoreline cracks showed evidence of some flexing as the system attempted to accommodate an incremental increase in discharge above the freeze-up datum. With the ice cover defining the water surface elevation, the available flow area was also defined at freeze-up (A_{ic}). Ignoring creep, which would relieve the bending stress in the ice cover, any increase in discharge above the freeze-up discharge has to be accommodated by an increase in mean velocity. Increases in the velocity naturally lead to lowering of the bed elevation if the material is erodable. When the ice cover prevents the stage from rising in response to an increase in discharge, the ice cover is classified as “confining.”

The confining effect of the ice cover was also detected by the probes upstream of the bridge pier in White River as a discharge increase prior to break-up. Characterizing sediment movement under an ice cover is difficult, but bridge piers increase the complexity. Olsson (2000) conducted a laboratory study using floating Styrofoam ice sheets to assess the influence of an ice cover on the depth of scour around bridge piers. He reported that the floating cover increases the scour depths up to 35% compared with open-water conditions. In the field the ice is not free floating because the piers provided intermediate anchor points for the ice cover.

The ice cover is thicker adjacent to the bridge pier because of the thermal conductivity of the pier and natural water-level fluctuations. The vertical face of this ice collar is jagged because the channel skim ice repeatedly breaks and refreezes; the upper and lower surfaces of the ice collar gradually curve into the vertical pier (Fig. 3). This curvature redirects the current towards the bed with little loss of momentum. In shallow rivers this localized jetting action may dramatically increase the resuspension of particles, especially the non-compacted material deposited in the scour hole following a previous event. The cyclic flooding-freezing process around the pier also artificially thickens the ice surrounding the pier. In the near vicinity of the pier, the ice sheet that forms between piers and abutments is typically frozen to or has sufficient shear interlock with the ice collar to resist uplifting water pressure. As the inter-pier ice thickens and becomes more rigid, it spans between the bridge piers or abutments as a structural beam, preventing the water from rising in the vicinity of the bridge. The flexibility of the ice cover can be quantified by its characteristic length (l), which can be approximated by $16h^{3/4}$, where h is the ice thickness in meters. The radius of the area influenced by deflecting or restraining the ice cover is four times the characteristic length. With the bridge pier spacing ranging between 60 and 100 m, it is conceivable that the areas of influence for the piers overlap. For example, a 0.5-m-thick ice cover has a characteristic length of 9.5 m, or a radius of influence of 38 m. Given a 60-m span between piers, the radii of influence would overlap, and the interaction between the piers would prevent the ice sheet between the piers from freely responding to the increased discharge, thereby “confining” the flow area between the piers. Upstream of the bridge the ice cover is only fixed at the shore, and the midchannel ice can flex as the water level increases. Thus, the ice sheet upstream of the bridge serves as a funnel, capturing the flow and confining it under the ice sheet at the piers. If the ice sheet is continuous around the bridge, any increases in discharge are reflected in the velocity and accelerated scour.

Conclusions

An ice cover can have a significant influence on the sediment transport process, particularly in the vicinity of bridge piers. Sediment transport and scour analysis needs to consider the deviation in the discharge from the time of freeze-up; if the discharge is greater than at freeze-up, the ice cover may to some extent confine the flow. The mean velocity then increases to accommodate the additional discharge, with a subsequent increase of the near-bed velocities and possible acceleration of the erosion of the riverbed.

Acknowledgments

The Omaha District of the U.S. Army Corps of Engineers (COE), the Rock Island District of the COE, and the Vermont Agency of Transportation funded studies on the Missouri River, Mississippi River, and White River, respectively.

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Looking Upstream at Scisco Chute and Access Channel

Lentic-Lotic Habitat Access Channel

Time-Domain Reflectometry Probe Station

Camera Mounted on Tree

APPENDIX G

PUMP STATION INSPECTION REPORT

PUMP STATION INSPECTION REPORT

Name of Project and Program (EMP, 1135, Etc.):

Andalusia Refuge Rehabilitation and Enhancement Project, EMP
Pool 16, River Miles 462-463, Rock Island County, Illinois

Date/Hour Inspection Began/Ended:

Date: 11/29/00 Time: 0900

Inspectors:

Corps Representatives: Mark Clark, Rachel Fellman, John Behrens
Local Sponsor Officials: Jay Finn, ILDNR

River/Forebay Elevations:

River El.: _545.5___ Stage El.: ____N/A___ Zero Gage El.: ___N/A__
Management Unit El.: _546.5___ Stage El.: ____N/A___ Zero Gage El.: ___N/A__

Project Data:

Pumping Arrangement and Configuration: Two (2) submersible KSB pumps set up for bi-directional pumping.

Size of Moist Cell Unit(s) (Acres): 130 Acres

Fill Time (Days): Actual: To raise MSMU between EL. 546.0 to EL. 547.0 equates to 5 days of pumping.
Design: 14 days for the same elevations.

Empty Time (Days): Actual: ILDNR lowers the MSMU to EL. 543.0
Design: EL. 542.0

General Comments:

1. Gaskets were observed to be detaching from the aluminum stoplogs.

2. A problem was experienced this fall by the pump operator while attempting to maintain the MSMU between EL. 543.0 – 543.5. The "Pump Out" pump could not be operated in the "manual" or "auto" mode. The cause of the operational flaw was not investigated or corrected.

PUMP STATION MAINTENANCE INSPECTION GUIDE

RATED ITEM	A	M	U	EVALUATION	REMARKS
SECTION I				***FOR INTERNAL USE AND EVALUATION***	
1. Pump Station Size	A			Pump station has adequate capacity (considering pumping capacity, ponding areas, Compare Fill/Empty times with Design, etc.). (A or U.)	
SECTION II				***FOR LOCAL SPONSOR USE***	
2. O&M Manual	A			O&M Manual is present and adequately covers all pertinent areas. (A or U.)	Corps Operations and Maintenance Manual is dated December 1995. Recommendation: The O&M information should include a pump curve for the pumps. The pump station operators and maintenance personnel should review the manuals biannually for routine maintenance to be identified and performed as recommended by the equipment manufacturers. Identify such review and maintenance in the operation logbook. Maintain good record keeping and perform the required maintenance as outlined in the operation and maintenance manuals.
3. Operating Log	A			Pump Station Operating Log is present and being used. (A or U.)	Recommendation: A logbook for the pump station should be initiated. The logbook should be in a notebook, 3-ring binder, or bound logbook and should be in neat tabular form. Entries in the logbook should indicate such items as date, water elevations, and periodic lubrication, pump hours or running time, maintenance/ repairs, and special events that are significant in nature. The logbook should be stored and protected in the same location and manner as operation and maintenance manuals. Protection provided shall be moisture and rodent proof. The logbook should also include sections for pump performance testing, pump overhaul or service work performed, sump maintenance, pump discharge outlet work, and forebay cleaning (dredging), etc. Include in the logbook brief descriptions of any service work or maintenance. These descriptions could possibly be located in their own section that could be separate from the daily entries if space does not allow for it.

