US Army Corps of Engineers
St. Paul District

UPPER MISSISSIPPI RIVER SYSTEM

ENVIRONMENTAL MANAGEMENT PROGRAM

DEFINITE PROJECT REPORT/ENVIRONMENTAL

ASSESSMENT (SP-13)

LONG LAKE

HABITAT REHABILITATION

AND ENHANCEMENT PROJECT

POOL 7
UPPER MISSISSIPPI RIVER
TREMPEALEAU AND LA CROSSE COUNTIES, WISCONSIN

JULY 1991

LONG LAKE HABITAT REHABILITATION AND ENHANCEMENT PROJECT

EXECUTIVE SUMMARY

The Long Lake project area is a 15-acre backwater lake situated among several other backwater channels and lakes in the same vicinity. Long Lake is located in pool 7 on the Wisconsin side of the main channel of the Mississippi River immediately downstream of lock and dam 6. This backwater area provides above average habitat for fish of the families centrarchidae, perchidae, and ictaluridae except for one limiting factor, periods of severe dissolved oxygen depletion in the late summer and winter months.

The plan formulation process considered several alternatives that could improve dissolved oxygen to the lake. This assessment process primarily revolved around investigating sources of water having adequate dissolved oxygen that could be diverted into Long Lake. Most water bodies adjacent to Long Lake either proved to be an unreliable source of dissolved oxygen or there was the potential that other areas would be adversely affected by the diversion of this water. Only two viable alternatives remained following the original evaluation of options. These were two routes that would bring water in from the Mississippi River. The costs of the two alignments were essentially the same. Therefore, the recommended alignment was selected on the basis of habitat gains and avoidance of the need to acquire.

The selected plan calls for excavation of a channel approximately 620 feet in length between the Mississippi River and Long Lake. It is estimated that 10,200 cubic yards of material would be removed to create the channel. A 48-inch-diameter reinforced concrete pipe with sluice gate would be placed along the channel to control inflow into the lake during periods of high flow. By introducing direct flow into Long Lake, minimum dissolved oxygen levels of 5 mg/l would be provided on a year-round basis to a majority of the lake area. Habitat unit gains have been projected to increase by over 800 percent in Long Lake from the with-out to the with-project condition. Improvement of the dissolved oxygen should lead to increased use of the area by fish throughout the year.

Total direct construction costs of the selected plan are $139,900. Indirect costs for engineering and design work and construction supervision and administration bring the cost to $212,700. During the general design phase of this project, $50,000 was expended. Average annual operation and maintenance costs of the project are estimated to be $4,000 and would be the responsibility of the U.S. Fish and Wildlife Service, in cooperation with the non-Federal sponsor, the Wisconsin Department of Natural Resources.

St. Paul District
Corps of Engineers

July 1991

TABLE OF CONTENTS (CONT)

TABLE OF CONTENTS (CONT)

DEFINITE PROJECT REPORT

LONG LAKE
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POOL 7, UPPER MISSISSIPPI RIVER
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INTRODUCTION

AUTHORITY

The authority for this report is provided by Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662). The proposed project would be funded and constructed under this authorization. Section 1103 is summarized as follows:

> Section 1103. UPPER MISSISSIPPI RIVER PLAN
>
> (a)(1) This section may be cited as the Upper Mississippi River Management Act of 1986.
>
> (2) To ensure the coordinated development and enhancement of the Upper Mississippi River system, it is hereby declared to be the intent of the Congress to recognize that system as a nationally significant ecosystem and a nationally significant commercial navigation system....The system shall be Administered and regulated in recognition of its several purposes.
>
> (e)(1) The Secretary, in consultation with the Secretary of the Interior and the states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, is authorized to undertake, as identified in the Master Plan -
>
> (A) a program for the planning, construction, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement....

PARTICIPANTS AND COORDINATION

Participants in planning for the Long Lake project included the Upper Mississippi River Wildlife and Fish Refuge and the Region 3 Offices of the U.S. Fish and Wildlife Service (USFWS), the Wisconsin and Minnesota Departments of Natural Resources (WDNR and MDNR), and the St. Paul District, Corps of Engineers. The U.S. Fish and Wildlife Service was a cooperating agency throughout the process as defined by regulations developed by the Council on Environmental Quality for the implementation of the National Environmental Policy Act (40 CFR 1500-1508).

PROJECT PURPOSE

Resource Problems and Opportunities

The purpose of this study is to document existing habitat conditions, predict future habitat conditions, identify existing and future habitat deficiencies, define specific objectives, formulate and evaluate alternative plans that would address the objectives, and select and recommend a course of action for implementation. Long Lake is a small backwater lake that suffers dissolved oxygen depletion during both summer and winter, as documented by WDNR and Corps of Engineers (COE) water quality monitoring. If the dissolved oxygen problem can be solved, Long Lake has the physical characteristics to provide high quality habitat for backwater fish species such as largemouth bass, black crappie, and bluegill.

Scope of Study

The scope of the study focused on solving the dissolved oxygen depletion problem in Long Lake.

Project Boundaries

Long Lake a water body located along the main stem of the Mississippi River in Wisconsin, is targeted for rehabilitation and enhancement. Because the lake is influenced by adjacent water bodies, and because potential solutions to problems may extend beyond its boundaries, the project area is generally defined as the area between the centerline of the main channel and the Burlington Northern Railroad tracks, extending from river miles (R.M.) 710.5 to 714.0. Figure 1 shows the location of Long Lake, while figure 2 shows Long Lake and the adjacent water bodies that lie within the primary area of investigation.

GENERAL PROJECT SELECTION PROCESS

ELIGIBILITY CRITERIA

A design memorandum (or implementation document) did not exist at the time of the enactment of Section 1103. Therefore, the North Central Division, U.S. Army Corps of Engineers, completed a "General Plan" for implementation of the Upper Mississippi River System - Environmental Management Program (UMRS-EMP) in January 1986. The U.S. Fish and Wildlife Service (USFWS), Region 3, and the five affected States (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) participated through the Upper Mississippi River Basin Association. Programmatic updates of the General Plan for budget planning and policy development are accomplished through Annual Addendums.

Coordination with the States and the USFWS during the preparation of the General Plan and Annual Addendums led to an examination of the Comprehensive Master Plan for the Management of the Upper Mississippi River System. The Master Plan, completed by the Upper Mississippi River Basin Commission in 1981, was the basis of the recommendations enacted into law in Section 1103. The Master Plan report and the General Plan identified examples of potential habitat rehabilitation and enhancement techniques. Consideration of the Federal interest and Federal policies has resulted in the conclusions below:

(1) (First Annual Addendum). The Master Plan report...and the authorizing legislation do not pose explicit constraints on the kinds of projects to be implemented under the UMRS-EMP. For habitat projects, the main eligibility criteria should be that a direct relationship should exist between the project and the central problem as defined by the Master Plan, i.e., the sedimentation of backwaters and side channels of the UMRS. Other criteria include geographic proximity to the river (for erosion control), other agency missions, and whether the condition is the result of deferred maintenance....

(2) (Second Annual Addendum).

(a) The types of projects that are definitely within the realm of Corps of Engineers implementation authorities include the following:

- backwater dredging
- dike and levee construction
- island construction
- bank stabilization
- side channel openings/closures
- wing and closing dam modifications
- aeration and water control systems
- waterfowl nesting cover (as a complement to one of the other project types)
- acquisition of wildlife lands (for wetland restoration and protection) Note: By letter of 5 February 1988, the Office of the Chief of Engineers directed that such projects not be pursued.

(b) A number of innovative structural and non-structural solutions which address human-induced impacts, particularly those related to navigation traffic and operation and maintenance of the navigation system, could result in significant long-term protection of UMRS habitat. Therefore, proposed projects which include such measures will not be categorically excluded from consideration, but the policy and technical feasibility of each of these measures will be investigated on a case-by-case basis and the measures will be recommended only after consideration of system-wide effects.

PROJECT SELECTION PROCESS

Projects are nominated for inclusion in the District's habitat program by the respective State natural resource agency or the U.S. Fish and Wildlife Service (USFWS) based on agency management objectives. To assist the District in the selection process, the States and USFWS agreed to utilize the expertise of the Fish and Wildlife Work Group (FWWG) of the River Resources Forum (RRF) to consider critical habitat needs along the Mississippi River and prioritize nominated projects on a biological basis. The FWWG consists of biologists responsible for managing the river for their respective agency. Meetings are held on a regular basis to evaluate and rank the nominated projects according to the biological benefits that they could provide in relation to the habitat needs of the river system. The rankings are forwarded annually to the RRF for consideration of the broader policy perspectives of the agencies involved. The RRF submits the coordinated ranking to the District and each agency officially notifies the District of its views on the ranking. The District then formulates and submits a program that is consistent with the overall program guidance as described in the UMRS-EMP General Plan and Annual Addenda and supplemental guidance provided by the North Central Division.

Projects consequently have been screened by biologists closely acquainted with the river. Resource needs and deficiencies have been considered on a pool-by-pool basis to ensure that regional needs are being met and that the best expertise available is being used to optimize the habitat benefits created at the most suitable locations. Through this process the Long Lake project was recommended and supported as capable of providing significant habitat benefits.

SPECIFIC SITE SELECTION

Long Lake was recommended for study by the Wisconsin Department of Natural Resources. After consideration of RRF recommended priorities, the public interest in the project, the value of the resource, and the opportunity for rehabilitation/enhancement, the Long Lake project was ranked 19th in a listing of the St. Paul District's HREP projects. Based on that priority, funds were made available to begin study on the project in FY 90.

ASSESSMENT OF EXISTING RESOURCES

PHYSICAL SETTING

Long Lake is a backwater lake located on the Wisconsin side of the main channel of the Upper Mississippi River between R.M. 712 and 713. The lake lies approximately 1.5 miles downstream of lock and dam 6. The nearest city is Trempealeau, Wisconsin, located immediately adjacent to the lock and dam.

Prior to the construction of the lock and dam system on the Upper Mississippi River, Long Lake was an isolated lake lying in what was probably the remnant of a long abandoned side channel. The creation of Pool 7 in the 1930's raised normal water levels to the extent that Long Lake is now connected by downstream sloughs to the main channel of the river. (See attachment 4 for a detailed discussion on change in water levels due to construction of the lock and dam system.) This connection is either via Webb Slough (figure 2), or Big Marsh Slough which connects Long Lake to Big Marsh. The mouth of Webb Slough is located at R.M. 711.5. Big Marsh enters the Mississippi River via Spring Slough at R.M. 710.9.

There are a number of other water bodies in the vicinity of Long Lake which will be discussed in some detail in this report due to their potential to affect conditions in Long Lake. These include Big Marsh which lies to the southeast of Long Lake; First, Second, and Third Lakes, a series of lakes which lie northeast of Long Lake along the Burlington Northern Railroad Line; Mud Lake, the connecting water body between Third Lake and Big Marsh; and Round Lake, which is located between Long Lake and Third Lake. Round Lake also has a connecting channel into Mud Lake. The final water resource of note is Tank Creek which flows from the east into Mud Lake. All of these water bodies eventually connect with the Upper Mississippi River through Spring Slough.

WATER RESOURCES

Long Lake

Long Lake is approximately 3,200 feet long and 250 feet wide. The lake is about 15 acres in size and has a maximum depth of 13 feet. About 5 acres of the lake are less than 3 feet deep, while much of the lake is 5-7 feet deep. The substrate of the lake appears to be primarily silt. The surface sediments are expected to be underlain by variable layers of alluvial sands, silts and clays.

Flow conditions in and out of Long Lake are highly variable, and depend upon hydrologic conditions on the Mississippi River and Black River. Water flows into Long Lake from Webb Slough and exits via Big Marsh Slough into Big Marsh (figure 3) during normal and high flow conditions. During low river discharge conditions (usually more typical of winter conditions) the stages on the Mississippi River are at a minimum and flow directions are reversed, with water entering Long Lake through Big Marsh Slough and exiting through Webb Slough. Two hydrologic conditions affect this flow pattern: during periods of receding Mississippi River levels, when water may exit both Webb and Big Marsh Sloughs and when the water levels in the Big Marsh area are higher than those in Long Lake or the Mississippi River due to high flows on the Black River. Ice formation and subsequent constriction of Webb Slough and Big Marsh Slough reduces flow rates through these sloughs in the winter. (A more detailed discussion of these hydrologic conditions may be found in attachment 4.)

Water quality data for Long Lake is limited. Recent data has been collected by the WDNR and the Corps to evaluate the dissolved oxygen situation in Long Lake.

Summer Dissolved Oxygen - Dissolved oxygen and temperature were monitored on a continuous basis from July 28 to August 3, 1987 (Schellhaass and Sullivan, 1987). The sampling point was in three feet of water, approximately 16 inches below the surface. Water temperature ranged from 26.8 to 28.7 degrees C. Dissolved oxygen during this time frame showed readings ranging from 0.0 to 6.8 mg/l, with 87 percent of the 143 hourly readings below the Wisconsin water quality standard of 5.0 mg/l. A dissolved oxygen level of 5 mg/l is generally sufficient for aquatic life in a warm water setting. (Note that the diel variability of dissolved oxygen is determined largely by the abundance and productivity rates of aquatic plants and algae.)

A dissolved oxygen and temperature profile taken at the deepest point in the lake on August 3, 1987 showed water temperatures relatively stable down to a depth of 5 feet. At that point water temperatures dropped at a relatively constant rate such that water temperatures at the bottom were about 17 degrees centigrade. Dissolved oxygen levels dropped rapidly such that at 2 feet below the surface and below, dissolved oxygen levels were about 0.5 mg/l.

Dissolved oxygen was monitored in Long Lake during early August, 1990 by the Corps of Engineers (Holme and Sentz, 1990). Results from a continuous monitor showed dissolved oxygen ranging from 5.8 mg/l to 15.0 mg/l, with no readings below the State water quality standard of 5.0 mg/l. Spot early morning monitoring in other locations showed dissolved oxygen as low as 2.4 mg/l near the surface, to almost 0 mg/l at the bottom of the lake. Water temperatures were about 4 degrees C. lower than during the 1987 monitoring. Nineteen eighty-seven was a drought year while 1990 was a relatively cool wet summer. It is surmised that the difference in water temperatures and dissolved oxygen content between 1987 and 1990 is a reflection of the difference in weather and flow conditions.

Winter Dissolved Oxygen - Dissolved oxygen monitoring during the winter of 1987-88 began on January 15, 1988 (Rogala and Sullivan, 1988). On that date, dissolved oxygen levels above 5.0 mg/l were present at all four monitoring stations (figure 4) in Long Lake (attachment 2, table 1), though levels as low as 1.5 mg/l were beginning to show up. Water temperature had generally dropped to the 1.5-2.5 degrees C. By February 8, dissolved oxygen levels had dropped significantly, averaging 0.2 mg/l at the bottom and 2.5 mg/l below the ice. The maximum level recorded was 2.7 mg/l. By this date, strong inverse temperature stratification was also occurring with bottom temperatures averaging 3.4 C, mid level temperatures averaging 1.6 C, and below the ice temperatures were at 0 C. By February 29, dissolved oxygen levels had rebounded such that all stations had at least one reading above 5 mg/l. Some of the bottom readings still showed near total dissolved oxygen depletion.

Dissolved oxygen monitoring during the winter of 1988-89 began on January 16, 1989 (Bartsch and Sullivan, 1989). By that date severe dissolved oxygen depletion was already evident at all four stations in Long Lake (attachment 2, table 2). The highest level recorded was 3.3 mg/l while bottom dissolved oxygen levels were averaging only 0.6 mg/l. Inverse temperature stratification was also evident by this date. On January 31, dissolved oxygen levels remained below 2.3 mg/l at three of the monitoring stations but had rebounded to very high (13.8 mg/l) levels below the ice at the station at site 1, indicating algal productivity (see figure 4). Inverse temperature stratification remained strong on January 31.

By February 14, 1989, dissolved oxygen levels had rebounded such that three of the four stations had at least one reading above 5.0 mg/l. Inverse temperature stratification was still in place at all stations on this date. On February 28 all stations had at least 6.5 mg/l below the ice though bottom dissolved oxygen levels at two stations were still 0.0 mg/l. Inverse temperature stratification was still in place at all stations on February 28. On March 8 dissolved oxygen remained high below the ice at three stations but had sagged to below 4 mg/l at the fourth. Inverse temperature stratification still remained in place at all stations on March 8.

Webb Slough

Webb Slough is approximately 6,000 feet long and varies in width from 50 to 300 feet. The slough covers about 25 acres. Aerial photography from 1927 (pre-lock and dam) shows Webb Slough as a marshy area with only two small areas of open water. Based on probings taken during field visits, the bottom sediments in Webb Slough appear to be primarily fine silts and clays with some areas of sand present. A sandbar exists at the entrance to Webb Slough from the Mississippi River. However, flowage easement surveys show that a sandbar has always existed at this site. Whether the current sandbar is due to active sediment transport, is a remnant of the old sand bars, or exists due to both factors is not known.

Soundings have been taken along Webb Slough during visits to the area. At either end of Webb Slough (upstream near Long Lake and downstream where it enters the Mississippi River) water depths are generally less than 2 feet. Water in the main portion of the slough is generally 2-3 feet deep. From the 1932 flowage easement surveys for pool 7, it appears that most of the shallow areas in this slough were present immediately after inundation.

Spot checks for dissolved oxygen in Webb Slough were made on August 7, 1990 (Holme and Sentz, 1990). (At this time flow was observed to be moving through Webb Slough into Long Lake.) Dissolved oxygen measurements declined from a high of 10.9 mg/l near the entrance of the slough from the Mississippi River, to a low of 4.1 mg/l where Webb Slough enters Long Lake.

Winter dissolved oxygen was measured in the vicinity of the inlet and outlet of Webb Slough in the same time period that dissolved oxygen was being monitored on Long Lake during the winters of 1987-88 and 1988-89 (Rogala and

Sullivan, 1988). See attachment 2, table 3 for this information. Dissolved oxygen levels dipped below the 5 mg/l on occasion, but levels generally were above those observed in Long Lake. A slight current was usually present at these sites which would indicate flows through Webb Slough may have been helping keep dissolved oxygen levels from dropping to some of the low levels observed in Long Lake.

Second and Third Lakes

Second and Third Lakes lie approximately one-half mile north of Long Lake. Second Lake drains into Third Lake, which drains into Mud Lake. Second Lake is 23.5 acres and has a maximum depth of 7 feet. Third Lake is 29.2 acres and has a maximum depth of 8 feet. Both lakes are spring fed with watersheds of less than one square mile (Klick, et. al., 1970). Flow measurements taken at the channel between Third Lake and Mud Lake indicated that the discharge was approximately 5 cubic feet per second. This channel is partially occluded because of beaver activity. Very limited dissolved oxygen monitoring in the winters of 1987-88 and 1988-89 (Rogala and Sullivan, 1988) indicated dissolved oxygen depletion is probably not a problem in these lakes in the winter.

Round Lake

Round Lake lies immediately east of Long Lake and drains to the southeast into Mud Lake. Round Lake is approximately 40 acres in size and relatively shallow. The Brown Survey and the 1927 aerial photography show Round Lake occupying it's present basin prior to the creation the lock and dam system. Historically, this lake has been supplied with water from springs in the lake, local run-off, and occasional inflow via the channel leading into Mud Lake.

Limited dissolved oxygen monitoring during the winters of 1987-88 and 1988-89 did not reveal an appreciable dissolved oxygen problem in Round Lake (attachment 2, table 4), though these winters were relatively mild in terms of length and snow cover. Two surveys were taken for dissolved oxygen during the summer of 1990 (Holme & Sentz, 1990). These showed severe dissolved oxygen depletion with readings ranging from 0 mg/l to 5.8 mg/l. It appears from the limited data available that dissolved oxygen levels may drop below 5 mg/l during mid to late summer. This is probably due to the lake's shallow nature, abundant aquatic vegetation, and isolation. It is expected that high water temperatures and low dissolved oxygen concentrations would be encountered during mid to late summer.

Tank Creek

Tank Creek flows into the east side of Mud Lake. Tank Creek is about 3 miles long and drains a marshy area that merges into the Black River bottoms. The creek has a predominantly sand substrate and supports a warm water fishery dominated by forage fish (Klick, et. al., 1970). Tank Creek had a flow of 32.5 cfs when measured in February 1988. The source of this flow includes groundwater inputs and seepage from the Black River. Based on information from people familiar with the area, Tank Creek flow rates have been increasing in recent years because of greater inputs from the Black River.

Mud Lake and Big Marsh

Mud Lake and Big Marsh are shallow backwater lakes to the east-southeast of Long Lake. The latter area is connected to Long Lake via Big Marsh Slough, entering about midway down the western side of Big Marsh Lake. The Brown Survey and the 1927 aerial photography indicates that much of the area occupied by Mud Lake and Big Marsh was fast land prior to the creation of pool 7. Based on the Brown Survey mapping and some limited physical observations, it appears that most of Mud Lake and Big Marsh is less than 3 feet deep at normal pool elevations. Big Marsh Slough is less than 2 feet deep for most of its 4,800 foot length.

Dissolved oxygen monitoring during the winters of 1987-88 and 1988-89 (Rogala and Sullivan, 1988) showed no dissolved oxygen problems in these lakes (attachment 2, table 5). It is believed that Tank Creek flows may help to maintain adequate dissolved oxygen levels in Mud Lake and Big Marsh in the winter. This, however, does not appear to be the case in the summer. A dissolved oxygen survey conducted on August 8, 1990 (Holm & Sentz, 1990), indicated that the dissolved oxygen concentration of Tank Creek water entering Big Marsh diminished from 8.2 mg/l to 4.5 mg/l within a relatively short distance along its course through the marsh to the Mississippi River. The 4.5 mg/l dissolved oxygen level appeared to be present throughout much of the marsh on that day. This suggests that fluvial impact is a minor component of the marsh dissolved oxygen budget during mid to late summer.

Upper Mississippi River

The main channel of the Upper Mississippi River lies approximately one-half mile from Long Lake. However, a major side channel of the river flows approximately 500 feet from the riverward side of the lake.

GEOLOGY

The most significant geological event explaining the nature of the Mississippi River within pool 7 occurred at the end of the Pleistocene glaciation approximately 10,000 years ago. Tremendous volumes of glacial meltwater, primarily from the Red River Valley's glacial Lake Agassiz, eroded the preglacial Minnesota and Mississippi River valleys. As meltwaters diminished, the deeply eroded river valleys aggraded substantially to about the present levels. Since post-glacial times, a braided stream environment has dominated this reach of the Mississippi River, due to the river's low gradient and oversupply of sediment from its tributaries. Prior to the impoundment of pool 7 in the 1930's, the broad floodplain of the river was characterized by this braided stream system that consisted of swampy depressions, sloughs, natural levees, islands, and shallow lakes. Since impoundment, a relatively thin veneer of silts, clays, or sands has been deposited over most of the river bottom within the pool.

VEGETATION

Long Lake

In contrast to many small backwater lakes on the Upper Mississippi River, Long Lake has a relatively narrow littoral zone. Over much of it's length, the lake drops off quite rapidly to depths of 5 feet or greater within 25-35 feet of the shoreline. The littoral areas of Long Lake support a relatively dense growth of water milfoil, coontail, and pondweeds.

Most of the shoreline of Long Lake is vegetated by a mixture of relatively mature upland and bottomland forest. In some areas, adjacent residents maintain lawns up to the Federal property line running along the shoreline.

Webb Slough

The 1973 GREAT I habitat mapping shows Webb Slough with about 50 percent aquatic vegetation coverage, primarily coontail and pondweeds. August 1989 aerial photographs also show extensive aquatic vegetation growth.

Round Lake

The 1973 GREAT I habitat mapping shows approximately 80 percent of Round Lake's surface covered with aquatic vegetation, primarily water lilies, American lotus, coontail, and pondweeds. August 1989 aerial photographs indicate that there has not been much change in the surface coverage of aquatic plant growth in Round Lake since 1973. Approximately 20 percent of the lake stills remains open, in the same general area that was free of aquatic vegetation in the 1973 aerial photographs. Local citizens have indicated that this 20-acre area without surface vegetation has abundant submergent growth.

Mud Lake and Big Marsh

The GREAT I 1973 habitat mapping shows Mud Lake and Big Marsh to be nearly covered by aquatic vegetation, primarily coontail, pondweeds, water lilies, American lotus, and arrowhead. The 1989 aerial photographs continue to show nearly complete surface coverage by aquatic plants.

FISH AND WILDLIFE

Long Lake

Fish surveys were conducted in Long Lake by the Wisconsin DNR in late July and in early October, 1987, using fyke net and DC electrofishing collection techniques (Engel, 1988). Twenty-eight species of fish were collected, most being species that would be expected to be found in the type of habitat provided by Long Lake. The most common species collected were black crappie, bluegill, and spotted sucker, comprising 70 percent of the 2000+ fish collected. The most common gamefish collected were largemouth bass and northern pike. The late August dissolved oxygen conditions and the type of collection gear used had an influence on the collection results.

The physical characteristics of Long Lake in terms of water depths and protection from current are such that the lake would provide above average backwater fish habitat if the dissolved oxygen problem did not exist.

Long Lake provides some habitat for waterfowl, wading birds, and furbearers. Long Lake's value to waterfowl is as a springtime concentration area for diving ducks when more open waters are windswept, as a pairing site for wood ducks and mallards, as brood rearing habitat for wood ducks, and as a fall feeding area for mallards and wood ducks.

Webb Slough

No fishery data is available for Webb Slough. Based on the habitat present, it is likely that many of the fish species found in Long Lake probably also are found in Webb Slough. Webb Slough provides more valuable habitat for waterfowl, wading birds, and furbearers than Long Lake because of it's more isolated nature and because of a greater area of shallow water and aquatic plant beds.

Round Lake

No fishery data is available for Round Lake. Based on it's characteristics, it is expected that the lake provides good habitat for backwater fish species. Local residents have indicated that fishing for crappie and bluegill in Round Lake can be excellent at times. Round Lake receives high levels of use by diving ducks during migration periods.

Mud Lake and Big Marsh

No fishery data is available for Mud Lake and Big Marsh. Based on their characteristics, it is expected that these areas provide good habitat for backwater fish species, except during mid to late summer when they become heavily vegetated. It is likely that heavy aquatic plant growth results in diurnal dissolved oxygen sags during the later part of summer.

Mud Lake and Big Marsh provide important diving duck habitat, particularly for canvasbacks, during the spring migration period. No data is available, however, it is likely that the lake is heavily used during the fall migration period also.

THREATENED AND ENDANGERED SPECIES

Three Federally listed species occur in this portion of the Upper Mississippi River valley, the bald eagle (*Haliaeetus leucocephalus*), the peregrine falcon (*Falco peregrinus*), and the Higgins' eye pearly mussel (*Lampsilis higginsi*). There is no evidence or reason to suspect that any of these species would occur at Long Lake.

CULTURAL RESOURCES

There are 15 known archaeological sites and 12 historic sites within two miles of the proposed project area. The National Register of Historic Places has been consulted, and as of 1 December 1990, there are no sites on or eligible for the Register in the immediate vicinity of Long Lake. Pool 7 does not appear to be as rich in cultural resources as adjacent pools due to the geomorphology of the area. The nature of the alluvial deposits in Pool 7 shows a capping by post-1850 sediments. These sediments have minimized the possibility of finding older sites. It is likely that an abundance of archaeological sites exist in the pool, but they are, for the most part, deeply buried. A cultural resources survey of the shoreline of Pool 7, undertaken in 1989, failed to locate any sites along the banks of Long Lake, Round Lake or the main channel of the Mississippi River.

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, coordination has been undertaken with the Wisconsin State Historic Preservation Officer (SHPO), the State Archaeologist, and the National Park Service. The SHPO's office requested that a cultural resources survey be done of the project area. An archaeological survey undertaken in 1990 for the Corps of Engineers along the proposed channel excavation also failed to locate any evidence of cultural resources. Copies of the report have been sent to the SHPO for comment. Their response is found in attachment 5.

SOCIOECONOMIC RESOURCES

While much of the Long Lake shoreline is in Federal ownership, in many places this is only a narrow strip of land. Approximately 1/3 of the Long Lake shoreline is occupied by permanent and seasonal residences. The city of Trempealeau, Wisconsin, (approx. pop. 1,150) is located about 1.5 miles northwest of the lake, adjacent to Lock and Dam 6.

RECREATION RESOURCES

Long Lake has a public boat ramp. It appears that most of the homes around the lake were located there because of the recreational/scenic amenities provided by the lake. However, because of the dissolved oxygen depletion problem that exists, Long Lake it is not a quality fishing lake.

PROJECT OBJECTIVES

INSTITUTIONAL FISH AND WILDLIFE MANAGEMENT GOALS

Fish and wildlife management goals and objectives for the area fall under those more broadly defined for the Upper Mississippi River Wildlife and Fish Refuge as a whole (USFWS 1987, Upper Mississippi River National Wildlife and Fish Refuge Environmental Impact Statement/Refuge Master Plan, FWS, USDOI, North Central Regional Office, St. Paul, Minn.). The management objective that most directly applies to the project area is:

+ Maintain and enhance, in cooperation with the states, the habitat of fish and other aquatic life on the Upper Mississippi River.

Coordination with the U.S. Fish and Wildlife Service and the Wisconsin Department of Natural Resources identified the following as the primary management goal for Long Lake:

+ Manage Long Lake as habitat for backwater fish populations, e.g., black crappie, largemouth bass, and bluegill.

The general refuge management goal and the management goal for Long Lake were used as a guide in the development of specific project goals and objectives.

PROBLEM IDENTIFICATION

Existing Habitat Conditions

The most obvious habitat problem in Long Lake is summer and winter dissolved oxygen depletion, as documented by the WDNR monitoring efforts and discussed in the WATER RESOURCES section of this report. Although low dissolved oxygen concentrations have been reported in Long Lake in both winter and late summer, the greater concern is with winter conditions. During this time, escape routes for fish out either Webb Slough or Big Marsh Slough can be restricted because of ice freezing close to the bottom of the shallow portions of these channels where water depths are less than 2 feet. Depending on oxygen depletion patterns, fish may be cut off from these escape routes by anoxic water.

The significance of dissolved oxygen as a limiting factor is illustrated by a preliminary evaluation of the habitat suitability conditions in Long Lake. This was conducted using habitat suitability index (HSI) models for three of the more common fish species of interest in Long Lake (bluegill, black crappie, and largemouth bass). These models use measurements of physical/chemical/biological parameters for a body of water. The models convert these measurements to a standard numerical value, called a suitability index. Suitability indexes (SI) for various life requirements (food, cover, water quality, etc) are then converted into an overall habitat suitability index for the water body for the fish species of interest.

Table 1 contains the results of this assessment. The numbers in parenthesis are the suitability index and habitat suitability indexes if dissolved oxygen was not limiting. As can be seen from the HSI values in parenthesis, if dissolved oxygen were not limiting, the value of Long Lake for these species would be in the .85 -1.00 range, which is very good to excellent.

Table 1 - Preliminary Habitat Suitability Assessment

Life Requisite	Bluegill Summer[1]	Bluegill Winter[2]	Black Crappie Summer[3]	Largemouth Bass Summer[4]
Food SI	.90	n/a	1.0	1.0
Cover SI	.90	1.0	1.0	.75
Water Quality SI	.40 (.80)	.10 (.95)	.20 (1.0)	.40 (.95)
Reproduction SI	.90	n/a	1.0	.90
Other SI	n/a	1.0	n/a	n/a
HSI	.40 (.85)	.10 (.95)	.20 (1.0)	.40 (.90)

[1] (Stuber, et.al., 1982a), [2] (Palesh and Anderson, 1990), [3] (Edwards, et.al., 1982), [4] (Stuber, et.al., 1982b)

Estimated Future Habitat Conditions

Conditions in Long Lake are not expected to change appreciably over the next 50 years. Sedimentation may result in a minor decrease in lake depths, but not to the extent that the basic physical/chemical character of the lake would be altered.

PROJECT GOALS AND OBJECTIVES

General Habitat Goals

The general habitat goal for Long Lake is to eliminate dissolved oxygen depletion as a limiting factor on the habitat quality of the lake for fish.

Specific Planning Objectives

The planning objective, established at the beginning of the study, is to maintain dissolved oxygen concentrations in the upper 1/3 of the water column above 5 mg/l during critical times of the year, i.e., late summer and throughout most of the winter.

The USFWS and WDNR indicated that partial fulfillment of the planning objective would be acceptable, depending upon the level of fulfillment and the associated project costs.

ALTERNATIVES

PLANNING OPPORTUNITIES

The most salient planning opportunity at Long Lake is the lake itself. Its physical characteristics in terms of water depths, protection from current, and limited littoral area are very good with respect to providing habitat for desired backwater fish such as largemouth bass, black crappie, and bluegill. The dissolved oxygen depletion problem is the major factor preventing the lake from supporting a high quality, year-round backwater fishery.

PLANNING CONSTRAINTS

Institutional

Long Lake lies within the boundaries of the Upper Mississippi Wildlife and Fish Refuge. Most of the shoreline of Long Lake is in Federal ownership. The Land Use Allocation Plan allocates all of the Federally owned shoreline and the water bodies themselves for wildlife management. The Wisconsin DNR manages the fishery resources of Long Lake. Long Lake is not within a designated refuge closed area.

Hydraulic

The small hydraulic head differential between Long Lake and the Mississippi River for low flow conditions, and the changing flow patterns that can occur with changes in river stage may make it more difficult to provide sufficient reliable flow into Long Lake from the river. The head differential between Round Lake and Long Lake appears to be adequate to provide reliable flows; Ice formation in the very shallow reaches of Webb Slough or Big Marsh Slough will reduce the flow of water in the winter. (See Attachment 4 for additional information.)

Environmental

At the present time there are no particular environmental constraints at Long Lake in terms of non-target resources. Efforts to improve fishery habitat in Long Lake should not detract from the wildlife habitat values of Long Lake or Webb Slough.

Constraints associated with the introduction of main channel water to Long Lake during the winter are current and temperature. At low water temperatures backwater fish species are less tolerant of current as their slow metabolism makes it difficult for them to maintain position. Introducing winter flows to Long Lake should minimize inducing any currents as much as possible.

Main channel water in the winter can be at or near 0 degrees C. Introducing this cold water to Long Lake could lower lake water temperatures to the point where fish could not survive. Introducing winter flows to Long Lake should minimize this thermal effect as much as possible.

Second and Third Lakes have high fishery values while Mud Lake and Big Marsh provide excellent waterfowl habitat. These values should not be adversely impacted by any measures proposed for rehabilitating and/or enhancing the fishery values of Long Lake.

Excavation of channels to provide fresh water flows to Long Lake would involve the excavation of fast land and some lake bottom. This excavated material would consist primarily of alluvial silts, sands, and clays. This material would include top strata consisting of fine silts and clays of more recent origin (post-lock and dam construction). None of this material has been previously tested. However, there is no reason to suspect that contaminants would be present in levels to cause concern.

ALTERNATIVES IDENTIFIED

Several alternatives that might meet the identified project objective were considered, as well as no-action alternative.

The no action would consist of no Federal funds being provided to meet the project objective.

Four basic alternative approaches for improving the dissolved oxygen conditions in Long Lake were identified. They are (1) reduce the dissolved oxygen demand in Long Lake, (2) add dissolved oxygen to Long Lake, (3) exclude water entering Long Lake that has a low dissolved oxygen content, and (4) add dissolved oxygen by introducing water to Long Lake that has a high dissolved oxygen content.

Reduce Dissolved Oxygen Demand

One typical method of reducing dissolved oxygen demand is the elimination of the aquatic vegetation that creates an oxygen demand when it decays.

Add Dissolved Oxygen to Long Lake

Mechanical aeration is a technique employed to maintain adequate dissolved oxygen especially during the winter months. The technology is available and it has proven effective.

Excluding Water

Wisconsin DNR observations while monitoring summer dissolved oxygen in Long Lake were that anoxic water from Big Marsh may be contributing to the problems in Long Lake. Given this, a closure as shown on figure 5 which would prevent Big Marsh flows from entering Long Lake was considered.

Introducing Water

Adding water that has adequate levels of dissolved oxygen requires a source for this water. Potential water sources at Long Lake include the Upper Mississippi River, Tank Creek, Round Lake, and Third Lake. The following discusses each of these potential alternative water sources.

Upper Mississippi River - A major side channel of the Mississippi River lies a short distance from Long Lake across a peninsula. This side channel would be a reliable source of oxygenated water, both summer and winter. Figure 6 shows two possible locations for inlet channels to transport oxygenated water into Long Lake. The difference in water surface elevation between the side channel and Long Lake is relatively small during low flow conditions. This difference, along with the size of the inlet channel and the size of the outlet slough, determines the amount of river water that can be introduced to Long Lake. A range of discharges is possible because of the variable head differentials that can be present between the river and Long Lake. Flow reversals are also possible. However, the river is the most dependable source of oxygenated water available for the Long Lake backwater area.

Tank Creek - Based on available data it appears that Tank Creek has the potential to be a source of oxygenated water, especially during the winter. A channel could be constructed as shown on figure 5 to allow some of Tank Creek's flow to enter Long Lake. The reliability of this creek for supplying dissolved oxygen is subject to aquatic community demands prior to reaching Long Lake. An additional concern is the impacts on dissolved oxygen in Big Marsh if some of the flow from Tank Creek were routed to Long Lake. The construction of a closure in Big Marsh Slough as shown on figure 5 would be required to increase the water surface elevation at the mouth of Tank Creek and force flows into Long Lake.

Round Lake - Round Lake lies immediately landward of Long Lake. Figure 7 shows potential channel routes from Round Lake to Long Lake. Round Lake dissolved oxygen levels are subject to aquatic community demands during the summer and snow cover during the winter. This makes it highly questionable whether Round Lake water could be counted on as a reliable source of oxygenated water during critical periods.

Third Lake - Third Lake could be used to supplement Round Lake flows if Round Lake were used as the water source for Long Lake. A closure where Round Lake and Third Lake currently discharge into Mud Lake may be required to assure proper functioning of this option (figure 7). This closure would force Third Lake water to discharge through Round Lake and Long Lake. Snow cover, aquatic community demands and ice occlusion of Webb Slough and/or Big Marsh Slough continue to be problems here, as they were with the Round Lake option alone. Given the dissolved oxygen readings taken on Tank Creek and Big Marsh, the ability of this type of system at Round Lake and Third Lake to improve dissolved oxygen conditions in Long Lake is questionable.

ALTERNATIVES ELIMINATED FROM CONSIDERATION

Following a preliminary review a number of alternatives were eliminated from further consideration. These are discussed below along with the reasons for their elimination.