RATED ITEM	A	M	U	EVALUATION	REMARKS
4. Annual Inspection	A			Annual inspection is being performed by the local sponsor. (A or U.)	Recommendation: The local sponsor should perform routine maintenance in accordance with the operation and maintenance manuals for the equipment. Annual inspection dates, discrepancies that are found, and actions taken should be entered into the logbook. Recommend that a written checklist be developed for the annual inspection to ensure it is performed in accordance with manufacturer's recommendations as described in the operation and maintenance data.
5. Plant Building	A			A Plant building is in good structural condition. No apparent major cracks in concrete, no subsidence, roof is not leaking, etc. Intake louvers clean, clear of debris. Exhaust fans operational and maintained. Safe working environment. M Spalding and cracking are present, or minimal subsidence is evident, or roof leaks, or other conditions are present that need repair but do not threaten the structural integrity or stability of the building. U Any condition that does not meet at least Minimum Acceptable standard.	Four (4) 6-inch-diameter ventilation holes have been installed by Corps personnel to assist with building ventilation and reduce condensation. The building is concrete and is in good condition.
6. Pumps	A			A All pumps are operational. Preventive maintenance and lubrication are being performed. System is periodically subjected to performance testing. No evidence of unusual sounds, cavitation, or vibration. M All pumps are operational and deficiencies/minor discrepancies are such that pumps could be expected to perform through the next period of usage. U One or more primary pumps are not operational, or noted discrepancies have not been corrected.	"To River Pump" operating hrs 1114.4 "To Pond Pump" operating hrs. 751.0 The operator believes the "To River Pump" hour meter registers twice the number of hours on the meter compared to the actual pumping time. Each pump designed for 6,775 gpm @ 8.5 TDH. Recommendation: The reported problem with the "To River Pump" run time meter should be investigated and corrected.

RATED ITEM	A	M	U	EVALUATION	REMARKS
7. Motors, Engines and Gear Reducers	A			A All items are operational. Preventive maintenance and lubrication being performed. Systems are periodically subjected to performance testing. Instrumentation, alarms, and auto shutdowns operational. M All systems are operational and deficiencies/minor discrepancies are such that pumps could be expected to perform through the next expected period of usage. U One or more primary motors are not operational, or noted discrepancies have period of usage.	Perform operation and maintenance to the pump motors in accordance with the operation and maintenance manuals. Replace lubricant with pump motors in accordance with the manufacturer's recommendations.
8. Sumps/Trash Racks	A			**SPECIAL INSTRUCTIONS:** *Measure silt accumulation in sumps and trash racks. Measure water depth at inlet and outlet.* A Sumps/Trash Racks are free of concrete deterioration, protected from permanent damage by corrosion and free of floating and sunken debris. Sumps are clear of accumulated silt. Passing debris is minimized by spacing of trash rack bars. Periodic maintenance performed on trash racks and removal of accumulated silt in sumps is performed. M Trash racks and sumps have some accumulated silt or debris but are not currently inhibiting the pump(s) performance. No periodic maintenance has been performed. Present condition could be expected to perform through the next expected period of usage provided removal of floating debris is accomplished. U Proper operation can not be ensured through the next period of usage. Possible damage could result to the pumping equipment with continued operation.	The ILDNR has added a outer trash rack to minimize aquatic vegetation from clogging the pump station main trash rack. No excessive debris or siltation was observed. River Side- The water depth in front of the trash rack was measured to be 3'-6" and approximately 2" of silt accumulation. The water depth behind the trash rack was measured to be 6'-0". Moist Soil Management Unit Side- The water depth behind the trash rack was measured to be 8'-0". Could not reach the front of the trash rack to measure water depth. Recommendation: Dates of any maintenance or cleaning performed should be logged into the operation logbook.

RATED ITEM	A	M	U	EVALUATION	REMARKS
9. Other Metallic Items	A			A All metal parts in plant/building are protected from permanent damage by corrosion. Equipment anchors and grout pads show no rust or deterioration. M Corrosion on metallic parts (except equipment anchors) and deterioration period of usage. U Any condition that does not meet at least Minimum Acceptable standards.	
10. Ancillary Equipment i.e. Compressed Air Siphon Breakers Fuel Supply Vacuum Priming Pump Lubrication Heating/Ventilation Engine Cooling Engine Oil Filtering	A			A All equipment operational. Preventive and annual maintenance being performed. Equipment operation understood and followed by pump station operators. M Ancillary equipment is operational and deficiencies/minor discrepancies are such that equipment could be expected to perform through the next period of usage. U One or more of the equipment systems is inoperable. The present condition of the inoperable equipment could reduce the efficiency of the pump station or jeopardize the pump station's role in flood protection.	Not Applicable
11. Backup Ancillary Equipment	A			A Adequate, reliable, and enough capacity to meet demands. Backup units/equipment are properly sized, operational, periodically exercised, and in an overall well maintained condition. M Backup ancillary equipment is operational and deficiencies/minor discrepancies are such that equipment could be expected to perform through the next period of usage. U Backup ancillary equipment not considered reliable to sustain operations during flooding conditions.	Not Applicable

RATED ITEM	A	M	U	EVALUATION	REMARKS
12. Pump Control System		M		A Operational and maintained free of damage, corrosion, or other debris. M Operational with minor discrepancies. U Not operational, or uncorrected discrepancies noted from previous inspections.	Corps personnel have completed float guard modifications. Pump operator reported a problem with the " To River" pump when ILDNR were trying to maintain the MSMU between EL. 543.0-543.5. The pump could not be operated in either "manual" or "auto" mode while the MSMU was at the identified elevations. Recommendation: ILDNR should investigate the cause of the suspected float malfunction and correct the problem to allow full range pumping. New pump station personnel should be thoroughly trained the correct operation and maintenance procedures for all pump station electrical and mechanical equipment.
13. Intake and Discharge Outlets	A			Functional. No damaging erosion evident. Opening/closing devices for vertical gates, flap gates, etc. are functional in a well-maintained condition. (A or U.)	Gaskets were observed to be detaching from the aluminum stoplogs. Recommendation: Gaskets should be reattached to stoplogs.
14. Insulation Megger Testing (For pump stations with electric pumps only)		M		A Megger test has been performed within the last 36 months. Results of megger test show that insulation of primary conductors and electric motor meet manufacturer's or industry standard. M Results of megger test show that insulation resistance is lower than manufacturer or industry standard, but can be expected to perform satisfactorily until next testing or can be corrected. U Insulation resistance is low enough to cause the equipment to not be able to meet its design standard of operation.	No megger testing has been performed. Recommendation: The ILDNR should perform megger testing on the electric pump motors periodically.
15. Final Remarks					

APPENDIX H

LEVEE INSPECTION REPORT

LEVEE INSPECTION REPORT

1. Name of Flood Control Works:
   Andalusia Refuge Habitat Rehabilitation and Enhancement Project (HREP)

2. Date/Hour Inspection Began/Ended:
   29 November 2001 - 0900/1100

3. Inspectors (Including Levee Officials):
   Corps Representative(s) - Mark Clark, John Behrens, and Rachel Fellman
   Sponsor Representative(s) - Jay Finn (ILDNR Site Manager)

4. Inspection Procedures Followed:
   Drove the entire levee system

5. Evaluation of Flood Control Works:
   Acceptable

6. General Comments:
   Overall maintenance of levee system acceptable; however, tree removal required along toe of levee L/S from Sta. 16+75 to Sta. 29+80 to allow for adequate access

Inspector's observations and comments as follows:

RATING	ITEM	LOCATION Sta. to Sta.	REMARKS Note: R/S - Riverside L/S - Landside
	LEVEE SLOPES		
A	Depressions		
A	Erosion		
A	Slope Stability		
A	Cracking		
	Seepage Areas *(Do not rate. Note areas that are of concern during high water.)*		
A	Animal Burrows		