Reducing Dissolved Oxygen Demand

Long Lake generally has a lack of aquatic plants; therefore, elimination of existing vegetation would not appreciably reduce dissolved oxygen demand. This alternative was dropped from further consideration because no practical method of reducing dissolved oxygen demand in Long Lake was identified.

Adding Dissolved Oxygen to Long Lake

This alternative was eliminated from further consideration because the annual operation and maintenance responsibilities associated with mechanical aeration are significant. This, coupled with safety problems made this alternative undesirable.

Excluding Water

This alternative was eliminated from further consideration because the inflow of low dissolved oxygen water into Long Lake from Big Marsh appears to be only a small seasonal factor. Therefore, its control would not influence the dissolved oxygen levels in Long Lake frequently enough to be of value. In addition, the construction of a closure channel between Long Lake and Big Marsh is not desirable to local interests.

Introducing Water

Tank Creek - Introducing water to Long Lake from Tank Creek was eliminated from further consideration because: (1) it would be difficult to direct the appropriate portion of Tank Creek to Long Lake without the construction of costly control works at the mouth of Tank Creek, (2) diversion of a portion of Tank Creek to Long Lake would likely exacerbate summer dissolved oxygen sags in Big Marsh, and (3) the construction of a closure channel between Long Lake and Big Marsh is not desirable to local interests.

Round Lake and Third Lake - Introducing water to Long Lake from Round Lake and/or Third Lake was eliminated from further consideration because this source is not considered to be reliable enough to meet project goals. It is highly questionable whether Round Lake alone, or in conjunction with Third Lake, has sufficient outflow of oxygen-rich water to meet the project objective in Long Lake. During the summer, Round lake appears to also have periods of low dissolved oxygen. The addition of water from Third Lake would probably not be able offset the dissolved oxygen demand in Round Lake such that the combined flow would be sufficient to positively influence Long Lake. During the winter, Round Lake is susceptible to dissolved oxygen fluctuations because of variations in snow cover, just as Long Lake is. Therefore, in periods of low dissolved oxygen on Long Lake, in all probability, dissolved oxygen levels will also be decreased on Round Lake.

ALTERNATIVES CONSIDERED IN DETAIL

During the initial examination of alternatives, the only alternative that appeared reasonably feasible was construction of a channel to provide Upper Mississippi River water to Long Lake. Unlike the other alternatives this option has a dependable source of dissolved oxygen both in the summer and the winter. Two possible channel alignments were developed for a channel from the Mississippi River to Long Lake. These are discussed in the EVALUATION OF ALTERNATIVES section.

EVALUATION OF ALTERNATIVES

NO ACTION

This alternative would not meet the project goal of enhancing backwater habitat. Specific details of future conditions with no action have been described in previous sections; therefore, they will not be reiterated in this section. (In particular, refer to the "Estimated Future Habitat Conditions" section in this report.)

ACTION ALTERNATIVES

Alternative Channel Alignments

Two routes from the Mississippi River into Long Lake (figure 6) were evaluated in detail. Alignment 1 would be located entirely on Federal land. This particular channel/culvert system would enter Long Lake at about 800 feet below the head of the lake on the west shoreline. Alignment 2 would be located on undeveloped private land and would enter Long Lake near its upper end.

When first evaluating the Mississippi River alternatives it appeared that the only way to insure adequate flow in and through Long Lake during the winter was to do some dredging in Webb Slough. This was based on an initial perusal of the available flow data which indicated that during the winter, ice cover in Webb Slough could reduce flows to as little as 1 cfs. During the summer flows could be as little as 5 cfs. Given these potential flow conditions, the possibility of meeting dissolve oxygen requirements was assessed by looking at the amount of time it would take to affect a complete change of water in Long Lake. It was determined that a 1 cfs flow would produce at least a weekly exchange rate in the effected portions of Long Lake with either alignment (table 2).

Table 2 - Analysis of Exchange Rates

Align-ment	Flow (cfs)		Area Affected in Long Lake		Volume Affected (acre-feet)		Est. Exchange Rate (days)	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
1	5	1	9 ac.	4 ac.	38	10	4	5
2	5	1	12 ac.	7 ac.	47	13	5	6.5

Additional survey data and flow data was analyzed as the more detailed study progressed. This indicated that flow rates in summer and winter would be much higher than originally anticipated. If Webb Slough were not dredged, based on conditions and data from 1988, flow during the summer for alignment 1 and alignment 2 would be 8 cfs and 10 cfs respectively. These would be reduced to 6.5 and 7.5 cfs respectively during the winter. This information has led to the conclusion that dredging in Webb Slough should not be needed. Therefore, the cost estimate for both alignments does not include dredging in Webb Slough.

SUMMARY AND COMPARISON OF ALTERNATIVES

Table 3 compares the features of the two alignments. As can be seen from table 3 the cost for construction of a channel along either alignment is essentially the same.

Table 3 - Comparison of Alternative Channel Routes

Alignment	Inlet Channel Length (ft)	Inlet Excavation Needed (cy)	Cost	AAHU Gain
1 (Federal)	620	10,200	$212,700	+18
2 (Private)	380	6,600	$215,400	+18

Note: Real Estate requisition costs are included in the total project cost. These are estimated to be $8,600 for alignment 1 and $32,000 for alignment 2.

The original planning objective was to provide 5 mg/l or greater dissolved oxygen in the upper 1/3 of the water column in Long Lake. Neither alignment would be expected to meet this objective for the entire lake at all times, especially during the winter. Both channel alignments would enter Long Lake above Webb Slough. It is expected that during the winter the introduced flow will exit out of Long Lake via Webb Slough, instead of traveling out Big Marsh Slough. This, in turn, will effect the ability to maintain oxygenated conditions in the lower reaches of Long Lake downstream of the opening to Webb Slough. Areas above the channel inlets would not be effected.

From a hydraulic standpoint, alignment 2 provides for slightly greater head differential between the inlet channel and the Long Lake backwater system. As stated previously, with alignment 1, a typical discharge into Long Lake will be 8 cfs during low flow periods. Alignment 2 will likely result in an increase in discharge during the summer to 10 cfs. In the winter with ice cover in Webb Slough these flows would be 6.5 cfs for alignment 1 and 7.5 cfs for alignment 2. (See attachment 4 for a discussion on project design.)

The ability of the two alignments to satisfy dissolved oxygen needs was evaluated. This analysis primarily centered around the length of time for the predicted inflow to effect a complete exchange of water in Long Lake. It is believed that with a flushing rate of once per week or more frequent, the effected areas of Long Lake would acquire several of the characteristics of the Upper Mississippi River; i.e., saturated D.O. and low diel variability in temperature and D.O. As can be seen in table 2, a flow rate of 5 cfs would be more than enough to produce a weekly water exchange with either alignment. Both alignments will be able to satisfy this criteria in summer and winter.

During the summer both alignments would have a much greater effect in maintaining adequate dissolved oxygen levels in Long Lake for two reasons.

First, greater flows can be provided in the summer because greater head differentials are more common. Secondly, the general flow patterns in the summer have Long Lake flowing out Big Marsh Slough, so the introduced water will flow down the entire length of the lake.

Habitat evaluation procedures were used to evaluate potential benefits to Long Lake (attachment 3). This procedure is not sensitive enough to evaluate the potential differences in habitat benefits associated with the two alignments.

At this point in the comparison of the two alignments the following are points about which there can be little disagreement:

- the cost difference between the two alignments is negligible.

- the calculable habitat benefits using habitat evaluation procedures are equal.

- neither alignment will fully satisfy the planning objective, since the channel will provide only a refuge of oxygenated water in a portion of Long Lake during much of the winter season.

- dissolved oxygen depletion in the summer in Long Lake is a short-term problem (July-August) that usually is not complete dissolved oxygen depletion such that fish mortality would be expected. Both alignments would benefit at least 60 percent of the lake. Therefore the difference in the amount of the lake affected by the two alignments in the summer is not considered to be biologically significant.

- initial contact with the primary landowner along alignment 2, indicated that he would be unwilling to provide the land required for this option.

The following factors were also considered in the selection process:

- while alignment 2 would provide a greater area of oxygenated water it also has greater potential for adverse thermal effects in the winter because a larger portion of the lake would be effected by very cold water from the main channel. This effect can not be quantified without costly studies beyond the scope of this project. However, the effect may be significant.

- alignment 2 would enter Long Lake in a primarily littoral area at the upper end of the lake, while alignment 1 would enter the lake where the littoral zone is narrow. Thus, alignment 2 has greater potential for impacting more sensitive habitat. This effect can not be quantified.

- either alignment can provide in the winter is an area of oxygenated water to provide a refuge for fish survival. The difference between the two alignments in terms of amount of lake oxygenated during the winter is not considered biologically significant as both will suffice to provide for fish survival. As a point of comparison most mechanical aeration systems used in Midwestern lakes to alleviate winter dissolved oxygen problems only aerate a very small area of the lake which fish can then use as a refuge to survive the winter.

Alignment 1 is the preferred alternative because of the potential adverse effects (littoral habitat impacts and winter thermal effects), are expected to be less than with alignment 2. This was further confirmed by the apparent lack of a willing seller of the required real estate.

Incremental Analysis

The selected project would provide 18 AAHU of habitat gain at an average annual cost of $23,250. The cost of these gains would be $1,290/AAHU. When it was determined that the dredging of Webb Slough was not necessary to solve the dissolved oxygen depletion, it was evaluated to determine if the dredging was justified in terms of other habitat gains.

The dredging of Webb Slough would provide an additional 2 AAHU, mainly as the result of providing deeper water for winter cover. The cost of dredging Webb Slough was estimated at $312,000 (average annual cost = $28,090). The cost per unit return for the Webb Slough dredging would be $14,045/AAHU. It was decided that the benefits to Webb Slough that dredging would provide were not justified.

No further incremental analysis was conducted because the channel from the Upper Mississippi River to Long Lake is an indivisible increment. The channel is sized to be provide the flow necessary to alleviate the dissolved oxygen problem in Long Lake. Sizing the channel larger to provide additional flow would provide no commensurate gain in benfits. In fact, addtional flow above the design flow could prove detrimental in terms of maintaining the desirable backwater lake characteristics of Long Lake.

The selected plan of action consists of construction of a culvert/channel system from an Upper Mississippi River side channel to Long Lake which would supplement flows (and dissolved oxygen) into the lake. Most of this system would be an open channel with a single gated culvert to control the amount of water that could enter the lake.

The proposed channel (figures 8 and 9) would have a bottom width of 10 feet, 1 vertical (V) on 2.5 horizontal (H) side slopes and would have a bottom elevation of 634 feet (NGVD, 1912). The bottom width was selected to keep head losses at a minimum through the inlet channel. The alignment for the channel follows the Federal property line as closely as possible while trying to take maximum advantage of the surrounding topography in order to minimize costs. Therefore, the channel would be constructed along existing depressions for portions of its length. It is estimated that 10,200 cubic yards of material would be excavated in order to construct the proposed channel.

The control structure consists of one 74 foot long, 48-inch diameter reinforced concrete pipe (rcp) with sluice gate (figure 10). The purpose is to decrease inflow of sediment-laden water during high flow conditions on the Mississippi River and to be able to control flows during other critical times. The invert elevation of the culvert would be set at 634.0 feet NGVD, 1912 at the downstream end of the culvert and 634.3 feet at the upstream end. This would keep the top of the culvert submerged by one foot of water which should minimize the impacts of ice formation on the design capacity of the culvert system. Flow rates for low flow conditions (less than 20,000 cfs) with the culvert in place and the gate open based on 1988 low flow conditions, water surface elevations is estimated at 8 cfs for open water conditions in late summer and 6.5 cfs for conditions with ice cover in the winter. Please see Hydrology Appendix for more details. (Subsurface investigations will be conducted at the location of the proposed control structure during the plans and specifications stage to verify foundation conditions.

A 20-foot-long rock liner will be placed at the upstream end of the inlet channel. This will be 12 inches thick above elevation 640 feet msl, increased to an 18-inch layer from this elevation to the bottom of the bank. A 12-inch layer of riprap and 6 inches of bedding will also be placed upstream and downstream of the culverts. See figure 10 for the location of the riprap in the vicinity of the culverts. The estimated quantities required for these areas are 125 cubic yards of riprap and 65 cubic yards of bedding. The riprap and bedding will be obtained from existing commercial sources. A detailed

discussion of inlet channel design and project discharges can be found in attachment 4.

Based on the current information, the following is offered as the likely method of construction. An access road would be extended from an existing local gravel road to the proposed culvert/channel. This road would be of a standard sufficient to allow future access for operation and maintenance of the project. The channel alignment would be cleared and grubbed with all wood products left in the forest to provide additional habitat or put to some other beneficial use, if possible.

The channel would then be excavated by mechanical means. As much of the excavated material as possible would be sidecast in the immediate vicinity (while meeting state floodplain regulations and doing minimal damage to the existing forest areas). Part of this material would also be placed along the downstream bank of the channel to form a road for future maintenance. It is currently estimated that approximately 500 cubic yards of excavated material can be placed in the immediate vicinity. The remainder would be trucked to a sand pit located just outside Trempealeau.

The culvert and control structure would be placed prior to completion of the channel. Dewatering will probably be required to construct the concrete head wall which is part of the control structure.

ENVIRONMENTAL EFFECTS

An environmental assessment has been conducted for the proposed action, and a discussion of the impacts on habitat conditions follows. As specified by Section 122 of the 1970 Rivers and Harbors Act, the categories of impacts listed in the environmental impacts matrix (table 5) were reviewed and considered in arriving at the final determination. The Finding of No Significant Impact will be signed after the public review period has elapsed and any issues have been resolved.

RELATIONSHIP TO ENVIRONMENTAL REQUIREMENTS

The proposed project complies fully with applicable environmental statutes and Executive Orders for the current stage of planning. Among the more pertinent are the National Environmental Policy Act, the Fish and Wildlife Coordination Act, the Clean Water Act, the National Historic Preservation Act, the National Wildlife Refuge System Administration Act, Executive Order 11990 (Protection of Wetlands), and Executive Order 11988 (Floodplain Management). A section 404(b)(1) evaluation was not required because the only fill associated with the project (riprap and bedding) is covered by nationwide permit (33 CFR 330.5(a)(13)).

NATURAL RESOURCE EFFECTS

Terrestrial Habitat

Construction of the channel from the Mississippi River to Long Lake will convert approximately 1.4 acres of upland forest habitat to open channel and access road. This conversion of habitat is not expected to have any appreciable effect on wildlife populations in the area because of the relatively small area being impacted.

Aquatic Habitat/Biological Productivity

The basic purpose of the project is to improve habitat quality in Long Lake by alleviating dissolved oxygen depletion problems. The effect of the project will be to make a 15 acre backwater lake productive, year-round habitat for black crappie, largemouth bass, bluegill, and other species that use this type of habitat by removing dissolved oxygen a limiting factor.

Some ancillary positive effects are expected to occur to Webb Slough during the winter when the introduced water flows out of Webb Slough. This should provide adequate dissolved oxygen conditions for fish survival in this slough throughout most winters.

Table-4

ENVIRONMENTAL IMPACT ASSESSMENT MATRIX

NAME OF PARAMETER	MAGNITUDE OF PROBABLE IMPACT						
	<—— INCREASING BENEFICIAL IMPACT			NO APPRECIABLE EFFECT	INCREASING ADVERSE IMPACT ——>		
	SIGNIFICANT	SUBSTANTIAL	MINOR		MINOR	SUBSTANTIAL	SIGNIFICANT
A. SOCIAL EFFECTS							
1. Noise Levels				X			
2. Aesthetic Values					X		
3. Recreational Opportunities			X				
4. Transportation				X			
5. Public Health and Safety				X			
6. Community Cohesion (Sense of Unity)			X				
7. Community Growth & Development				X			
8. Business and Home Relocations				X			
9. Existing/Potential Land Use				X			
10. Controversy				X			
B. ECONOMIC EFFECTS							
1. Property Values				X			
2. Tax Revenues				X			
3. Public Facilities and Services				X			
4. Regional Growth				X			
5. Employment				X			
6. Business Activity			X				
7. Farmland/Food Supply				X			
8. Commercial Navigation				X			
9. Flooding Effects				X			
10. Energy Needs and Resources				X			
C. NATURAL RESOURCE EFFECTS							
1. Air Quality				X			
2. Terrestrial Habitat					X		
3. Wetlands				X			
4. Aquatic Habitat		X					
5. Habitat Diversity and Interspersion				X			
6. Biological Productivity		X					
7. Surface Water Quality		X					
8. Water Supply				X			
9. Groundwater				X			
10. Soils				X			
11. Threatened or Endangered Species				X			
D. CULTURAL EFFECTS							
1. Historic Architectural Values				X			
Pre-Hist & Historic Archeological Values				X			

Surface Water Quality

Construction of the channel should have negligible effects on water quality as most of the channel will be excavated in the dry before the plugs are removed at the ends.

Over the long term the project should have substantial positive water quality benefits by increasing dissolved oxygen levels in Long Lake during critical times of the year such as late summer and over winter.

CULTURAL RESOURCE EFFECTS

Surveys of the project area have not located any sites along the banks of Long Lake and adjacent areas. Channel excavation, however, has the potential to disturb previously undetected cultural resources buried under post-1850 alluvium. The location of the chosen alternative channel between Long Lake and the Mississippi River was surveyed for cultural resources in October 1990. No sites were found.

SOCIOECONOMIC EFFECTS

Recreational Opportunities

The project would improve the quality of Long Lake for recreational fishing. Primary beneficiaries would be expected to be local residents and residents of Trempealeau and the surrounding rural area.

Aesthetic Values

During construction, there would be some minor aesthetic impacts due to the clearing and earth moving activities. Once completed, the project would be only a negligible intrusion to the natural setting of the area.

Community Cohesion

Completion of the project would give local residentd who have supported the project a sense of community accomplishment.

Business Activity

The project may increase recreational use of Long Lake which would provide minor benefits to local businesses.

SUMMARY OF PLAN ACCOMPLISHMENTS

The selected plan will introduce fresh water flows to Long Lake during most periods and will sufficiently oxygenate portions of the lake to allow year-round fish survival and use of the lake. This will allow Long Lake to provide productive, high quality habitat for backwater fish for the projected 50-year life of the project. Better escape routes for fish are also provided through the inlet channel.

Habitat evaluation procedures were used to quantify projected benefits from the project. The details of the evaluation are present in attachment 3. The project would provide 12.2 AAHU of output for Long Lake, an increase of 800% over the without project condition. The project would also provide 5.8 AAHU of output for Webb Slough, a 60% increase over the without project condition. At an average annual cost of $23,250, the cost of the expected outputs is $1,290/AAHU.

OPERATION, MAINTENANCE, AND REPAIR

GENERAL

Upon completion of construction, the U.S. Fish and Wildlife Service (USFWS) would accept responsibility for operation and maintenance (O&M) of the Long Lake project in accordance with Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662 and subsequent Annual Addendums. The non-Federal sponsor would be the Wisconsin Department of Natural Resources (WDNR). Specific operation and maintenance features would be defined in a project O&M manual which would be prepared by the Corps and coordinated with the involved agencies during the plans and specifications phase. The estimated operation and maintenance costs are shown below in table 6.

OPERATION

Operation would be limited to opening and closing the sluice gate at appropriate times of the year. Generally this system would be shut down in early spring at the time of ice breakup (i.e. prior to spring snowmelt runoff). The system could be opened at the discretion of the USFWS anytime prior to low dissolved oxygen periods which are typically present in the late summer. The gate would normally remain open until the following spring; however, the USFWS could temporarily close the gates during any high flow periods to minimize sediment introduction into Long Lake.

MAINTENANCE AND REPAIR

Maintenance and repair requirements would include work associated with the channel/culvert system. It would consist of keeping the channel free of debris, replacement of riprap and maintenance of the control structure. Debris removal would in all probability primarily revolve around limiting beaver activity in the area, although floating debris may also need to be removed from the channel. Minor amounts of settling and displacement of the riprap lining at the channel entrance may require occasional replacement. Note that this is not expected to occur unless a large flood event causes erosion in the river bank near the channel. The sluice gate will need to be lubricated to keep it in operating condition. An O&M manual detailing operation and maintenance requirements would be prepared by the Corps during the plans and specifications phase. Development of the manual would be coordinated with the U.S. Fish and Wildlife Service and the Wisconsin Department of Natural Resources. Over the 50-year project life, the average annual O&M costs of the project are estimated to be $4,100. A breakdown of projected costs are contained in table 5.

Table 5 - Estimated Operation and Maintenance Costs

Item	Amount
Inspection and reporting	$ 400 [a]
Debris removal (inc. beaver activity)	2,000 [b]
Maintenance of control structure	500 [c]
Operation of control structure	1,000 [d]
Riprap replacement	200
Total annual cost	$4,100

Note: (1) Total projected operation and maintenance costs over a 50-year project life are estimated to be $117,500.

(2) Following are the calculations used to arrive at costs shown in the table. These are rounded off to the nearest $50 when shown in the above table.

a) Inspection: (1/2 man day/job x 8 hr/man-day x $30/hr) + (50 miles/job x $0.25/mile) = $130/job $130/job x 2 times/year = $260
Reporting: (1/2 man day/job x 4 hr/man-day x $30/hr) = $120

b) (1 man day/job x 8 hr/man-day x $30/hr) x 2 men + (50 miles/job x $0.25/mile = $500/job $500/job * 4 times per year = $2,000

c) (1 man day/job x 8 hr/man-day x $30/hr) + (50 miles/job x $0.25/mile) = $260/job

d) (1/2 man day/job x 8 hr/man-day x $30/hr) + (50 miles/job x $0.25/mile) = $130/job $130/job x 8 times/year = $1,040

PROJECT PERFORMANCE EVALUATION

A monitoring plan for project evaluation purposes was designed to directly measure the degree of attainment of the selected project objective. The plan is described below and presented in tables 6 and 7.

Performance evaluation monitoring for Long Lake would consist of summer and winter dissolved oxygen monitoring for three years following project construction. Three years is considered sufficient to determine if the channel is providing adequate flow to alleviate the dissolved oxygen problems in the lake. See attachment 7 for a more detailed description of the proposed performance evaluation plan.

TABLE-6
UMRS-EMP Monitoring and Performance Evaluation Matrix

Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Remarks
Sedimentation Problem Analysis	System-wide problem definition [to PA(S)9]*. Evaluate planning assumptions.	USFWS	USFWS (EMTC)	LTRM	Lead into pre-project monitoring; define desired conditions for plan formulation.
Pre-project Monitoring	Identify and define problems at specific sites.	Sponsor	Sponsor	Sponsor	Should attempt to begin defining baseline.
Baseline Monitoring	Establish baselines for performance evaluation.	Corps	Field stations or sponsors thru Cooperative Agreements, or Corps.**	LTRM ****	Should be over several years to reconcile purturbations.
Data Collection for Design	1. Identify project objectives. 2. Design of project. 3. Develop Performance Evaluation Plan.	Corps	Corps	HREP	After fact sheet. Data may aid in defining baseline.
Construction Monitoring	Assure permit conditions met.	Corps	Corps	HREP	
Performance Evaluation Monitoring	Determine success of projects.	Corps	Field stations or sponsors thru Cooperative Agreements, sponsor thru O&M***, or Corps.**	LTRM ****	After construction.
Analysis of Biological Responses to Projects	1. Determine critical impact levels, cause-effect relationships, and long-term losses of significant habitat.	USFWS	USFWS (EMTC)	LTRM	Biological Response Study tasks beyond scope of Performance Evaluation, Problem Analysis, and Trend Analysis.
	2. Demonstrate success or response of biota.	Corps	Corps/USFWS (EMTC)/Others	LTRM ****	

*Refers to Sedimentation Problem Analysis Tasks, pages 35-36, LTRM Operating Plan

**Choice depends on logistics. When done by the States under a Cooperative Agreement, the role of the EMTC will be to: (1) advise and assist in assuring QA/QC consistency, (2) review and comment on reasonableness of cost estimates, and (3) be the financial manager. If a private firm or state is funded by contract, coordination with the EMTC is required to assure QA/QC consistency.

***Some limited reporting of information for some projects (e.g., waterfowl management areas) could be furnished by on-site personnel as part of O&M.

****Requires a transfer of allocations from the Habitat Project account to the LTRM account.

TABLE-7
Pre- and Post-construction Measurements

Goal	Project Objective	Enhancement Feature	Unit of Measure	Measurement Plan	Monitoring Interval	Projected Cost per Effort	Field Observations
Improve winter & summer centrarchid habitat	Maintain summer dissolved oxygen levels >5 mg/l	Introduce water via channel from Mississippi River	mg/l	Measure diel DO levels and flow during one week in August	1, 2, and 3 year's post-construction	$6,500	Presence of fish during summer and winter
	Maintain winter dissolved oxygen levels >5 mg/l	Introduce water via channel from Mississippi Rive	mg/l	Measure DO, flow, and temperature every 3 weeks during safe ice cover conditions	1, 2, and 3 year's post-construction	$11,620	

Average annual monitoring cost over the 50-year project life = $4,900

Monitoring activities would be closely coordinated with any similar efforts by the Long-Term Resource Monitoring program. Information gathered by local resource agencies on a routine basis, such as test netting or creel census and information on angling success, would also be used.

COST ESTIMATE

The total project cost for the selected plan was estimated to be $212,700. This cost does not include prior allocations of $50,000 for general design (planning). A detailed cost estimate of this project is contained in attachment 8. A summary of costs is shown in Table 8.

Table 8 - Summary of Total Project Costs

Item	Cost
Channelization	$139,900
Engineering and Design(1)	58,600
Supervision and Administration	14,200
Total	$212,700

(1) This does not include prior allocations of $50,000 for general design (planning)

REAL ESTATE REQUIREMENTS

All construction features of the proposed project would be located on land owned by the Corps of Engineers and managed as part of the Upper Mississippi River National Wildlife and Fish Refuge by the USFWS. Appropriate agreements would be made with the U.S. Fish and Wildlife Service to excavate the channel/culvert system on the refuge. Easements must be acquired to provide access into the project site for construction of the project and future operation and maintenance. Acquisition of the former is the responsibility of the Corps of Engineers, with the latter being the responsibility of the U.S. Fish and Wildlife Service. The access road easement would involve acquisition from an estimated four private owners. The cost of the temporary construction easement is estimated to be $8,600.

SCHEDULE OF DESIGN AND CONSTRUCTION

Funds for plans and specifications can be provided by the Office of the Chief of Engineers (OCE), prior to approval of the project by the Assistant Secretary of the Army (Civil Works), upon a recommendation from Civil Works Planning after OCE staff review of the final report. As described in this report, this work would include additional soil borings along the proposed channel alignment in the area where the culverts will be placed. The schedule of project completion steps follows:

Requirement	Scheduled Date
Submit final Definite Project Report to Headquarters, US Army Corps of Engineers	June 1991
Obtain plans and specifications funds	October 1991
Obtain construction approval by Assistant Secretary of the Army (Civil Works)	October 1991
Completion of plans and specifications	June 1992
Advertise for bids	March 1993
Contract award	April 1993
Complete construction	September 1993

IMPLEMENTATION RESPONSIBILITIES

The responsibilities of plan implementation and construction fall to the Corps of Engineers as the lead Federal agency. After construction of the project, project operation and maintenance would be required for features of the channel/culvert system as outlined on the OPERATION, MAINTENANCE, AND REPAIR section of this report. These actions would be the responsibility of the U.S. Fish and Wildlife Service in cooperation with the Wisconsin Department of Natural Resources.

Should rehabilitation of the Long Lake project which exceeds the annual maintenance requirements be needed (as a result of a specific storm event or flood event), the Federal share of rehabilitation would be the responsibility of the Corps of Engineers. Performance evaluation, which includes monitoring of physical/chemical conditions and some limited biological parameters, would be a Corps responsibility. Attachment 6 contains a draft copy of the formal agreement that delineates the responsibilities which would be entered into by the Corps of Engineers and the U.S. Fish and Wildlife Service.

The Memorandum of Agreement formally establishes the relationships between the Department of the Army, represented by the Corps of Engineers, and the USFWS in constructing, operating, and maintaining the proposed Long Lake project.

The Wisconsin Department of Natural Resources provides technical data and advisory assistance during all phases of project development and acts as the non-Federal sponsor.

COORDINATION, PUBLIC VIEWS, AND COMMENTS

The proposed project has been coordinated with the USFWS, Wisconsin and Minnesota Departments of Natural Resources, the Wisconsin State Historic Preservation Office, and the Wisconsin State Archaeologist.

This report will be sent to Congressional interests, appropriate Federal, State and local agencies, special interest groups, interested citizens, and others listed in attachment 5.

CONCLUSIONS

The Long Lake habitat rehabilitation and enhancement project presents an opportunity to improve fish habitat which currently suffers both wintertime and summertime dissolved oxygen deficiencies that stress resident fish and force them to migrate to areas with adequate dissolved oxygen or cause them to perish in the winter if ice conditions prevent escape.

Several measures aimed at correcting the dissolved oxygen problem were considered. Only two alternatives were looked at in depth. The recommended project consists of construction of a channel/culvert system which allows fresh water flows to directly enter Long Lake from the Mississippi River.

The habitat enhancements which would be gained by the Upper Mississippi River System from implementation of the proposed project justify expenditure for preparation of plans and specifications and construction.

RECOMMENDATIONS

I have weighed the accomplishments to be obtained from this channel/culvert construction project against its cost and have considered the alternatives, impacts, and scope of the proposed project. In my judgment, the proposed project is a justified expenditure of Federal funds. I recommend that the Secretary of the Army approve the Long Lake project for habitat rehabilitation and enhancement at pool 7 in Trempeleau County, Wisconsin. The total estimated construction cost of the project is $212,700 which amount would be a 100-percent Federal cost according to Section 906(e)(3) of Public Law 99-662.

Richard W. Craig
Colonel, Corps of Engineers
District Engineer

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1421 U.S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101-1479

REPLY TO
ATTENTION OF

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act of 1969, the St. Paul District, Corps of Engineers, has assessed the environmental impacts of the following proposed project.

LONG LAKE
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 7, UPPER MISSISSIPPI RIVER
TREMPEALEAU AND LA CROSSE COUNTIES, WISCONSIN

The proposed action involves the excavation of a 800-foot channel from the Upper Mississippi River to Long Lake to introduce fresh water flows to alleviate chronic dissolved oxygen depletion problems in the Long Lake.

The finding of no significant impact is based on the following factors: (1) habitat disturbances associated with construction would be minor, and (2) the project would provide long-term improvements in the quality of fish habitat in Long Lake.

Project alternatives are discussed within the Alternatives Section of the Definite Project Report and the environmental impacts of the proposed action are discussed within the Environmental Effects Section.

The environmental review process indicates that the proposed action does not constitute a major Federal action significantly affecting the quality of the environment. Therefore, an environmental impact statement will not be prepared.

21 May 91
Date

Roger L. Baldwin
Colonel, Corps of Engineers
District Engineer

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Edwards, E.A., D.A. Krieger, M. Bacteller, and O.E. Maughan, 1982. Habitat suitability index models: Black Crappie. U.S.D.I. Fish and Wildlife Service. FWS/OBS-82/10.6. 25 pp.

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Stuber, R.J., G. Gebhart, and O.E. Maughan. 1982a. Habitat suitability index models: Bluegill. U.S.D.I. Fish and Wildlife Service. FWS/OBS-82/10.8. 26 pp.

Stuber, R.J., G. Gebhart, and O.E. Maughan. 1982b. Habitat suitability index models: Largemouth Bass. U.S.D.I. Fish and Wildlife Service. FWS/OBS-82/10.16. 32 pp.