RATING	ITEM	LOCATION Sta. to Sta.	REMARKS Note: R/S - Riverside L/S - Landside
A	Unwanted Levee Growth		
A	Grazing		
A	Sod		
MA	Encroachments	Sta. 16+75 to Sta. 29+80	L/S of levee – tree encroachment at toe of levee, suggest a 10-foot buffer between toe and trees
	LEVEE CROWN		
	Authorized Levee Access Gates *(Do not rate. List gate locations.)*		
A	Depressions		
A	Erosion		
A	Cracking		
A	Animal Burrows		
A	Unwanted Levee Growth		
A	Grazing		
A	Sod		
A	Road Crossings *(other than those with closure structures)*		
A	Encroachments		
	REVETTED AREAS		
A	Riprap/Revetment		

RATING	ITEM	LOCATION Sta. to Sta.	REMARKS Note: R/S - Riverside L/S - Landside
A	Unwanted Levee Growth		
A	Encroachments		
	FLOOD WALLS		
A	Stability of Concrete Structures		
A	Concrete Surfaces		
A	Structural Foundations		
	DRAINAGE STRUCTURE(S)		
	Toe Drains *(Do not rate. List stationing and locations of drains.)*		
N/A	Relief Wells		
A	Culverts		
A	Riprap/Revetment		
A	Stability of Concrete Structures		
A	Concrete Surfaces		
A	Structural Foundations		
A	Gates		
	CHANNELS		
A	Unwanted Levee Growth		
A	Stability of Concrete Structures		

RATING	ITEM	LOCATION Sta. to Sta.	REMARKS Note: R/S - Riverside L/S - Landside
A	Concrete Surfaces		
A	Structural Foundations		
A	CLOSURE STRUCTURE(S)		
	PUMP STATION(S) *(See "Pump Station Inspection Report" in Appendix G.)*		

APPENDIX I

PHOTOGRAPHS OF PROJECT FEATURES

Standing on top of perimeter levee near pump station looking east towards moist soil management unit (MSMU)

Water control structure for pump station

Looking east towards MSMU at islands

Near pump station looking northwest

Manual hoist & jib crane mounted to handrail

At pump station looking west towards river

On levee looking at pump station

Near pump station looking southwest

Manual hoist and jib crane mounted to handrail

Security measure for the utility box

Security measure for the access ladder

APPENDIX J

PROJECT TEAM MEMBERS

ANDALUSIA HREP TEAM MEMBERS

POC	Position	Agency	Address	City	State	Zip Code	Telephone Number	FAX Number	Email Address
Roger Perk	Program Manager	USACE	Clock Tower Building P.O. Box 2004	Rock Island	IL	61204	309-794-5475	309-794-5710	Roger.A.Perk@usace.army.mil
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Steve Moser	Site Superintendent	ILDNR	Hennepin Canal R.R. 2 Box 201	Sheffield	IL	61361	815-454-2328	815-454-2042	smoser@dnrmail.state.il.us
Ed Walsh	Fish Biologist	ILDNR	P.O. Box 149	Aledo	IL	61231	309-582-5611		ewalsh@dnrmail.state.il.us
Scott Schaeffer	Wildlife Biologist	ILDNR	Dearborn Hall 205 East Seminary	Mount Carroll	IL	61053	815-244-3655	815-244-1098	

APPENDIX K

REFERENCES

REFERENCES

Published reports relating to the Andalusia HREP or which were used as references in the production of this document are presented below.

(1) *Definite Project Report with Integrated Environmental Assessment (R-5), Andalusia Refuge Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program, Pool 16, Upper Mississippi River, Rock Island County, Illinois, July 1989*. 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) *Plans and Specifications, Upper Mississippi River System, Environmental Management Program, Pool 16, River Miles 462.0-463.0, Andalusia Refuge*, Solicitation No. DACW25-90-B-0031. These documents were prepared to provide sufficient detail of project features to allow construction of a confined dredged material placement site, hydraulically dredged channels, mechanically excavated channels, potholes, and check dams.

(3) *Plans and Specifications, Upper Mississippi River System, Environmental Management Program, Pool 16, River Miles 462.0-463.0, Andalusia Refuge*, Contract No. DACW25-93-C-0034. This document was prepared to provide sufficient detail of project features to allow planting of mast trees.

(4) *Operation and Maintenance Manual, Andalusia Refuge Rehabilitation and Enhancement, Upper Mississippi River Environmental Management Program, Pool 16, River Mile 462.0-463.0, Rock Island County, Illinois, June 1994*. This manual was prepared to serve as a guide for the operation and maintenance of the Andalusia HREP. Operation and maintenance instructions for major features of the project are presented.

(5) *Post-Construction Performance Evaluation Report (PER5F), Andalusia Refuge Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program, Pool 16, Upper Mississippi River Mile 462.0-463.0, Rock Island County, Illinois, February 1996*.

(6) *Post-Construction Supplemental Performance Evaluation Report (SPER501F), Andalusia Refuge Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program, Pool 16, Mississippi River Miles 462.0-463.0, Rock Island County, Illinois, August 1998.*

(7) *Post-Construction Performance Evaluation Report – Year 8 (2000), Andalusia Refuge Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program, Pool 16, Mississippi River Miles 462.0-463.0, Rock Island County, Illinois, June 2001.*

(8) *Post-Construction Performance Evaluation Report – Year 8 (2000), Andalusia Refuge Rehabilitation and Enhancement, Upper Mississippi River System Environmental Management Program, Pool 16, Mississippi River Miles 462.0-463.0, Rock Island County, Illinois, April 2002.*

(9) *Site Manager's Project Inspection and Monitoring Results, Andalusia Refuge Rehabilitation and Enhancement, Operation and Maintenance Manual, Upper Mississippi River Environmental Management Program, Pool 16, River Miles 462 through 463, Rock Island, Illinois*, July 1996, August 1997, June 1998, July 1999, September 2000, September 2001, October 2002.

APPENDIX L

DISTRIBUTION LIST

DISTRIBUTION LIST

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Wildlife Biologist
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Environmental Analysis Section, ME-19J
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Chicago, IL 60604

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District Chief
U.S. Geological Survey
Water Resources Division
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U.S. Geological Survey
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St. Louis, MO 63103-2833