Attachment 1

Figures

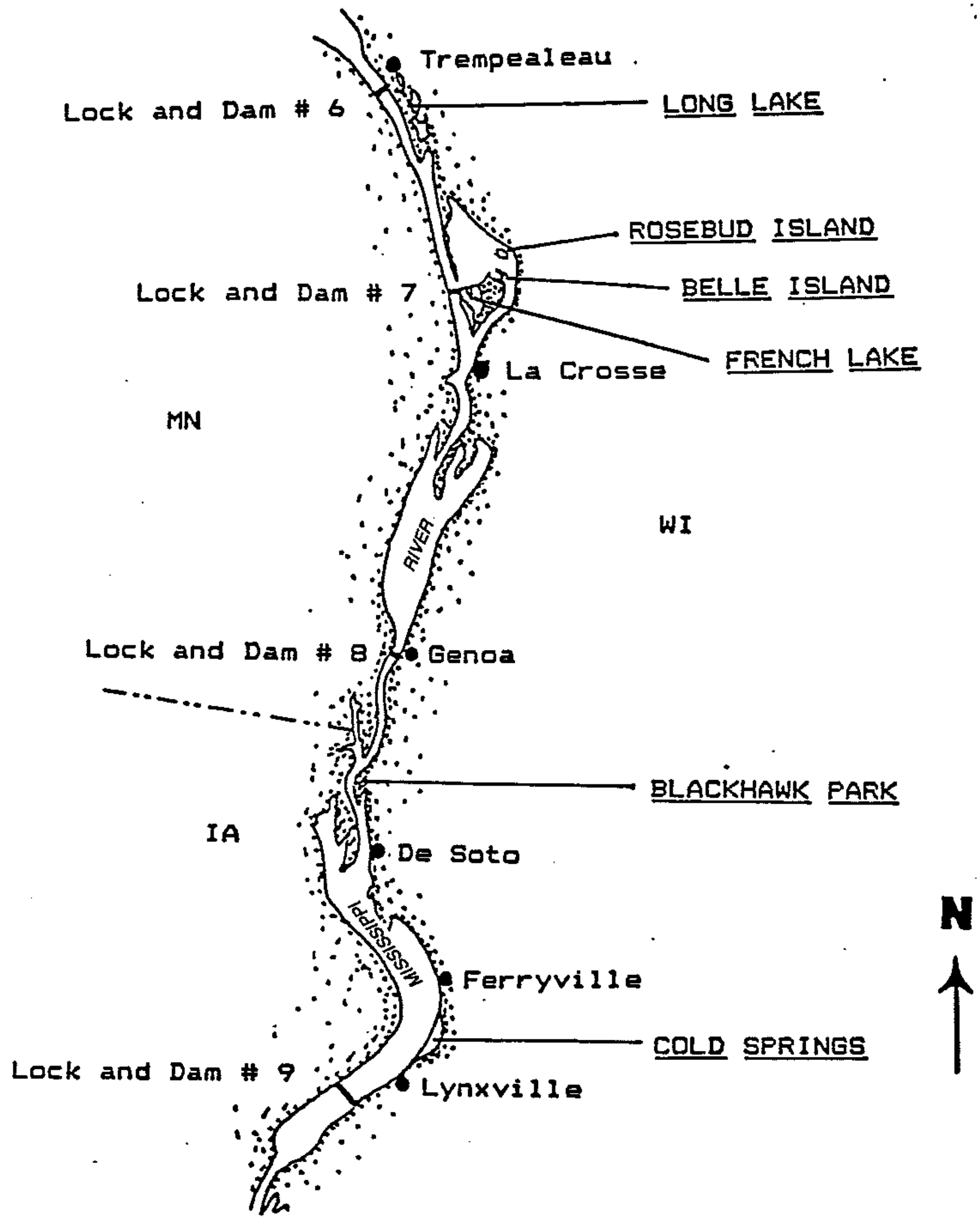


Figure 1. Location of Long Lake in Relation to Other HREP Project Areas

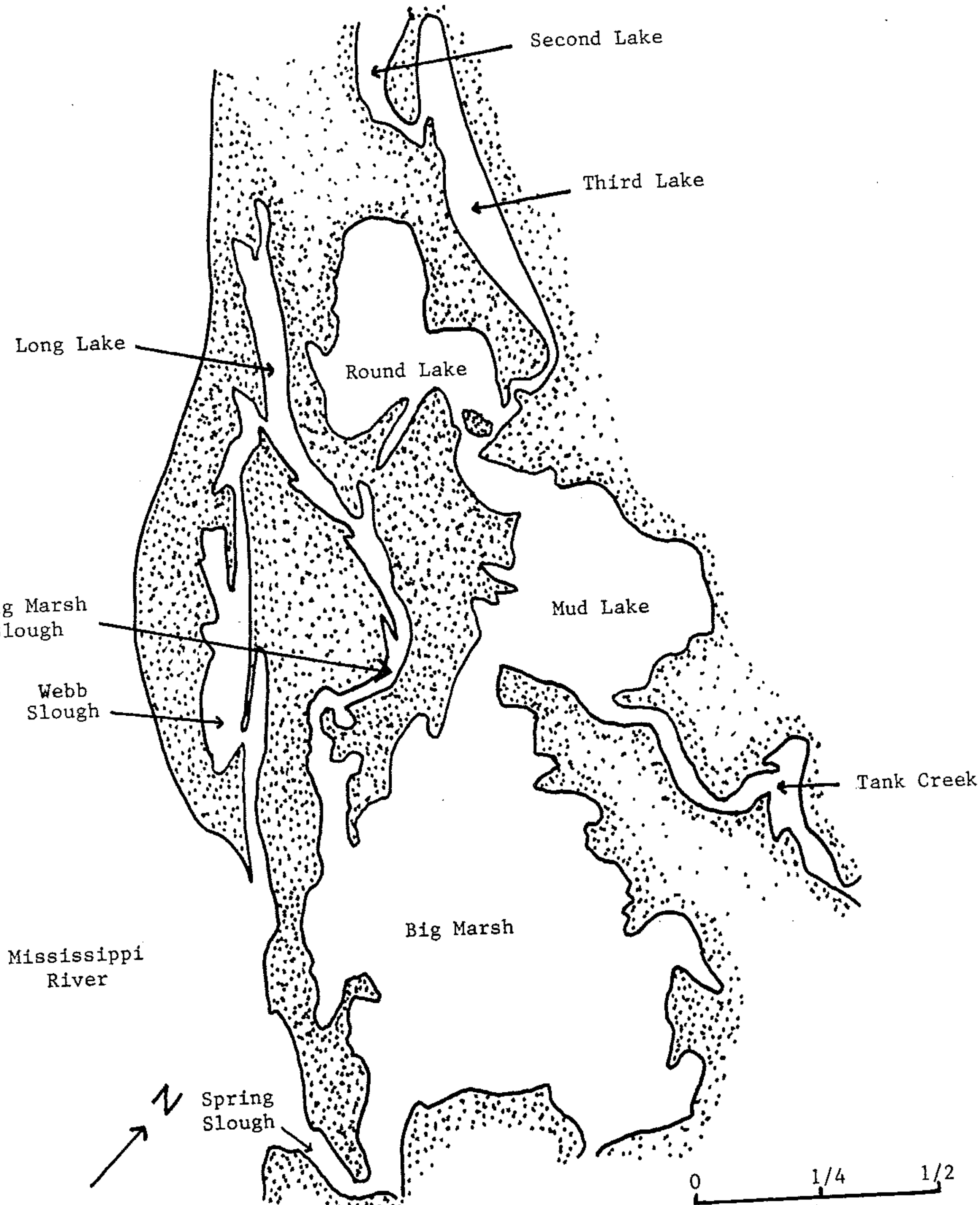


Figure 2 Study Area

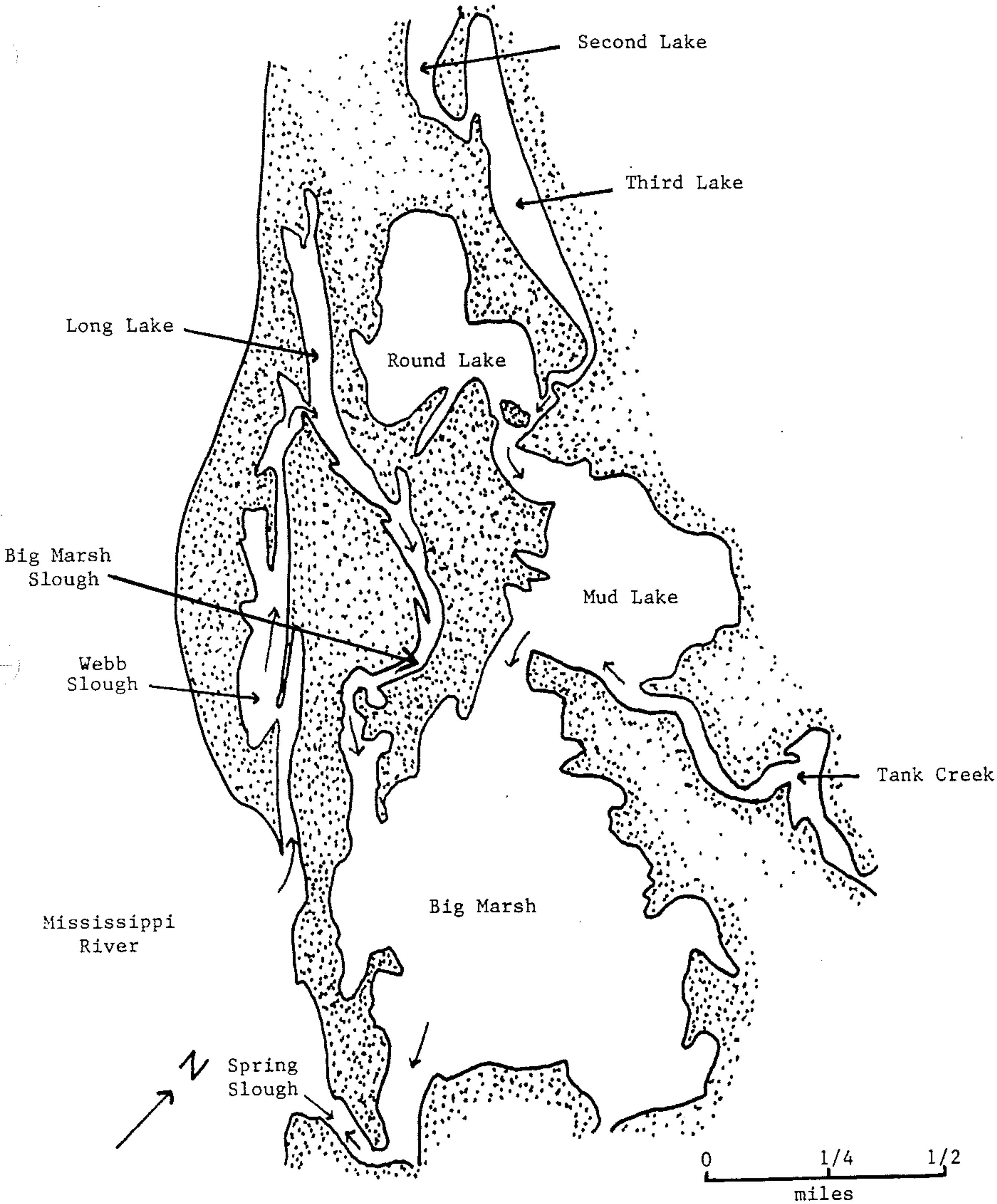


Figure 3. General Directions of Water Flow

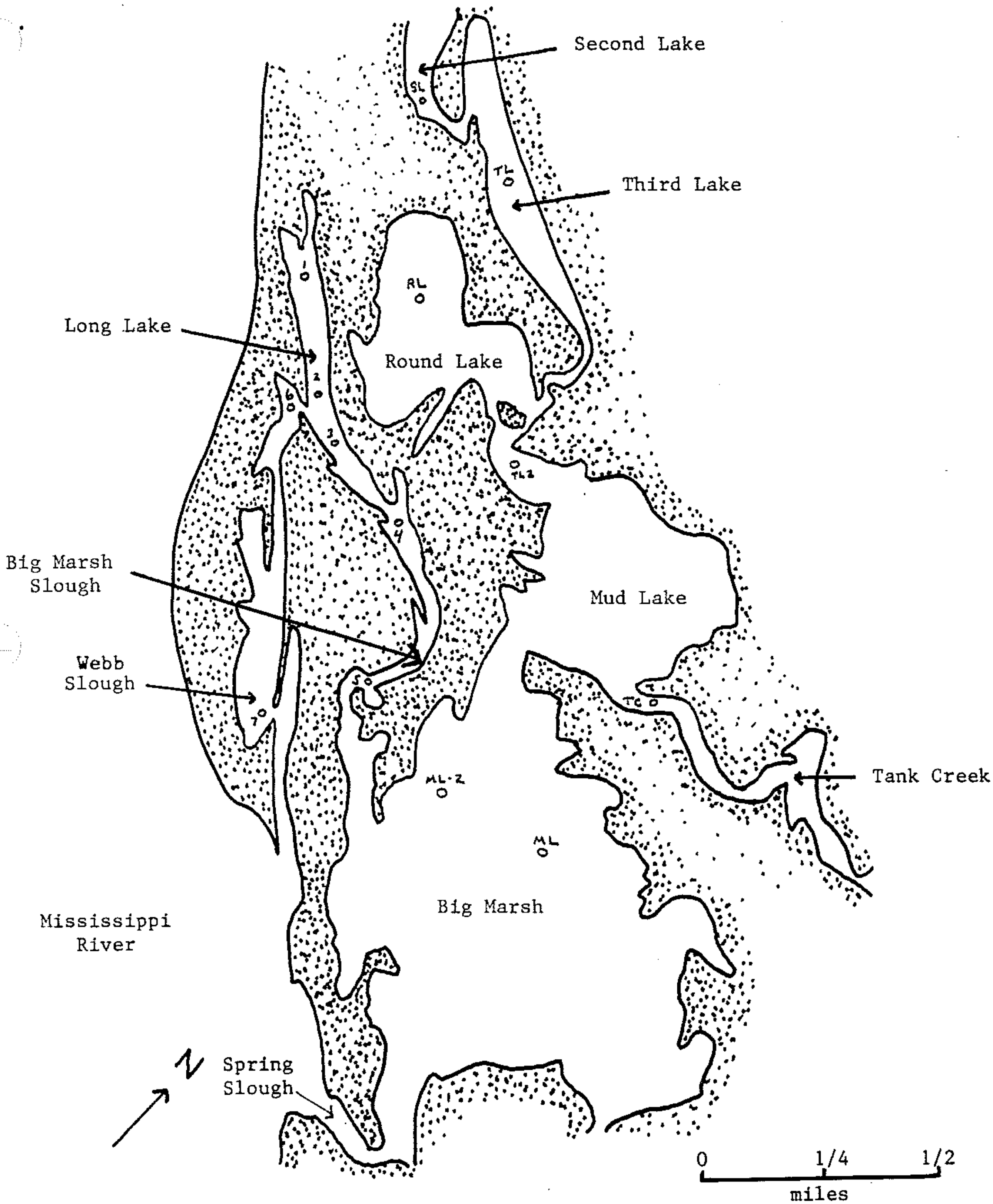


Figure 4. Wisconsin DNR Winter Water Quality Monitoring Stations

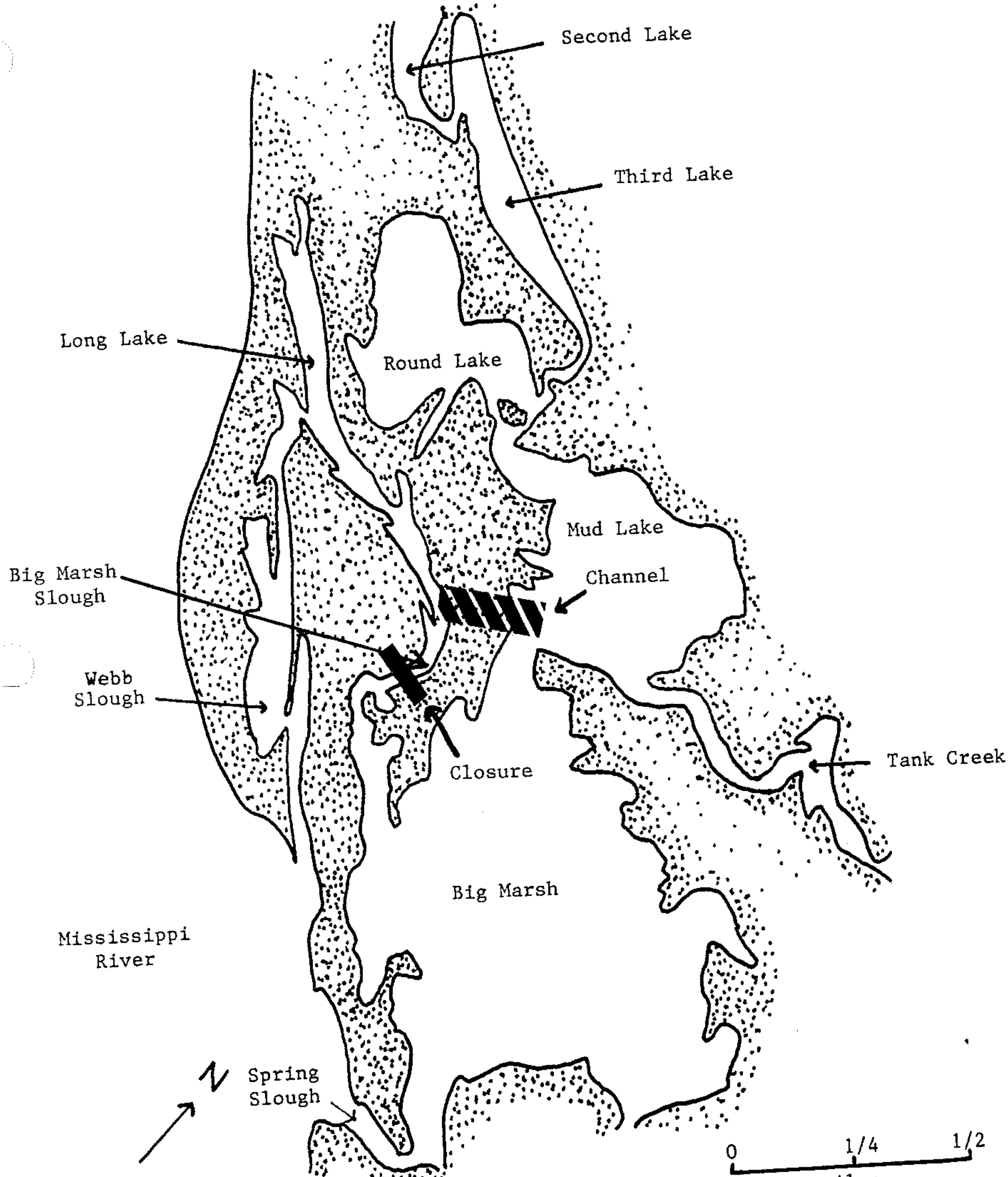


Figure 5. Potential Channel into Long Lake from Tank Creek/Mud Lake

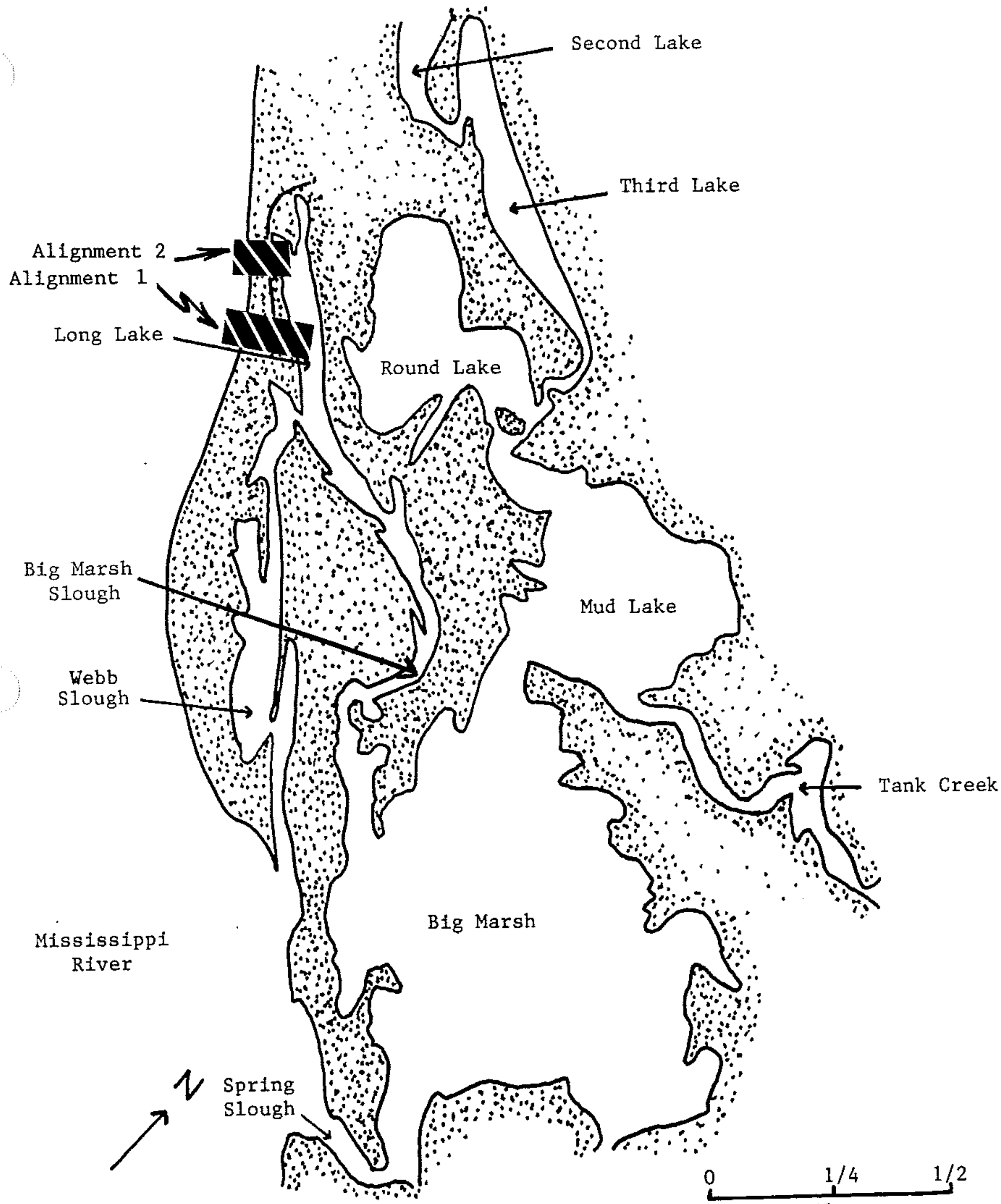


Figure 6 Potential Channels into Long Lake from the Mississippi River

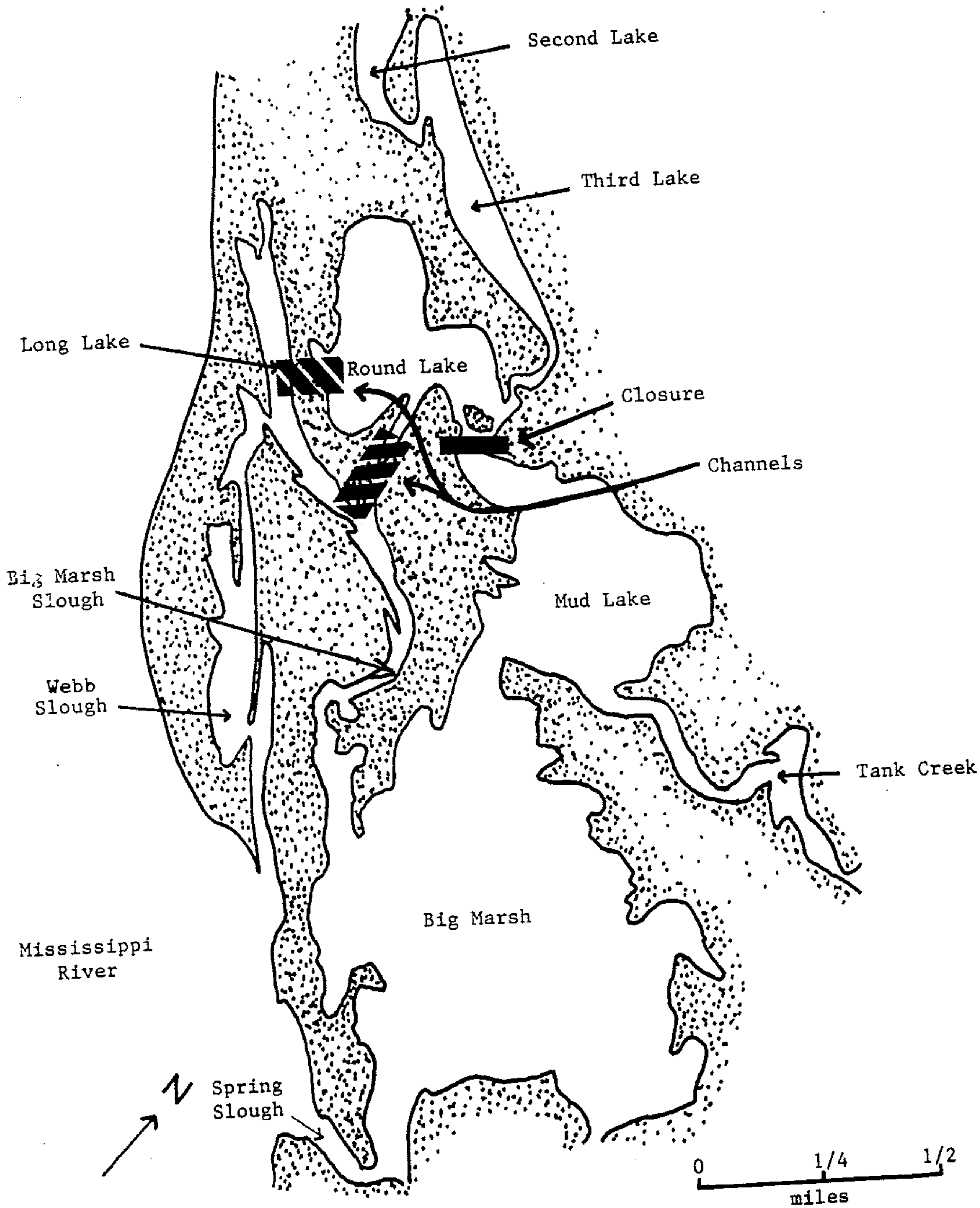


Figure 7. Potential Channels into Long Lake from Round Lake

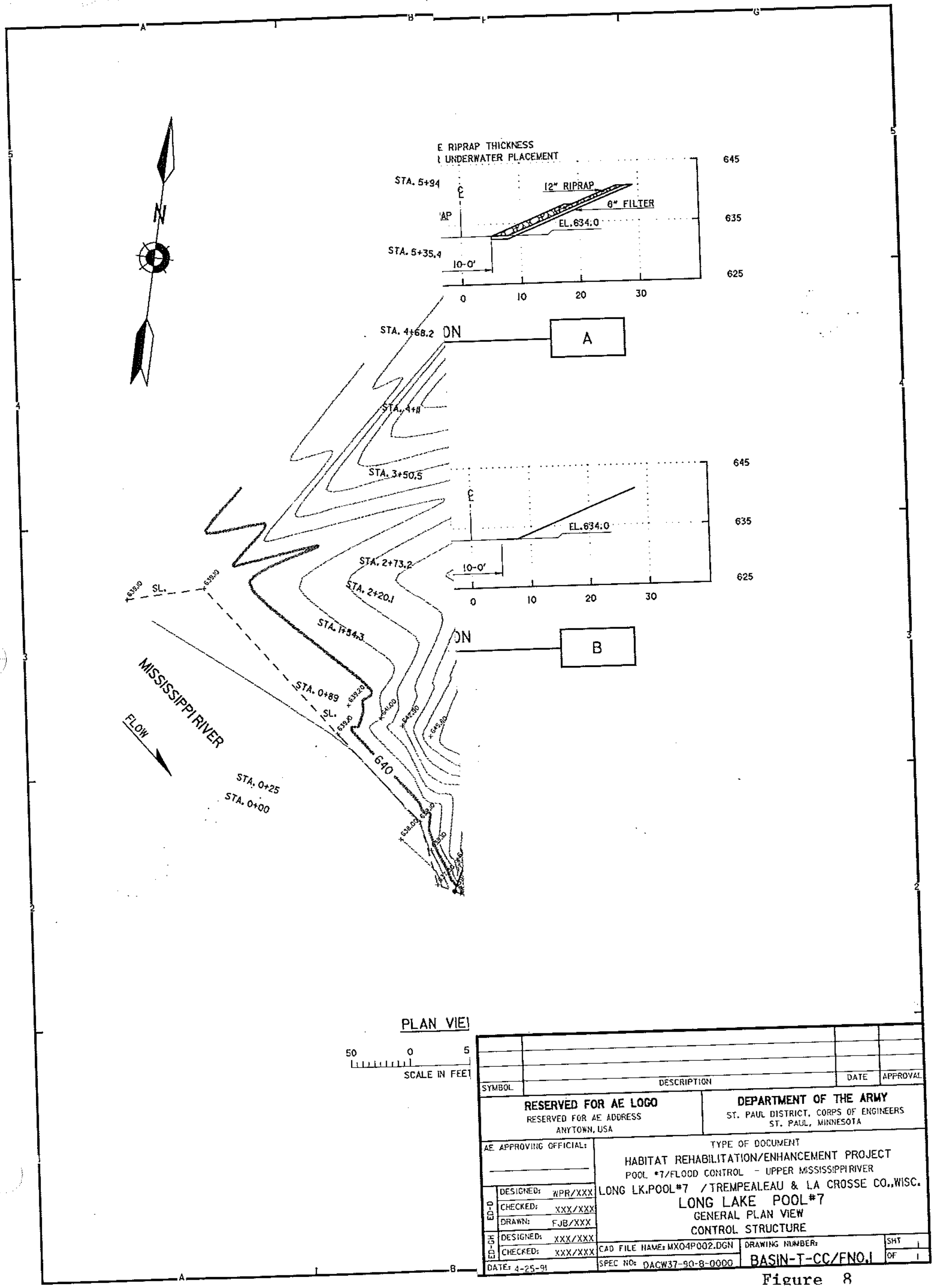
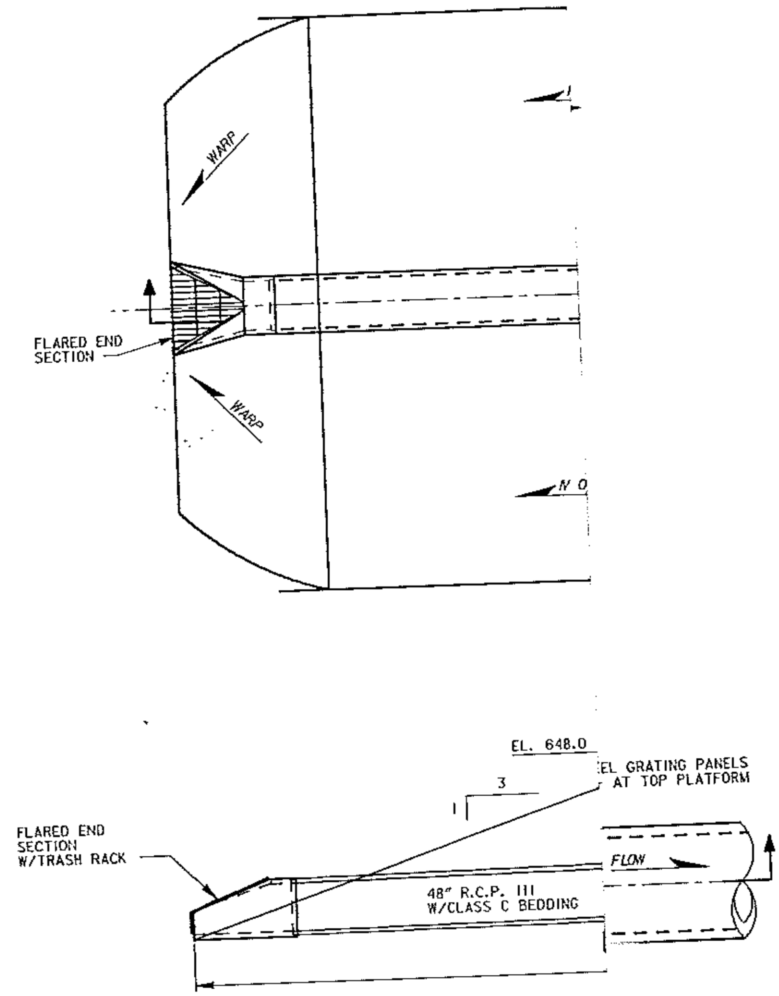
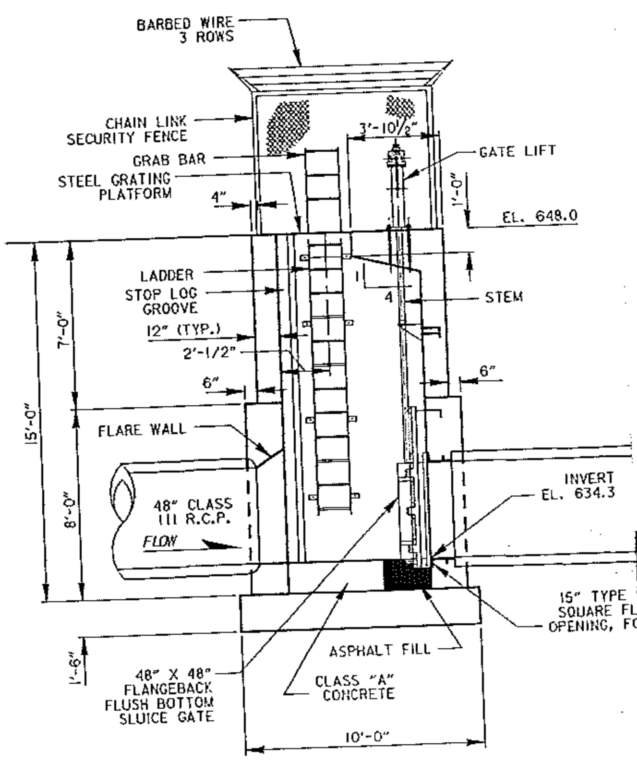

E RIPRAP THICKNESS
UNDERWATER PLACEMENT
STA. 5+94
12" RIPRAP
6" FILTER
EL.634.0
STA. 5+35.4
10-0'
645
635
625
0
10
20
30
STA. 4+68.2
A
STA. 4+11
STA. 3+50.5
EL.634.0
10-0'
645
635
625
0
10
20
30
STA. 2+73.2
STA. 2+20.1
STA. 1+54.3
B
STA. 0+89
SL.
640
STA. 0+25
STA. 0+00
MISSISSIPPI RIVER
FLOW
N
PLAN VIEW
50
0
5
SCALE IN FEET
SYMBOL
DESCRIPTION
DATE
APPROVAL
RESERVED FOR AE LOGO
RESERVED FOR AE ADDRESS
ANYTOWN, USA
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
AE APPROVING OFFICIAL:
TYPE OF DOCUMENT
HABITAT REHABILITATION/ENHANCEMENT PROJECT
POOL #7/FLOOD CONTROL - UPPER MISSISSIPPI RIVER
LONG LK.POOL#7 /TREMPEALEAU & LA CROSSE CO.,WISC.
LONG LAKE POOL#7
GENERAL PLAN VIEW
CONTROL STRUCTURE
ED-D
DESIGNED: WPR/XXX
CHECKED: XXX/XXX
DRAWN: FJB/XXX
ED-GH
DESIGNED: XXX/XXX
CHECKED: XXX/XXX
DATE: 4-25-91
CAD FILE NAME: MXO4P002.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER:
BASIN-T-CC/FNO.1
SHT 1
OF 1

Figure 8





SECTION B

SECTION THRU GATEWELL

SCALE: 1/4"=1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

PROBLEM APPRAISAL REPORT
DEFINITE POJECT REPORT

LONG LAKE

TREMPEALEAU & LA CROSSE COUNTIES, WISCONSIN

HABITAT REHABILITATION & ENHANCEMENT PROJECT

POOL 7, UPPER MISSISSIPPI RIVER

ED-D DESIGNED: M.G.E. CHECKED: M.G.E. DRAWN: H.P.A.

ED-GH DESIGNED: XXX/XXX CHECKED: XXX/XXX

DATE: 05-22-91

CAD FILE NAME: BCCCTFNO.DGN

SPEC NO: DACW37-91-B-0000

DRAWING NUMBER: BASIN-T-CC/FNO.1

SHT 999 OF 999

Figure 9

Attachment 2

Summary of Winter Dissolved Oxygen Monitoring

Table 1. Summary of Dissolved Oxygen and Water Temperature Data Collected from Long Lake During the Winter of 1987-88 by the Wisconsin DNR

DISSOLVED OXYGEN (MG/L)

DATE	DEPTH	SITE 1	SITE 2	SITE 3	SITE 4
1-15-88	TOP	6.8	5.2	2.2	1.5
	MIDDLE	2.2	5.6	6.7	5.4
	BOTTOM	2.0	5.7	6.7	2.4
2-8-88	TOP	1.9	2.5	2.7	2.7
	MIDDLE	1.1	0.3	0.1	0.6
	BOTTOM	0.0	0.1	0.1	0.1
2-29-88	TOP	5.6	9.0	0.4	0.1
	MIDDLE	6.2	3.4	9.1	8.4
	BOTTOM	6.3	0.4	0.1	6.0

TEMPERATURE (CENTIGRADE)

DATE	DEPTH	SITE 1	SITE 2	SITE 3	SITE 4
1-15-88	TOP	0.5	0.5	0.5	0.5
	MIDDLE	2.5	2.0	2.0	1.5
	BOTTOM	2.5	2.0	2.0	2.5
2-8-88	TOP	0.0	0.0	0.0	0.0
	MIDDLE	0.5	1.0	3.0	2.0
	BOTTOM	1.5	3.0	3.5	3.5
2-29-88	TOP	0.0	0.0	0.0	0.0
	MIDDLE	1.0	1.5	3.5	1.0
	BOTTOM	2.0	3.5	4.5	5.0

Table 2. Summary of Dissolved Oxygen and Water Temperature Data Collected from Long Lake During the Winter of 1988-89 by the Wisconsin DNR

DISSOLVED OXYGEN (MG/L)

DATE	DEPTH	SITE 1	SITE 2	SITE 3	SITE 4
1-16-89	TOP	2.2	3.3	1.7	1.7
	MIDDLE	1.9	2.4	1.1	0.6
	BOTTOM	1.5	0.5	0.3	0.2
1-31-89	TOP	13.8	2.3	2.0	2.3
	MIDDLE	11.8	1.8	0.5	1.6
	BOTTOM	5.7	1.4	0.2	0.3
2-14-89	TOP	18.2	5.7	4.5	10.0
	MIDDLE	14.0	4.8	2.2	4.7
	BOTTOM	12.9	1.7	0.0	0.0
2-28-89	TOP	>20.0	6.6	6.5	8.9
	MIDDLE		7.4	0.4	4.3
	BOTTOM	19.6	4.1	0.0	0.0
3-8-89	TOP	14.8	7.7	6.5	2.2
	MIDDLE		4.8	1.8	3.8
	BOTTOM	12.6	2.2	0.0	0.0

TEMPERATURE (CENTIGRADE)

DATE	DEPTH	SITE 1	SITE 2	SITE 3	SITE 4
1-16-89	TOP	0.5	1.0	0.5	0.0
	MIDDLE	2.5	2.0	2.5	2.0
	BOTTOM	3.0	3.0	3.0	4.0
1-31-89	TOP	0.5	0.5	0.0	0.0
	MIDDLE	1.5	2.5	3.0	2.0
	BOTTOM	2.0	3.0	3.5	4.0
2-14-89	TOP	0.5	1.0	0.5	0.5
	MIDDLE	2.5	2.5	3.0	1.5
	BOTTOM	2.5	3.0	4.0	4.0
2-28-89	TOP	0.5	1.0	0.5	0.0
	MIDDLE		2.5	3.0	1.5
	BOTTOM	2.0	3.0	4.0	4.5
3-8-89	TOP	0.5	0.5	0.5	0.0
	MIDDLE		1.5	3.0	1.5
	BOTTOM	2.5	3.5	4.0	4.0

Table 3. Summary of Dissolved Oxygen Data Collected from Webb Slough During the Winters of 1987-88 and 1988-89 by the Wisconsin DNR

SITE		1-15-88	2-8-88	2-29-88
6	TOP	2.7	2.3	8.7
	MIDDLE	5.5	0.2	2.8
	BOTTOM	5.5	0.1	2.2
7	TOP	6.6	0.9	8.8
	MIDDLE	6.8	0.9	
	BOTTOM	7.0	0.8	8.0

		1-16-89	1-31-89	2-14-89	2-28-89	3-8-89
6	TOP	2.4	2.3	4.2	6.7	7.0
	MIDDLE	2.0	1.8	2.7	3.2	3.9
	BOTTOM	1.1	1.3	2.5	2.7	1.9
7	TOP	6.8	3.8	12.0	9.8	
	MIDDLE	6.0	3.5	11.4		
	BOTTOM	0.4	2.8	7.8	9.6	

Table 4. Summary of Dissolved Oxygen Data Collected from Round Lake During the Winters of 1987-88 and 1988-89 by the Wisconsin DNR

SITE		1-15-88	2-8-88
RL	TOP	15.2	6.9
	MIDDLE	13.8	6.3
	BOTTOM	11.8	6.2

		1-16-89	1-31-89	2-14-89	2-28-89
RL	TOP	6.8	8.6	13.2	11.4
	MIDDLE	5.6	7.8	11.8	11.2
	BOTTOM	5.2		11.0	11.4

Table 5. Summary of Dissolved Oxygen Data Collected from Big Marsh and Tank Creek During the Winters of 1987-88 and 1988-89 by the Wisconsin DNR

SITE		1-15-88	2-8-88	2-29-88
ML	TOP	8.0		
	MIDDLE		9.4	11.0
	BOTTOM	8.2		
ML-2	MIDDLE			12.6
TC	TOP		9.0	
	MIDDLE			10.6
	BOTTOM		9	

		1-16-89	1-31-89	2-14-89	2-28-89
ML	TOP	10.5			
	MIDDLE		16.4	10.5	12.6
	BOTTOM	10.2			
TC	MIDDLE	11.1		9.8	11.8

Attachment 3

Habitat Evaluation Procedures

HABITAT EVALUATION PROCEDURE USED FOR THE LONG LAKE HABITAT REHABILITION AND ENHANCEMENT PROJECT

The Long Lake habitat rehabilitation and enhancement project involves the introduction of fresh water flows into Long Lake to alleviate chronic summer and winter dissolved oxygen depletion problems. Habitat evaluation procedures were used to quantify project outputs. Long Lake was evaluated because the purpose of the project is to improve habitat quality in Long Lake. Webb Slough was evaluated because some secondary benefits to this slough should occur as a result of the efforts at Long Lake.

METHODS

<u>Methodology</u> - The U.S. Fish and Wildlife Service's 1980 version of the Habitat Evaluation Procedures (HEP-80) was selected as the evaluation methodology because of the readily available fish species models associated with this methodology.

<u>Evaluation Species Selection</u> - The overall objective of the project is to improve habitat quality in Long Lake for backwater fish species. The largemouth bass (<u>Micropterus salmoides</u>), black crappie (<u>Pomoxis nigromaculatus</u>), and bluegill (<u>Lepomis macrochirus</u>) were considered as evaluation species because they are all species of interest in Upper Mississippi River backwater lakes. A preliminary evaluation was conducted using all three species to determine model suitability to the Long Lake situation. This preliminary evaluation indicated that any of the three species models would suffice, and that the results of the evaluation would likely be similar regardless which of the species was selected as the evaluation species.

The black crappie was selected as the evaluation species because Wisconsn Department of Natural Resources (WDNR) test netting and conversations with local fisherman identified the black crappie as the most common species of interest in Long Lake. The U.S. Fish and Wildlife Service black crappie model (Edwards, et. al., 1982) was used to develop summer HSI values. Because this model does not have variables for winter habitat a modification to the bluegill model developed by the St. Paul District (Palesh and Anderson, 1990) was used to develop winter HSI values.

The bluegill was selected as the evaluation species for Webb Slough because the habitat in Webb Slough is more conducive to bluegill than to black crappie. The U.S. Fish and Wildlife Service bluegill model (Stuber, et. al., 1982) was used to develop the summer HSI values, while the St. Paul District model modification was used to develop the winter HSI values.

Data Requirements - The evaluation was conducted using data collected by the WDNR (Schellhaass and Sullivan, 1987; Engel, 1988; Rogala and Sullivan, 1988, Bartsch and Sullivan, 1989) as part of their pre-project problem identification efforts, and data collected by the Corps as part of the project planning process. No additional data was collected specifically for the habitat evaluation procedure.

Future Without Project Conditions - For the future without project condition it was assummed that there would not be any appreciable change in Long Lake or Webb Slough. Because of its particular location sedimentation does not appear to be a significant factor in Long Lake. There are not other readily evident factors that would be expected to significantly change the physical/chemical nature and habitat quality of Long Lake and Webb Slough

MODEL RESULTS

Long Lake - The results of the evaluation are shown in table 1. As can be seen, under the baseline (base) condition and for the future without project (FW/O) condition dissolved oxygen is the limiting factor in determining habitat quality for the black crappie in Long Lake.