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CEMVR-ED-HH
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CEMVR-ED-HQ (Bierl)
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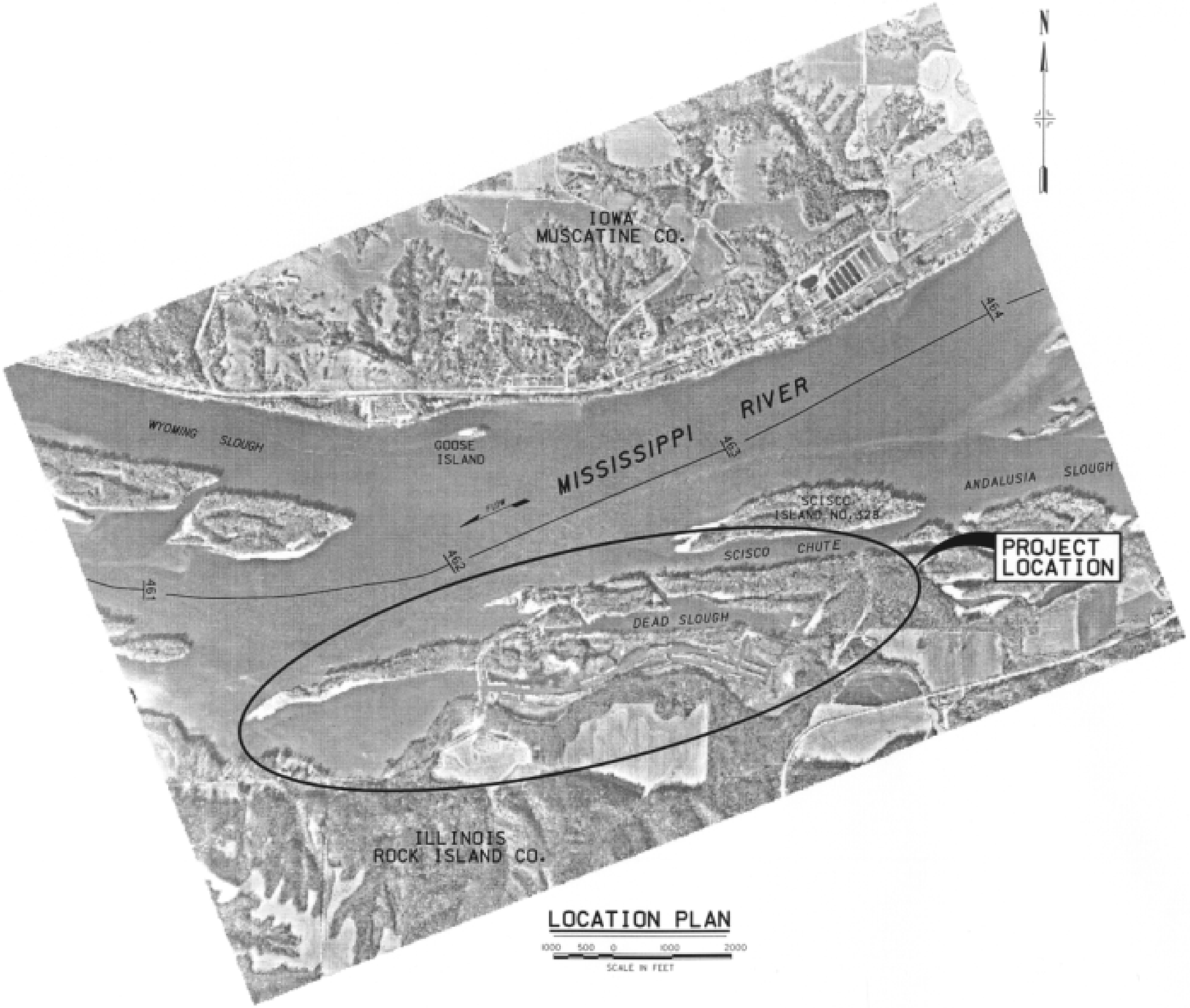
CEMVR-ED-S
CEMVR-OD-M
CEMVR-OD-MN
CEMVR-OD-MN (Swenson)

APPENDIX M

PLATES



LOCATION PLAN

1000 500 0 1000 2000
SCALE IN FEET

VICINITY MAP

25 0 25 50 75MI
SCALE IN MILES

NOTE:
DATE OF AERIAL PHOTO, NOVEMBER 26, 1995

US Army Corps of Engineers
Rock Island District

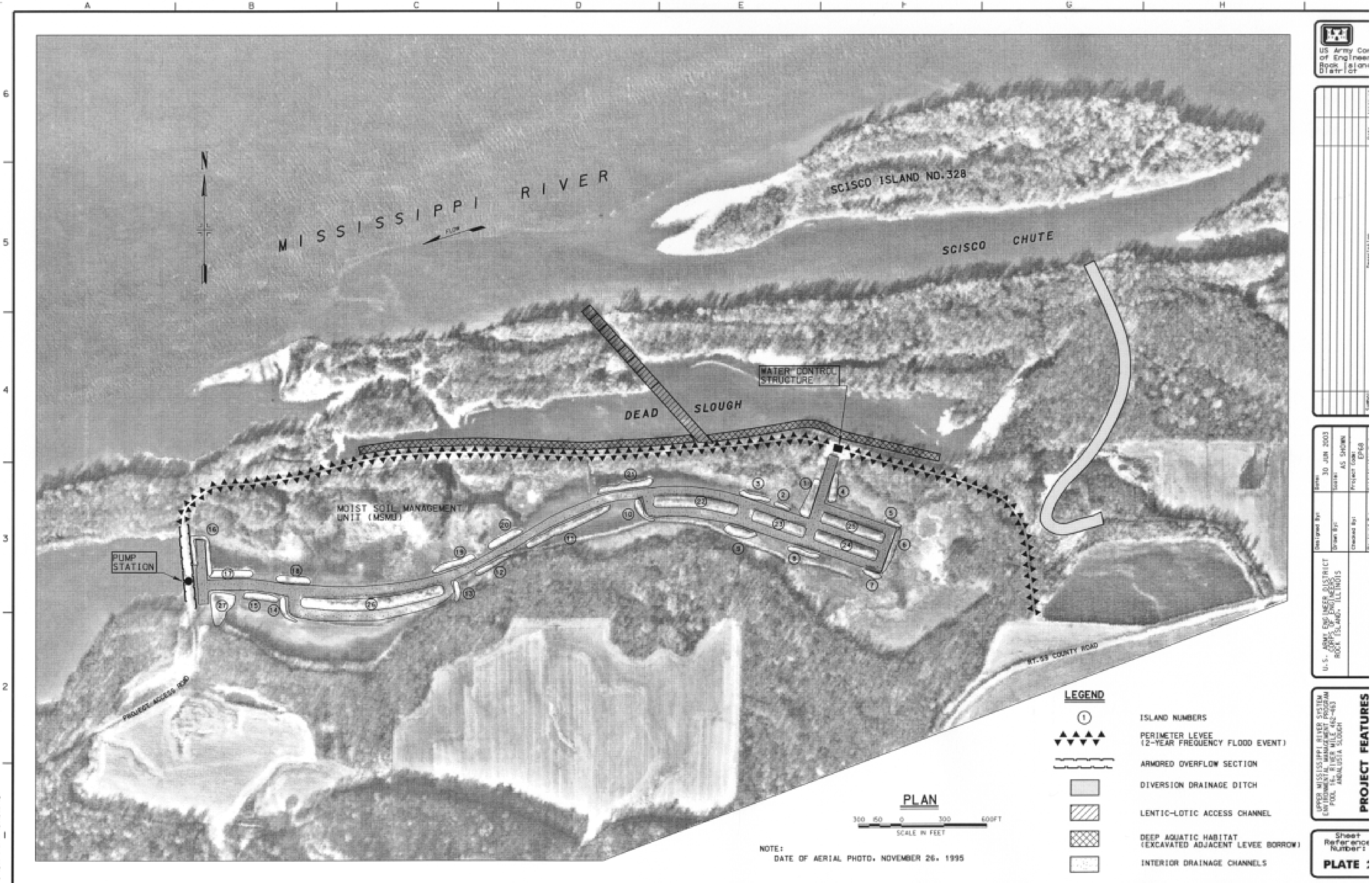
Designed By:	Date: 30 JUN 2003
Drawn By:	Scale: AS SHOWN
Checked By:	Project Code: EP68
Reviewed By:	Solicitation Number:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 16, RIVER MILE 462-463
ANDALUSIA SLOUGH