Under the future with (FW) project condition optimum habitat conditions (HSI = 1.0) can be achieved in the summer. This is because the only major limiting factor (low dissolved oxygen) can be eliminated.

While the introduction of water into Long Lake can remove dissolved oxygen as a limiting factor during the winter, two other factors are added that can reduce winter habitat quality for backwater fish, i.e., current and temperature reduction. It is very difficult to project how the proposed project will effect these parameters. The goal is to achieve a balance between solving the dissolved oxygen problem while not increasing current velocities or lowering water temperatures beyond what the fish can tolerate. This can only be achieved through operational experience and monitoring to determine what flow into Long Lake achieves this balance. Hydraulic analysis indicates that evaluation of current velocities in Long Lake should not occur due to the low flows being introduced in the winter. It was assummed that the introduced water would result in an average 1 degree Centigrade temperature reduction. The result is a winter HSI value of .91.

The overall HSI value was determined by using the more limiting of the two seasonal HSI values.

Webb Slough - The results of the Webb Slough evaluation are shown in table 2. As can be seen, under the baseline condition and for the future without project condition summer cover (excessive aquatic vegetation) and winter dissolved oxygen and cover (lack of deep water) are the limiting factors in determining habitat quality

TABLE 1. SI AND HSI VALUES FOR LONG LAKE

BLACK CRAPPIE

VARIABLE	BASE	FW/O	FW
V1 - turbidity	1.00	1.00	1.00
V2 - % cover	1.00	1.00	1.00
V6 - % littoral area	1.00	1.00	1.00
V7 - pH	1.00	1.00	1.00
V8 - temp (A)	1.00	1.00	1.00
V9 - temp (J)	1.00	1.00	1.00
V10 - temp (F)	1.00	1.00	1.00
V11 - temp (E)	1.00	1.00	1.00
V12 - D.O. (A,J,F)	0.20	0.20	1.00
V13 - D.O. (E)	1.00	1.00	1.00
V15 - TDS	1.00	1.00	1.00
FOOD	1.00	1.00	1.00
COVER	1.00	1.00	1.00
WATER QUALITY	0.20	0.20	1.00
REPRODUCTION	1.00	1.00	1.00
SUMMER HSI	0.20	0.20	1.00
Va - cover	1.00	1.00	1.00
Vb - D.O.	0.10	0.10	1.00
Vc - temp	0.70	0.70	0.50
Vd - current	1.00	1.00	1.00
COVER	1.00	1.00	1.00
WATER QUALITY	0.10	0.10	0.83
OTHER	1.00	1.00	1.00
WINTER HSI	0.10	0.10	0.91
OVERALL HSI	0.10	0.10	0.91

TABLE 2. SI AND HSI VALUES FOR WEBB SLOUGH

BLUEGILL

VARIABLE	BASE	FW/O	FW
V1 - % pool	1.00	1.00	1.00
V3 - % cover	0.40	0.40	0.40
V6 - turbidity	1.00	1.00	1.00
V7 - pH	1.00	1.00	1.00
V8 - diss. oxygen	0.70	0.70	0.70
V10 - temp. (A)	1.00	1.00	1.00
V11 - temp (E)	1.00	1.00	1.00
V12 - temp (F)	1.00	1.00	1.00
V13 - temp (J)	0.90	0.90	0.90
V14 - current (A)	1.00	1.00	1.00
V15 - current (E)	1.00	1.00	1.00
V16 - current (F)	1.00	1.00	1.00
V17 - current (J)	1.00	1.00	1.00
V18 - gradient	1.00	1.00	1.00
V20 - substrate	0.70	0.70	0.70
FOOD	0.63	0.63	0.63
COVER	0.40	0.40	0.40
WATER QUALITY	0.89	0.89	0.89
REPRODUCTION	0.89	0.89	0.89
OTHER	1.00	1.00	1.00
SUMMER HSI	0.75	0.75	0.75
Va - cover	0.40	0.40	0.40
Vb - D.O.	0.40	0.40	0.70
Vc - temp	0.70	0.70	0.50
Vd - current	1.00	1.00	1.00
COVER	0.40	0.40	0.40
WATER QUALITY	0.40	0.40	0.63
OTHER	1.00	1.00	1.00
WINTER HSI	0.40	0.40	0.63
OVERALL HSI	0.40	0.40	0.63

for the bluegill in Webb Slough.

Under the future with project condition a modest improvement in winter disolved oxygen conditions are expected as the water introduced into Long Lake will exit via Webb Slough. The overall HSI value of .63 was determined by using the more limiting of the two seasonal HSI values, the winter HSI.

HABITAT UNIT CALCULATIONS

Long Lake - Applying habitat evaluation procedures in the Long Lake situation requires some subjective judgements. The primary limiting factor in Long Lake is dissolved oxygen depletion. None of the project alternatives are expected to provide optimum dissolved oxygen conditions throughout Long Lake at all times. However, a healthy fish population does not require a body of water to be totally oxygenated. As long as a sufficient portion of the water body is oxygenated to satisfy other basic requirements such as food and cover, dissolved oxygen would not be considered limiting.

A larger portion of Long Lake would have to be adequately oxygenated in the summer because different species, and life stages within species, have different habitat requirements. During the winter warmwater species are basically in a survival mode, with adequate dissolved oxygen usually the single most significant habitat requirement. A lesser portion of Long Lake would need to be continually oxygenated during the winter to provide for basic fish survival.

The two channel alignment options considered in the final evaluation are expected to maintain, as a minimum, adequate dissolved oxygen in at least 1/3 of Long Lake during the winter. This assumes a situation where all of the introduced flow short circuits out Webb Slough. This should be sufficient to provide for survival of a resident fish population over the winter. Therefore, in the calculation of habitat benefits it was assummed that with either channel alignment option, dissolved oxygen would not be a limiting factor on winter habitat quality.

During the summer both channel alignment options would be expected to maintain adequate dissolved oxygen concentration over much of Long Lake. Short circuiting of the introduced water out Webb Slough is not expected to occur very often because most of the time Webb Slough is expected to be flowing into Long Lake. Therefore, in the calculation of habitat benefits it was assummed with either option, dissolved oxygen would not be a limiting factor on summer habitat quality.

If both alignment options remove dissolved oxygen as a limiting factor then the habitat unit gains with either option are the same. The calculated average annual habitat unit gains for Long Lake are shown in table 3 below. These are based on Long Lake being 15 acres in size.

Table 3. Project Habitat Unit Gains for Long Lake and Webb Slough

	Future Without AAHU	Future With AAHU	Change In AAHU
Long Lake	1.5	13.7	+12.2
Webb Slough	10.0	15.8	+5.8

<u>Webb Slough</u> - The ancillary benefits for Webb Slough as shown above are based on Webb Slough being 25 acres in size. Because flow from Long Lake is expected to exit Webb Slough during the winter it was assummed that the benefits to Webb Slough would accrue every winter.

SUMMARY

It is expected that both channel alignment options would remove dissolved oxygen as a limiting factor in Long Lake during both summer and winter. The calculable habitat unit benefits using habitat evaluation procedures would therefore be 12.2 AAHU for both options. While intuitively alignment 2 would be preferable over alignment 1 in providing introduced flow to a larger portion of the lake, habitat evaluation methods are not sensitive enough to quantify the additional habitat benefits that may be associated with alignment 1.

Ancilliary benefits of 5.8 AAHU were caluculated for Webb Slough based on the assumption that introduced flows exiting Long Lake would provide some alleviation of depressed winter dissoved oxygen conditions in Webb Slough.

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Attachment 4

Hydraulic Appendix

Long Lake HREP
Hydraulics Appendix

The Mississippi River Alternatives

Physical Processes
Hydraulic Data
Sediment Data
Ice Data
Project Design
Project Discharges

PHYSICAL PROCESSES

Long Lake is located on the east side of the navigation channel in upper Pool 7 between river miles 712 and 713 (see Figure A-1). Two secondary channels, Webb Slough and a channel between Long Lake and Big Marsh (referred to as Big Marsh Slough in this Appendix), provide flow to and from Long Lake. Hydraulic conditions in the Long Lake area are highly variable and depend on hydrologic conditions on the Mississippi and Black Rivers, and also on river stage variations due to the daily operation of Lock and Dam 6. During normal and high discharge conditions on the Mississippi, water usually enters Long Lake from the Mississippi River through Webb Slough (mouth of Webb Slough is located at RM 711.5) and exits through Big Marsh Slough into Big Marsh. During low river discharge conditions (usually more typical of winter time discharges), the stages on the Mississippi River are at a minimum and flow directions are reversed, with water entering Long Lake through Big Marsh Slough and exiting through Webb Slough. Other hydraulic/hydrologic conditions which may affect flow patterns include receding river stages when water may exit through Webb and Big Marsh Sloughs, and during high flow conditions on the Black River which results in higher discharges to Big Marsh via Tank Creek with increased stages in Big Marsh and subsequent flow from Big Marsh into Long Lake. Ice formation in the winter decreases the conveyance and flow rates in Webb and Big Marsh Sloughs. Water quality problems usually occur during low flows on the Mississippi River.

Prior to construction of Lock and Dam 7, the Long Lake area was typical of the irregularly braided Mississippi River floodplain with sloughs, lakes, and marshes present in the floodplain forest. The 1893 River Commission maps show that Long Lake was isolated from the river at that time. Construction of the lock and dams in the 1930's created a series of pools where a braided riverine environment previously existed. As shown in Table A-1, water surface elevations in the Long Lake area increased significantly for low flow conditions, while at higher flows the stages aren't greatly affected and may have even decreased slightly. For instance at a river discharge of 20,000 cfs the construction of Lock and Dam 7 caused an increase of 2.70 feet, however for a discharge of 50,000 cfs there was actually a decrease of .4 feet. This decrease is related to geomorphic changes (namely scour) in the channel bed downstream of Lock and Dam 6.

TABLE A-1

Discharge Versus Pre and Post Lock and Dam Water Surface Elevations

Discharge (cfs)	WSEL at River Mile 712.6 Prior to Lock Construction	After Lock Construction
20,000	636.72	639.40
30,000	639.00	639.76
40,000	640.55	640.60
50,000	641.70	641.30

Note: River mile 712.6 is the proposed location for the channel system connecting the River to Long Lake.

HYDRAULIC DATA

Discharge-Duration and Discharge-Frequency Relationships

The annual Discharge-Duration curve for Lock and Dam 6 is shown in Figure A-2. The discharges that correspond to the 5, 10, 50, 100, and 500 year floods are given in Table A-2.

TABLE A-2

Discharge - Frequency at Lock and Dam 6

Time of Return (Years)	Discharge (cfs)
5	128,000
10	152,000
50	216,000
100	247,000
500	315,000

Average Discharges

The average discharge in the Long Lake area is approximately 28,200 cfs.

Stage-Discharge Data

The plan of operation of Lock and Dam 7 is discussed in detail in the Lock and Dam 7 operation manual and is briefly described here.

Elevation 639 (all elevations given in this appendix are in feet above mean sea level, 1912 adjustment) is maintained at Lock and Dam 7 and the stages at all other points in the pool vary depending on discharge. At a total river discharge of 82,000 cfs all the gates at Lock and Dam 7 are raised out of the water, open river conditions are in effect, and the dam is out of control. On the recession, the gates are returned to the water when the pool at the dam drops to elevation 639.0, which occurs at a discharge of approximately 82,000 cfs. Elevation 639.0 is again maintained at the dam. Figure A-3 shows the operation curves for Lock and Dam 7. Table A-3 shows stage discharge information at various locations throughout the study area.

TABLE A-3

Pool 7 Hydraulic Information

DISCHARGE	LOCK & DAM 7 HW	WSEL DAKOTA	LOCK & DAM 6 TW	SLOPE LOCK & DAM 6 TW TO DAKOTA	
RM>>>	702.5	707.23	714.07		
10000	639.00	639.10	639.18	.00000221	
15000	639.00	639.17	639.30	.00000360	
20000	639.00	639.23	639.48	.00000692	
50000	639.00	639.78	641.84	.00005704	
60000	639.00	640.02	642.70	.00007421	
70000	639.00	640.32	643.50	.00008805	
80000	639.00	640.70	644.28	.00009913	
90000	639.60	641.15	645.03	.00010743	
100000	640.27	641.75	645.75	.00011076	
128000	641.92	643.28	647.59	.00011934	5 year flood
152000	643.15	644.42	648.82	.00012183	10 year flood
216000	646.04	647.05	651.32	.00011823	50 year flood
247000	647.25	648.18	652.38	.00011630	100 year flood

Note: 1. Stages were obtained from the Lock and Dam 7 operation manual.
2. Stages from other sources (ie. backwater curves) may vary.

Head Differentials and Water Surface Slopes

During the initial stages of this project, the interagency study team realized that information on stages and head differentials in the project area would be needed for project design purposes. Stage gages were subsequently installed by Corps of Engineers (COE) personnel and stages were read by WDNR (Wisconsin Department of Natural Resources) personnel during November of 1988 and by United States Fish and Wildlife Service (USFWS) personnel from July through October of 1990. This data is shown in the following table.

TABLE A-4

Stage Data in Project Area

Date	Time	Long Lake	River	Round Lake	Big Marsh	Mouth Web Slu	L/D 6 TW	Head River to LL	Slope L/D 6 to River gage	Lock & Dam 6 Discharge (cfs)
		------	------Stages	(1912 ADJ)	------	------	------			
	RM>>		712.75			711.5				
10 Nov 88		38.94			38.96		39.22			12,700
16 Nov 88	1047	39.29	39.30	39.85	39.33		39.60	.01	.000043	16,400
18 Nov 88	1300	39.37	39.40	39.91	39.40		39.66	.03	.000037	18,000
22 Nov 88	1210	39.54	39.55	39.92	39.57		39.84	.01	.000042	21,800
30 Nov 88	1113	39.20	39.24	39.94	39.25		39.51	.04	.000039	17,600
10 Jul 90	N/A	40.55	40.80	40.35	40.35	40.75	41.09	.25	.000042	47,700
18 Jul 90	N/A	39.55	39.60	39.65	39.40	39.65	39.79	.05	.000027	29,600
24 Jul 90	N/A	39.20	39.20	39.72	-	39.30	39.44	.00	.000034	22,600
31 Jul 90	N/A	40.65	40.87	40.40	40.48	40.85	41.01	.22	.000020	45,700
07 Aug 90	N/A	40.15	40.37	40.15	40.07	40.38	40.73	.22	.000052	44,700
04 Oct 90	N/A	39.30	39.40	39.70	39.25		39.46	.10	.000009	14,500

Note: 1. Lock and Dam 6 tailwater gage at RM 714.07
2. River Gage (for LL project) at RM 712.75
3. Round Lake Gage Tilted for 1990 readings
4. Add 600 to above elevations.

For the 1988 data, stage gages were located at Long Lake, Round Lake, Big Marsh, and in the Mississippi River adjacent Long Lake. For the 1990 data, a gage was added at the mouth of Webb Slough. See Figure A-1 for stage gage locations.

Examination of this data indicates that significant variations in head differential between the River and Long Lake may occur for a given discharge. A plot of this head differential versus total river discharge is shown in Figure A-4. Based on the 1988 low flow data for river discharges less than 20,000 cfs, the average head differential was 0.023 feet. For discharges up to 30,000 cfs, the head varied from 0.0 to 0.1 feet. The head differential varied between 0.2 and 0.25 feet for discharges between 40,000 cfs and 50,000 cfs, although only 3 data points were collected in this discharge range. Based on this data, no consistent relationship was apparent between River discharge and head differential. The 1988 data also indicates that the water surface elevation in Big Marsh is higher than that in Long Lake and the river at the upstream end of Long Lake during low river flow conditions. This would result in water entering Long Lake from Big Marsh through Big Marsh Slough and exiting through Webb Slough.

To get a better handle on head differentials in the project area, the long term record of stages at Lock and Dam 6 and Dakota, MN (RM 707.23) were also looked at. This data is plotted in Figure A-5 for the years 1984 to 1989. As can be seen, the relationship between river discharge and head differential between Lock and Dam 6 and Dakota is better defined, however, there is still a significant amount of scatter. A closer examination of the data indicates that for low flows (ie. discharges less than 20,000 cfs), the head differential from Lock and Dam 6 to Dakota usually varies from 0.0 to 0.5 feet, however there are events that may result in head differentials as large as 4 feet. The specific reason for these anomalies is probably related to operation of Lock and Dam 6.

As might be expected, given the variability of head differential versus river discharge, a comparison of head differential between the river gage (RM 712.75) and Long Lake to the head differential between Lock and Dam 6 and Dakota resulted in a poor correlation also.

The above data was also used to compare water surface slopes on the Mississippi River in the project area for low flow conditions. Based on this comparison the range of river slopes between Lock and Dam 6 and the river stage gage adjacent Long Lake (gage number 1 on figure A-1) for river discharges less than 20,000 cfs was .000009 to .000043, with the average being .000032. The slopes between Lock and Dam 6 and the Dakota gage (RM 707.23) on these same days was .000004 to .0000091 with the average being .000007. The reason for the water surface slope between Lock and Dam 6 and Long Lake being steeper is physically explained by the fact that this reach is in the extreme upstream end of the navigation pool where the slopes typically are the steepest. However, it is somewhat questionable as to how well the datum for the stage gages in the project area tied into the Lock and Dam 6 gage.

Secondary Channel Cross Sections

Cross sections in Big Marsh Slough, Webb Slough, and Long Lake have been obtained by the WDNR. This data is shown in Figures A-6 through A-13.

Secondary Channel Velocities

Velocity measurements were made in Webb and Big Marsh Slough in the winters of 1988 and 1989 by WDNR personnel. This data is shown in Table A-5. The location of each station is shown on Figure A-14.

TABLE A-5

Flow Velocities

(feet per second)

Date	Station Number						
	1	2	3	4	5	6	7
Water Depth (ft) at Station	4.5	6.5	11.5	7.5	1.5	4.5	4.5
1-15-88	0	0	0	0.03	0.09	0.04	0.07
2-08-88	0	0	0	0.02	0.14	0.03	0.08
2-29-88	-	-	-	0.03	0.15	0.07	C
1-16-89	-	-	ND	0.02	0.04	0.02	0.02
1-31-89	-	-	0.01	0.02	0.04	0.01	0.03
2-14-89	ND	ND	ND	ND	ND	ND	0.01
2-28-89	-	0.02	0.01	0.01	0.01	ND	0.02
3-08-89	-	-	ND	ND		ND	

Note: 1. Water depth equals typical depth of all data. Measured to the top of water in the test hole.
2. ND - flow not detected
3. C - flow present but not measured
4. Flow directions were Big Marsh to Long Lake to Mississippi River, except on 2/14/89 when flow was apparently reversed
5. The above data was collected by WDNR personnel

Stations 4, 5, 6, and 7 are located in Webb and Big Marsh Sloughs. Station 5 which had the shallowest water depth also had the highest velocities.

SEDIMENT DATA

Sediments found in the project area are typical of those found in the Mississippi Valley. In Webb Slough, substrates vary from sand to a fine mud consisting of silts and clays. In Long Lake and Big Marsh Slough, fine sediments are probably more prevalent.