LOCATION PLAN & VICINITY MAP

Sheet Reference Number:
PLATE 1


MISSISSIPPI RIVER
FLOW
SCISCO ISLAND NO.328
SCISCO CHUTE
DEAD SLOUGH
WATER CONTROL STRUCTURE
MOIST SOIL MANAGEMENT UNIT (MSMU)
PUMP STATION
PROJECT ACCESS ROAD
RT.59 COUNTY ROAD
PLAN
300 150 0 300 600FT
SCALE IN FEET
NOTE:
DATE OF AERIAL PHOTO, NOVEMBER 26, 1995
LEGEND
ISLAND NUMBERS
PERIMETER LEVEE (2-YEAR FREQUENCY FLOOD EVENT)
ARMORED OVERFLOW SECTION
DIVERSION DRAINAGE DITCH
LENTIC-LOTIC ACCESS CHANNEL
DEEP AQUATIC HABITAT (EXCAVATED ADJACENT LEVEE BORROW)
INTERIOR DRAINAGE CHANNELS
US Army Corps of Engineers Rock Island District
Designed By:
Drawn By:
Checked By:
Date: 30 JUN 2003
Scale: AS SHOWN
Project Code: EP68
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 16, RIVER MILE 462-463 ANDALUSIA SLOUGH
PROJECT FEATURES
Sheet Reference Number:
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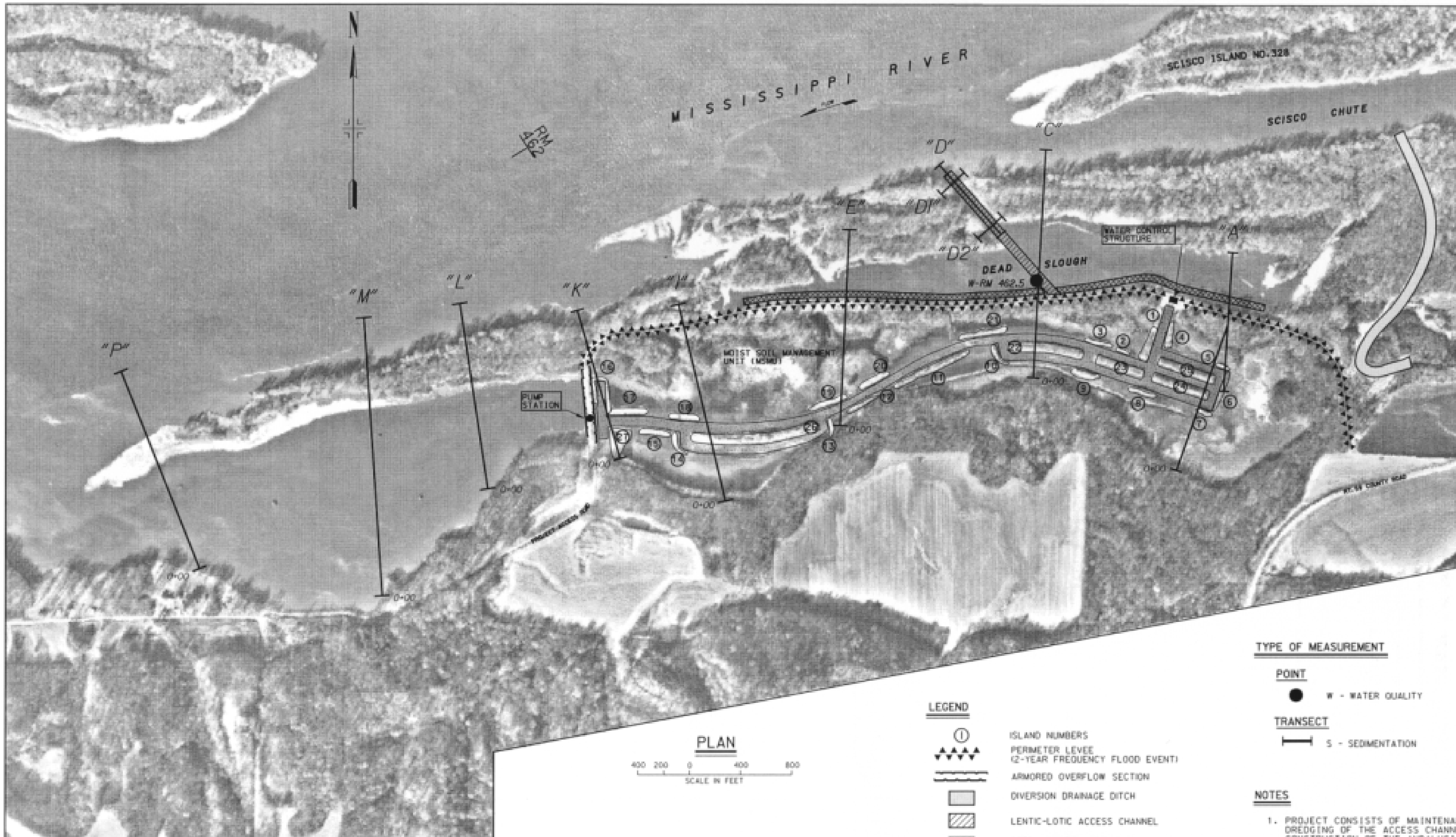

PLAN

400 200 0 400 800
SCALE IN FEET

LEGEND

- ① ISLAND NUMBERS
- PERIMETER LEVEE (2-YEAR FREQUENCY FLOOD EVENT)
- ARMORED OVERFLOW SECTION
- DIVERSION DRAINAGE DITCH
- LENTIC-LOTIC ACCESS CHANNEL
- DEEP AQUATIC HABITAT (EXCAVATED ADJACENT LEVEE BORROW)
- INTERIOR DRAINAGE CHANNELS

TYPE OF MEASUREMENT

POINT

● W - WATER QUALITY

TRANSECT

S - SEDIMENTATION

NOTES

1. PROJECT CONSISTS OF MAINTENANCE DREDGING OF THE ACCESS CHANNEL. CONSTRUCTION OF THE ANDALUSIA REFUGE COMPLEX WAS ESSENTIALLY COMPLETE MARCH 1994
2. DATE OF AERIAL PHOTO, NOVEMBER 26, 1995

US Army Corps of Engineers Rock Island District

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS

Designed By: | Date: 30 JUN 2003
Drawn By: | Scale: AS SHOWN
Checked By: | Project Code: EP68

UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 16, RIVER MILE 462-463 ANDALUSIA SLOUGH

MONITORING PLAN

Sheet Reference Number:

PLATE 3

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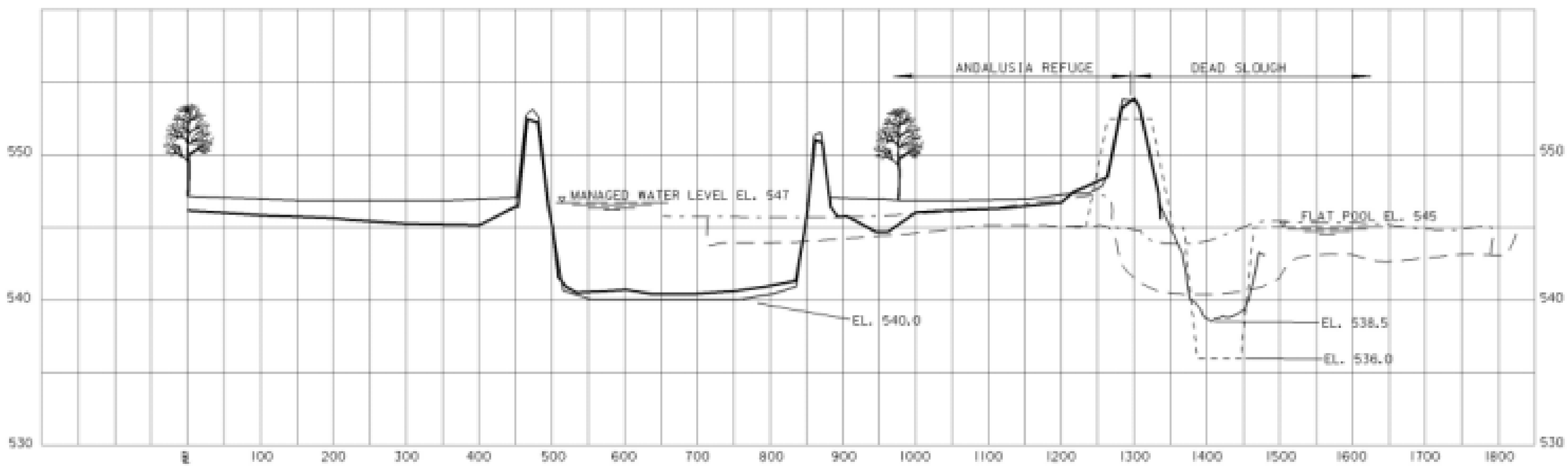
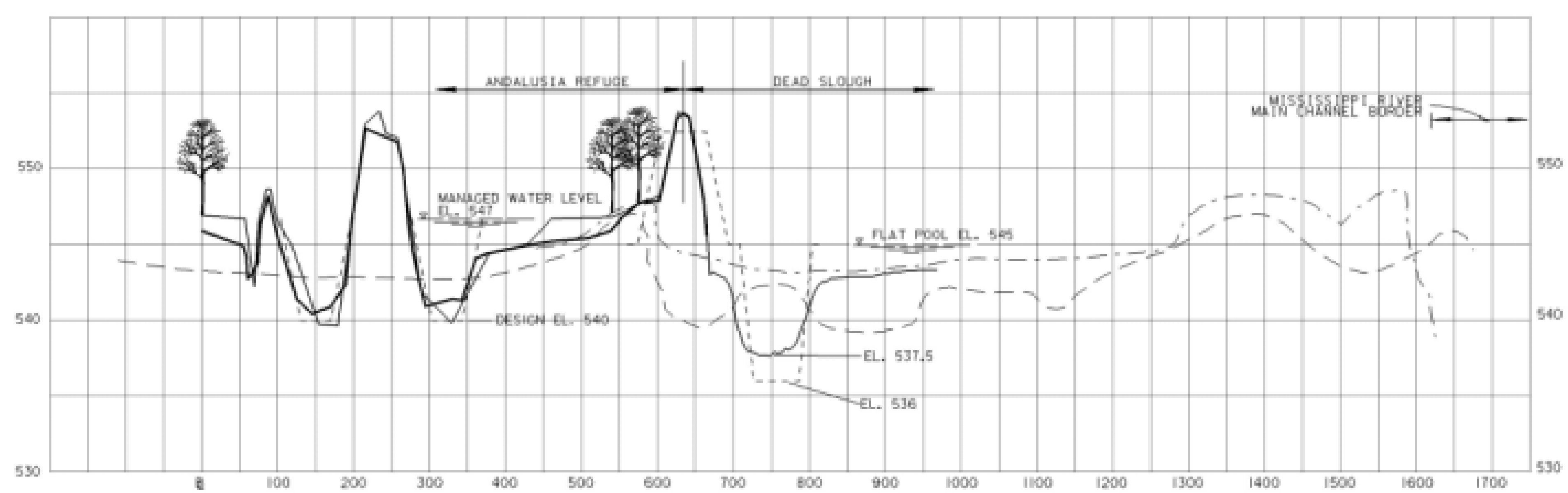


TRANSECT A



TRANSECT C

LEGEND

- 2002 SURVEY DATA
- 1997 SURVEY DATA, FIELD BOOK FC-96-16
- 1992 DESIGN TEMPLATE
- 1987 FIELD BOOK FC-87-9 AND FC-87-10
- 1936 PLANE TABLE, SHEETS 16-T-12 AND 16-T-13

US Army Corps of Engineers
Rock Island District

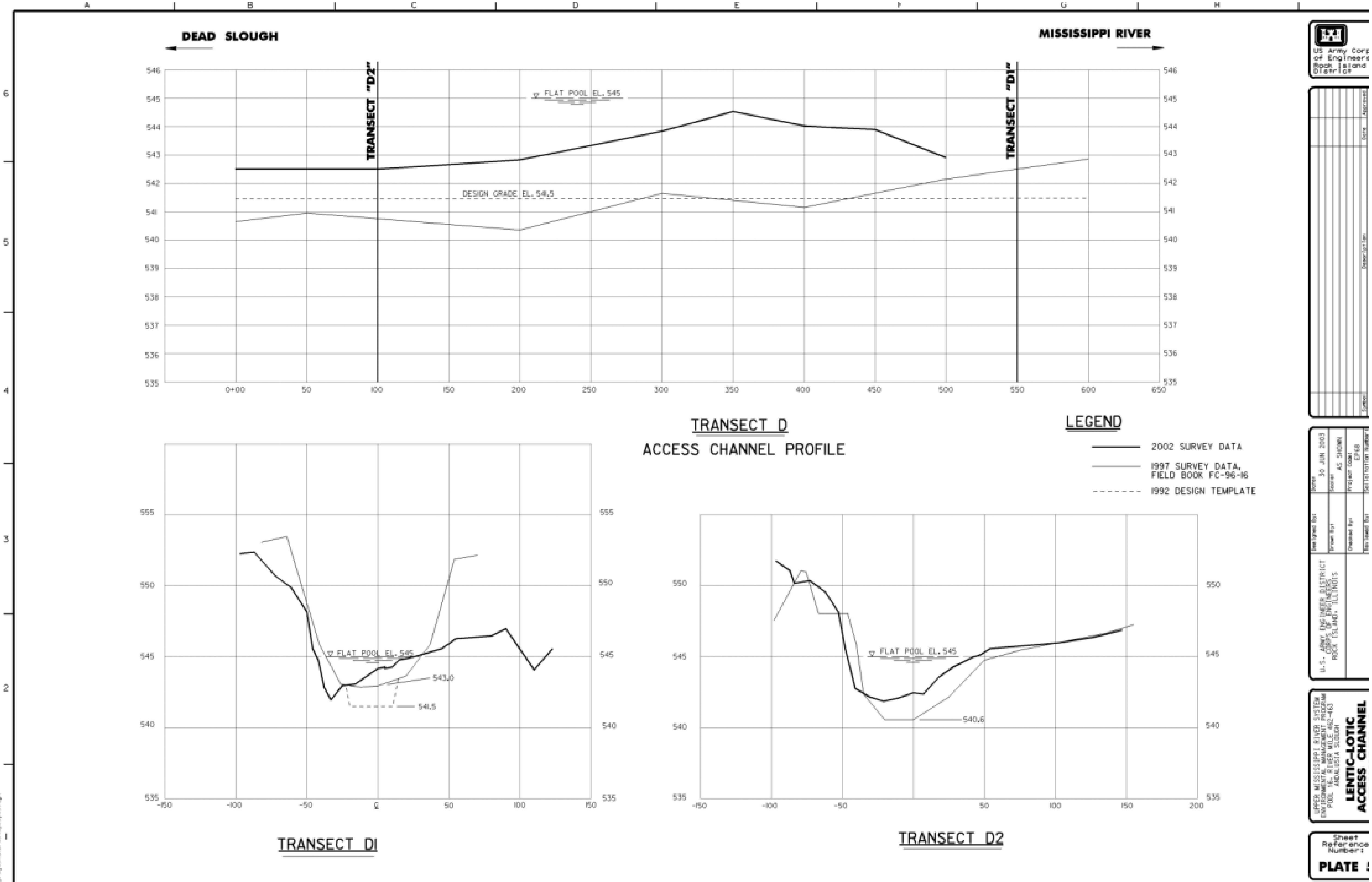
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Date: 30 JUN 2003
Scale: AS SHOWN
Project Code: EP68

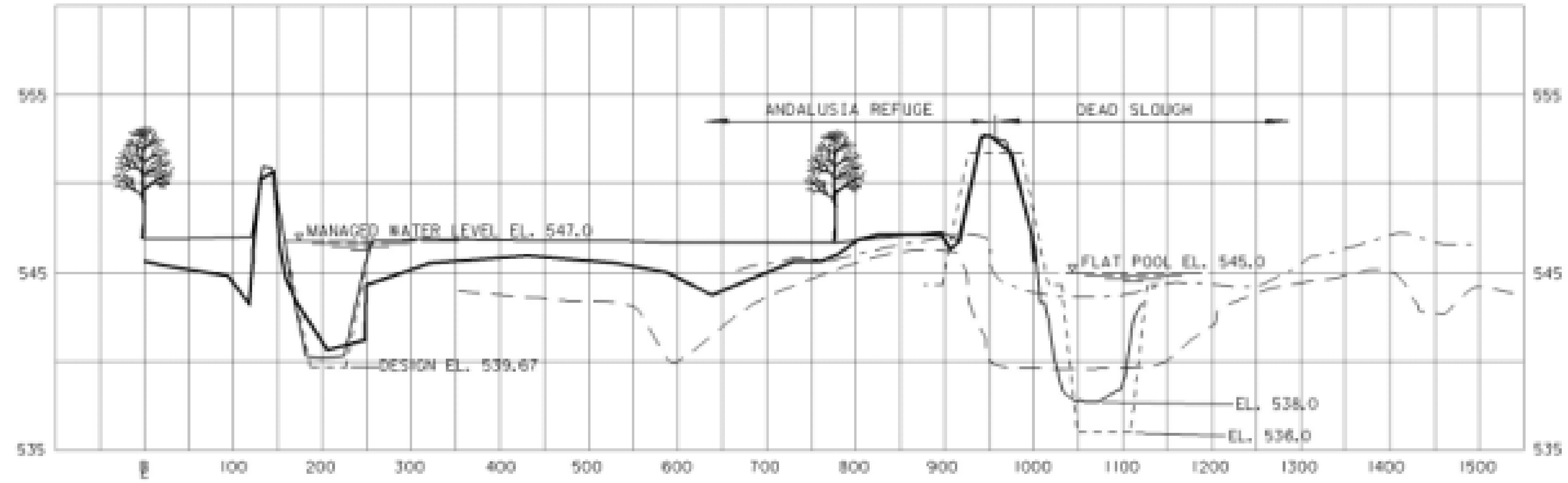
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 16, RIVER MILE 462-463
ANDALUSIA SLOUGH

TRANSECTS I

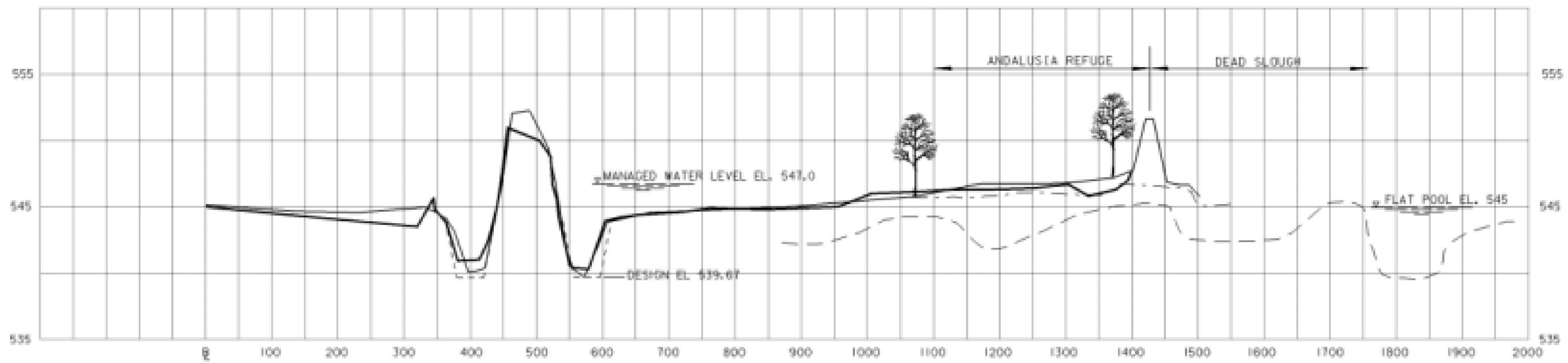
Sheet Reference Number:
PLATE 4



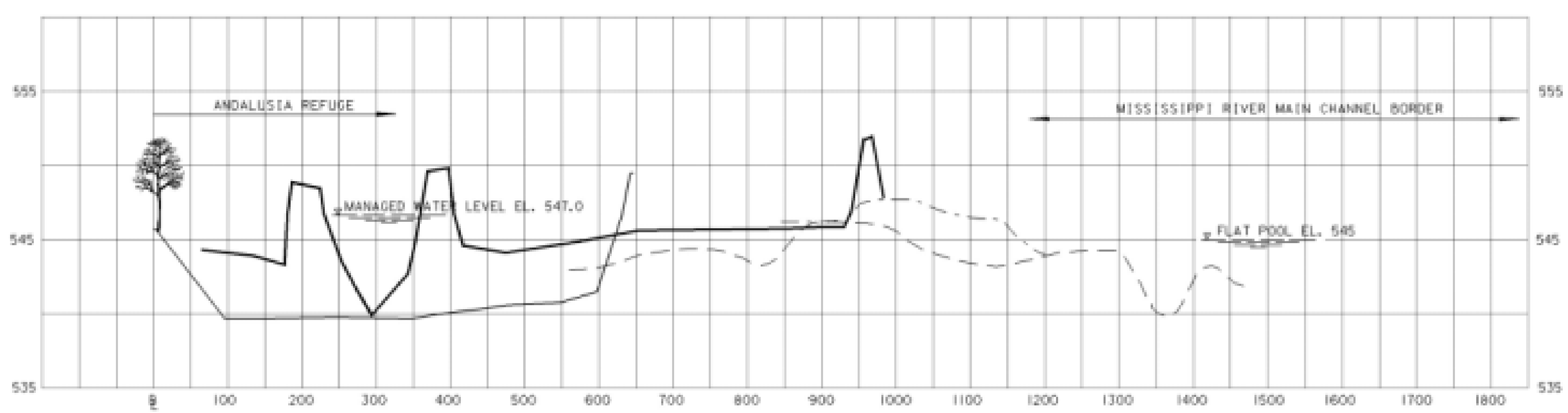
DEAD SLOUGH
MISSISSIPPI RIVER
TRANSECT "D2"
TRANSECT "D1"
FLAT POOL EL. 545
DESIGN GRADE EL. 541.5
TRANSECT D
ACCESS CHANNEL PROFILE
LEGEND
2002 SURVEY DATA
1997 SURVEY DATA, FIELD BOOK FC-96-16
1992 DESIGN TEMPLATE
543.0
541.5
540.6
TRANSECT D1
TRANSECT D2
US Army Corps of Engineers Rock Island District
30 JUN 2003
AS SHOWN
EP68
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 16, RIVER MILE 462-463 ANDALUSIA SLOUGH
LENTIC-LOTIC ACCESS CHANNEL
Sheet Reference Number:
PLATE



TRANSECT E



TRANSECT I



TRANSECT K

LEGEND

- ——— 2002 SURVEY DATA
- ——— 1997 SURVEY DATA, FIELD BOOK FC-96-16
- - - - - 1992 DESIGN TEMPLATE
- —·—· 1987 FIELD BOOK FC-87-9 AND FC-87-10
- — — 1936 PLANE TABLE, SHEETS 16-T-12 AND 16-T-13

US Army Corps of Engineers
Rock Island District

Date: 30 JUN 2003
Scale: AS SHOWN
Project Code: EP68

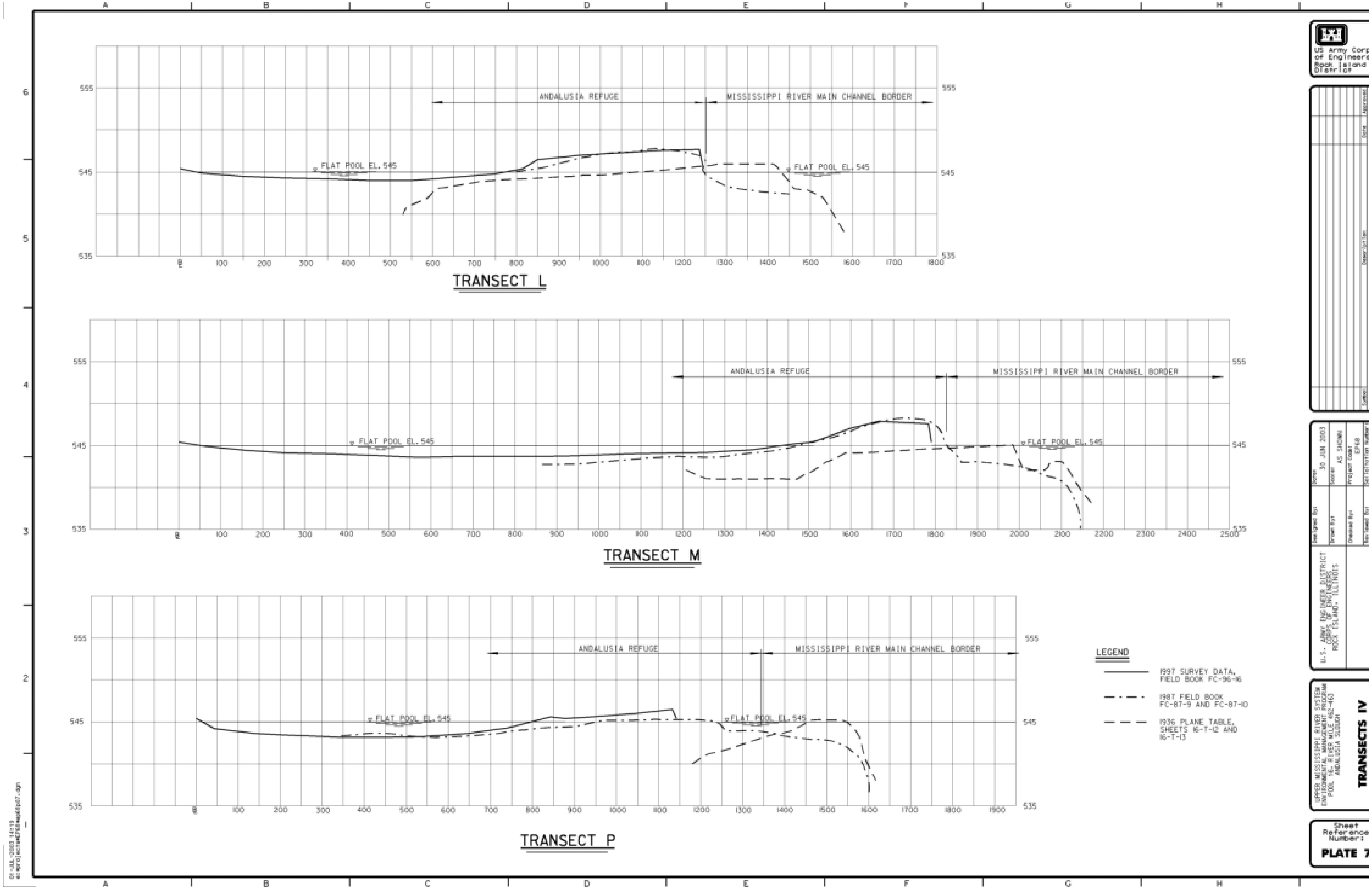
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 16, RIVER MILE 462-463
ANDALUSIA SLOUGH

TRANSECTS III

Sheet Reference Number:

PLATE 6



ANDALUSIA REFUGE
MISSISSIPPI RIVER MAIN CHANNEL BORDER
FLAT POOL EL. 545
555
545
535
TRANSECT L
TRANSECT M
TRANSECT P
LEGEND
1997 SURVEY DATA, FIELD BOOK FC-96-16
1987 FIELD BOOK FC-87-9 AND FC-87-10
1936 PLANE TABLE, SHEETS 16-T-12 AND 16-T-13
US Army Corps of Engineers Rock Island District
30 JUN 2003
AS SHOWN
EP68
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 16, RIVER MILE 462-463 ANDALUSIA SLOUGH
TRANSECTS IV
Sheet Reference Number:
PLATE 7

ANDALUSIA EMP SEDIMENTATION RANGES

JANUARY 1997 FC-96-16 SCALE: 1"=400'
MSL (1912) NAD 27 ILL WEST
FLAT POOL ELEVATION = 545.0
NOTE: RANGES ARE NOT MONUMENTED. ESTABLISHED BY GPS.

US Army Cor
of Engineer
Rock Island
District

Date: 30 JUN 2003
Scale: AS SHOWN
Project Code: EP68

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 16, RIVER MILE 462-463
ANDALUSIA SLOUGH

SURVEY CONTROL &
SEDIMENT TRANSECTS

Sheet Reference Number:
PLATE 8