Very little information on sedimentation is available for the project area. Throughout the Upper Mississippi the decrease in hydraulic energy slope (ie. water surface slope) due to Lock and Dam construction increased the imbalance between sediment supply and transport capacity of the Mississippi River, resulting in increased backwater sediment deposition. This effect probably hasn't been as significant in the Long Lake area since it is located at the upstream end of Pool 7 and the local increase in stages and decrease in hydraulic energy slopes isn't as great as those found in the lower portions of the pool.

Bathymetric data for Long Lake prior to Lock and dam construction doesn't exist, so the amount of sediment deposition in the lake cannot be quantified. However, the location of Long Lake at the upstream end of Pool 7 and the isolated nature of the lake suggest that sediment deposition hasn't been as great in Long Lake as in other backwater lakes. Because of the nature of this project, in that only a small amount of flow is to be introduced to Long Lake, a detailed analysis of sediment loads into Long Lake will not be done.

While some sediment deposition has undoubtedly occurred in both Webb Slough and Big Marsh Slough, field reconnaissance doesn't indicate significant changes in bottom elevation. There are two very shallow reaches in Webb Slough, however, both of these reaches were relatively shallow when Lock and Dam 7 was constructed. Field reconnaissance indicates that shoaling is apparently occurring at the mouth of Webb Slough, however examination of the flowage surveys indicates that a sand bar has always existed at this site. Whether, the apparent shoaling is due to active sediment transport, is a remnant of the old sand bar, or exists due to both factors is not known.

ICE DATA

Data collected by the WDNR in the winters of 1988 and 1989 indicates that ice thicknesses in Webb and Big Marsh Sloughs will vary between 1 and 2 feet depending on location. Table A-6 is a summary of this data. The location of each station is shown on Figure A-14.

TABLE A-6

Ice Thickness
(Inches)

Date	Station Number 1	2	3	4	5	6	7
Water Depth (ft) at Station	4.5	6.5	11.5	7.5	1.5	4.5	4.5
1-15-88	16	17	16	17	12	15	13
2-08-88	19	20	21	19	9	19	10
2-29-88	22	24	22	22	12	21	13
1-16-89	12	13	14	15	10	12	10
1-31-89	13	14	16	17	11	14	13
2-14-89	16	18	19	19	11	16	15
2-28-89	17	21	20	20	12	18	18
3-08-89	18	20	22	22	-	18	-

Note: 1. Water depth equals the water depth to the top of water in the test hole.
2. The above data was collected by WDNR personnel.

Stations 4, 5, 6, and 7 are located in Webb and Big Marsh Sloughs. Station 5 which had the shallowest water depth also had the least amount of ice formation and apparently never completely froze to the bottom. This indicates that the discharge through Big Marsh Slough, although small, was sufficient to prevent complete freeze up. Nevertheless, this is a significant restriction, representing a reduction in conveyance area of 70 percent or more.

PROJECT DESIGN

General Design

The project design includes an earth-lined inlet channel with a 50 foot long gated culvert control structure between the Mississippi River and Long Lake. The inlet channel will provide oxygenated flows to Long Lake for most hydrologic conditions. Dredging of Webb Slough is also an option. Table A-7 lists information relevant to the proposed design.

TABLE A-7

Design Information

Culvert (RCP) Size (in)	Number	Length (ft)	Invert El. U/S	Invert El. D/S	Inlet Channel Bottom Width (ft)	Side Slope	Bottom Elev.
48	1	50	634.3	634.0	10	1V:2.5H	634.0

Inlet Channel

The inlet channel will be located in the peninsula between Long Lake and the Mississippi River. Two alternatives (Figure A-15) exist for the inlet channel location. In the first alternative the inlet channel is located at the upstream end of federal property (RM 712.65), and would involve dredging a channel approximately 620 feet long. In the second alternative the inlet channel is located on a vacant lot approximately 850 feet upstream of the first alternative. The channel length for Alternative 2 is approximately 380 feet. The following description generally applies to both alternatives. The channel will have a trapezoidal shape with a 10 foot bottom width and 1V:2.5H side slopes. The bottom elevation of the channel will be 634. A 12 inch thick layer of riprap with a 6 inch filter blanket will be placed at the upstream end of the inlet channel to stabilize the banks at the inlet. This is mainly a concern during high water on Mississippi River which might cause bank erosion.

Generally sediment deposition isn't a major concern for this project since the design inflows are relatively low, and the gated control structure can be used to reduce inflows during flood events. The only possible exception is that shoaling at the upstream end of the inlet channel could occur if coarse sized sediment is available to the channel. This could occur because of two separate processes. The first process is described in Technical Report HL-79-5 "Shoaling at Harbor Entrances" as follows:

"There is a natural tendency for shoaling in entrances to harbors involving openings in bank lines of alluvial streams because of the sudden expansion in channel width and the lowering of the water level causing sediment-laden bottom currents to move toward the opening."

The second process is direct sediment transport into the inlet channel by the flows entering the channel. With either process deposition will occur at the upstream end of the channel, due to the low velocities within the inlet channel.

With the design flowrates being so low, it is doubtful that shoaling will reduce the effectiveness of this project to the point where maintenance is necessary. At Webb Slough for instance, the apparent shoaling has never resulted in a channel closure. However, reasonable design features were considered to minimize potential shoaling. One feature was to angle the entrance downstream. Existing literature suggests that by angling entrance channels downstream, shoaling can be minimized. Another feature that will be investigated further is to locate the channel away from obvious sediment sources. For example, reaches where shoals presently exist should be avoided, since some of the shoal material could be transported into the channel.

Another engineering factor affecting inlet channel location is the need to maximize head differential from the river to Long lake. To maximize head differential, the inlet channel must be located as far upstream as possible. Existing development on the private property at the upstream end of Long Lake limits the upstream extent of the channel. Field reconnaissance will be done during Plans and Specs to determine if there is a location or orientation that has less potential for shoaling, however, the channel alignment is to a large degree, fixed by the head differential and excessive costs associated with the purchase of developed land.

Control Structure

The control structure will be located near the midpoint of the inlet channel and will consist of one 48 inch reinforced concrete pipe (RCP) with a sluice gate in a gate well. The culvert is needed so that an access road exists to the south side of the inlet channel. The RCP is 50 feet long and the invert elevation is 634.0. The culvert elevations were chosen so that the top of the culvert will be submerged at least 1 foot below low flow water surface elevations. This will minimize the impacts of ice formation on culvert capacity. The purpose of this structure is to limit the amount of flow that enters Long Lake during critical periods. This might include high flow events when sediment laden flow would enter Long Lake or periods when flows have to be reduced due to fish habitat considerations. The outlet works consist of a flared pipe outlet and a 25 foot long rock lined channel expansion. Again 12 inch riprap with a 6 inch filter blanket is used. The riprap at the outlet is necessary to prevent scour during extreme events when head differentials could be large. As discussed previously, the maximum head differential between Lock and Dam 6 and Dakota is approximately 4 feet. Since the stage data collected in the project area didn't cover extreme events when the head differential is large, a simplified method of determining the maximum head differential that is likely between the river and Long Lake was used. This was done by determining the ratio of head differentials from the river to Long Lake, for available data, versus the head differential from Lock and Dam 6 to Dakota for the same days and multiplying this ratio by the maximum head differential of 4 feet between Lock and Dam 6 and Dakota. The result is a head differential of 0.7 feet. If the gate is completely open, this would result in a discharge into Long Lake of 70 cfs, which gives a culvert outlet velocity of 5.6 fps. Based on TR H-74-9 "Practical Guidance for Design of Lined Channel Expansions at Culvert Outlets" the d50 stone size and riprap blanket length for these conditions is 0.18' and 26 feet. A 12 inch layer of type HD riprap (see ETL 1110-2-120, encl. 3 and 6 Feb 91 CENCS-ED-GH memorandum) will meet the d50 requirement.

PROJECT DISCHARGES

During normal and high water conditions, flow usually enters Long Lake through Webb Slough and exits through Big Marsh Slough. However, the 1988 stage data, and velocity measurements taken in the winter, indicate that during low flow conditions, the flow is reversed with water entering Long Lake through Big Marsh Slough and exiting out Webb Slough. As discussed in the opening paragraph, hydrologic conditions on the Mississippi and Black Rivers and the operation of Lock and Dam 6, affect water surface elevations and flow directions in the project area. It will be possible, if stages in Big Marsh are much higher than in the Mississippi River or during receding river stages, to have reversed flow in the project channel. Hydraulic conditions are further modified by ice formation in the winter and vegetation growth in the summer which reduces channel discharges in Webb and Big Marsh Sloughs. For these reasons a rating curve giving project discharges versus river discharges cannot be developed. Rather, project discharges versus head differential at the control structure are presented, with further discussion on project discharges for low flow conditions. Figure A-16 and Table A-8 contain information on project discharges versus head differential at the control structure with the gate completely open. The control structure will be operated to reduce inflows to Long Lake under certain conditions.

TABLE A-8

Project Discharges Versus Head Differential Between the River and Long Lake

Head (ft)	Discharge for 1-48 inch RCP's (cfs)	
.005	6.0	
.010	8.5	
.015	10.0	
.023	12.5	(Average head differential for 1988 data)
.050	18.0	
.100	26.0	
.150	31.0	
.230	39.0	(Average head differential for 1990 data for river discharges of 40,000 to 50,000 cfs)
.400	51.0	
.600	64.0	
.700	70.0	(Maximum head differential likely to occur)
1.00	81.0	

Typical headlosses between the Mississippi River and Long Lake versus total river discharge can be found in the discussion on stage data, however, it must be realized that by opening the channel between Long Lake and the river, water surface elevations in Long Lake will increase slightly, and thus head differentials will be less for post project conditions than they were for preproject conditions. Head differentials for Alternative 2, the upstream location will increase due to water surface slopes on the river. The range of slopes between the Lock and Dam 6 gage and the river gage adjacent Long Lake was .000009 to .000043 for discharges less than 20,000 cfs. During winter low flow conditions the flatter slopes are more likely.

The most important condition with regards to project performance is during low flow conditions on the Mississippi River when water enters Long Lake through Big Marsh Slough, and exits through Webb Slough. This is when low dissolved oxygen conditions often occur in Long Lake. Usually this condition occurs during the winter time when ice covers Long Lake and the sloughs, although as shown by the 1988 stage data, it may also occur during the ice free season if river discharges are low enough. For this reason project performance should be based on this condition.

Channel discharges haven't been measured in Webb Slough or Big Marsh Slough. However the point velocities measured through the ice (Table A-5) can be multiplied by the cross sectional area of the transects in Webb and Big Marsh Sloughs (Figure A-6 to A-13) to determine the magnitude of secondary channel discharges for existing conditions. This was done for the point velocities at sites 7 and 5 and the cross sectional area (with ice area taken out) of transects 14 and 1. The results are presented in Table A-9.

TABLE A-9

Estimation of With-Ice Discharges Using Data From WDNR

Site & xsect.	Date	Depth (ft)	Ice Thickness (ft)	Velocity (fps)	A' (ft2)	Q (cfs)
		Webb Slough				
7 & 14	01/15/88	4.8	1.08	0.07	63	4.4
7 & 14	02/08/88	4.4	0.83	0.08	71	5.7
7 & 14	02/29/88	4.5	1.08	0	63	0
7 & 14	01/16/89	4.3	0.83	0.02	71	1.4
7 & 14	01/31/89	4.6	1.08	0.03	62	1.9
7 & 14	02/14/89	4.6	1.25	0.01	56	0.6
7 & 14	02/28/89	4.6	1.50	0.02	50	1.0
		Big Marsh Slough				
5 & 1	01/15/88	1.8	1.00	0.09	33	3.0
5 & 1	02/08/88	1.8	.75	0.14	47	6.5
5 & 1	02/29/88	2.0	1.00	0.15	33	5.0
5 & 1	01/16/89	1.6	.83	0.04	42	1.7
5 & 1	01/31/89	2.0	.91	0.04	38	1.5
5 & 1	02/14/89	2.0	.91	0	38	0
5 & 1	02/28/89	2.0	1.00	0.01	33	0.3

Note: 1. A' is the cross sectional area below ice.

The discharges ranged from 0 to 6.5 cfs, however this method, which obviously is crude, probably overestimates channel discharges, since the velocities were taken in deeper areas of the sloughs where velocities are highest. No correlation was found between channel velocities versus ice thickness or river stage.

Project Discharges for Open Water, 1988 Low Flow Conditions

An analytical model, based on Manning's equation, was used to predict project flowrates. The cross sectional data for the inlet channel, Webb Slough, and Big Marsh Slough was used to determine channel conveyance. Channel conveyance using Manning's equation is given by the following equation.

$$K = \frac{1.49 * A * R^{2/3}}{n}$$

K = channel conveyance
A = cross sectional area, ft2
R = hydraulic radius, ft
n = channel roughness coefficient

Values of channel roughness used were .030 for the inlet channel and .035 for Webb and Big Marsh Sloughs. A greater roughness coefficient was used in Webb and Big Marsh Slough since they are shallower and have excessive aquatic plant growth in the summer. In fact, because of the plant growth in the sloughs, the roughness coefficient probably should be larger, however this was accounted for by adjusting the effective channel area. Once conveyance is known, the discharge in a given channel or section of channel can be approximated by

$$Q = K * s^{.5}$$

s = h / L = water surface slope.
h = headloss over a channel length L
L = channel length

Since the 1988 data seems to best represent ice free low flow conditions, the stages from this time period will be used to estimate head losses and project discharges during low flow conditions. The boundary conditions (ie. water surface elevations in Big Marsh and in the river) were assumed to remain the same, while the elevation in Long Lake was again adjusted. Stages in Big Marsh and in the river adjacent the upstream end of Long Lake were higher than those in Long Lake for all observation days in 1988 (see Table A-4). The average head differential between Big Marsh and Long Lake was .034 feet and from the river to Long Lake was .023 feet. This would result in flows entering Long Lake through Big Marsh Slough and exiting through Webb Slough. If the project were in place, and boundary conditions remained the same, flow would enter Long Lake through the project channel, stages in Long Lake would increase slightly in order to increase the discharge out Webb Slough, discharges into Long Lake from Big Marsh would decrease, and discharges down Webb Slough would increase. As mentioned previously, very little data exists for calibrating the model, however, the estimated discharges based on a single velocity measurement, which were presented in Table A-9, was used to roughly calibrate the model for ice covered conditions. This is discussed in a later section. For the 1988 data, the following discharges resulted.

TABLE A-10

Project Discharges For
Open Water Conditions

Condition	Inlet Channel Alternative	Inlet Ch. Flow (cfs)	Big Marsh Slough Flow (cfs)	Webb Slough Flow (cfs)
Existing		0	12	12
Proposed	1	8	10	18
Proposed	2	10	9	19

For the 1988 data, the alternative 1 inlet channel location would have provided 8 cfs to Long Lake. The alternative 2 inlet channel location would have provided a project discharge of 10 cfs. A water surface slope of .000009 on the river was used to calculate the river water surface elevation at the alternative 2 location.

With-Ice Conditions

Ice formation in the proposed inlet channel to Long Lake and on Webb and Big Marsh Slough will reduce inflows to Long Lake. Ice formation will have the greatest effect in Webb and Big Marsh Slough because of the shallow water in them. To determine the potential impacts on project discharges due to ice formation, the reduction in channel conveyance, was estimated using Manning's Equation. The cross sectional area, hydraulic radius, and roughness coefficients of the channels will be changed to account for ice cover. While ice thicknesses obviously can vary depending on factors such as temperature, snow cover, and water velocity, the ice thicknesses that were measured on the date of the cross section surveys (see Figures A-6 through A-13) will be used to determine the effects of ice. A composite roughness coefficient for ice covered channels was calculated using methods in Ven Te Chow's "Open Channel Hydraulics" and assuming an ice roughness of 0.012, a channel bottom roughness of .030 for the inlet channel, and a channel bottom roughness of .035 for Big Marsh and Webb Sloughs. The equation for composite roughness is:

$$n = \frac{n2 * (a^{.75} + E^{1.5})}{(1 + a)^{.5}}$$

n = channel roughness with ice
n2 = ice cover roughness
a = P2/P1
P2 = Perimeter of ice
P1 = perimeter of channel
E = n1/n2
n1 = channel bottom roughness

The results of this analysis are shown in Table A-11.

TABLE A-11

Reduction in Channel Conveyance
Due to Ice Formation

Tran-sect	Ice Thickness inches	A ft2	P ft	R ft	n	K	Percent Reduction in Conveyance With Ice
		Inlet Channel					
-	No Ice	123	38	3.19	.030	13,239	-
	18	74	59	1.25	.025	5,118	61
		Big Marsh Slough					
1	No Ice	103	90	1.14	.035	4,785	-
	13	29	93	.31	.028	702	85
2	No Ice	113	78	1.46	.035	6,218	-
	12	47	110	.43	.028	1,422	77
		Webb Slough					
11	No Ice	245	81	3.03	.035	21,840	-
	20	128	122	1.05	.028	7,037	68
12	No Ice	339	213	1.59	.035	19,660	-
	15	123	265	.46	.028	3,900	80
13	No Ice	582	372	1.56	.035	33,330	-
13	18	140	431	.32	.028	3,500	90
14	No Ice	102	41	2.50	.035	8,000	-
14	12	66	66	1.00	.028	3,470	57

The reduction in channel conveyance was 61 percent for the inlet channel, ranged from 57 to 90 percent in Webb Slough, and ranged from 77 to 85 percent in Big Marsh Slough. The conveyance in Big Marsh Slough is less than those for the inlet channel and Webb Slough, indicating that ice will have the greatest impact here. Cross sections with lower depth to width ratios experience the greatest reduction, because much of there effective channel area is reduced by ice. Except for cross section 11 which is located at the mouth of Webb Slough, the conveyance in Webb Slough for the ice thicknesses given on the channel cross sections only varies from 3,470 to 3,900.

Project Discharges with Ice Cover, 1988 Low Flow Conditions

The information presented above was used in the analytical model to estimate project inflows with ice cover. The model was roughly calibrated for existing conditions using the approximate discharge data in Table A-9. Since Table A-9 only contains rough estimates of channel discharge, and since water surface elevations on the days of these measurements aren't known, all that could be done essentially was to make sure that the model gave reasonable results. The 1988 open water stage data was again used to estimate headlosses in the model. The channel conveyance used in Big Marsh Slough was the average of that at cross sections 1 and 2, and the conveyance used in Webb Slough was set equal to 3500. The boundary conditions (ie. water surface elevations in Big Marsh and in the river) were assumed to remain the same, while the elevation in Long Lake was again adjusted. This results in the following discharges with ice cover.

TABLE A-12

Project Discharges With Ice Cover

Condition	Inlet Channel Alternative	Inlet Ch. Flow (cfs)	Big Marsh Slough Flow (cfs)	Webb Slough Flow (cfs)
Existing		0	2.7	2.7
Proposed	1	6.5	2	8.5
Proposed	2	7.5	1.5	9

For the 1988 data with ice cover, the alternative 1 inlet channel location would have provided 6.5 cfs to Long Lake. The alternative 2 inlet channel location would have provided a project discharge of 7.5 cfs. A water surface slope of .000009 on the river was used to calculate the river water surface elevation at the alternative 2 location. Comparing these values to the no-ice condition shows that the discharge in Webb Slough decreased 77 percent for existing conditions, and 53 percent for conditions with the project in place. However inlet channel discharges only decreased 19 percent for option 1 and 25 percent for option 2.

The average tailwater elevation at Lock and Dam 6 for the 1988 data was 639.65. This is just under the average tailwater elevation that occurred in the winters of 1987, 1988, and 1989, and thus should be fairly representative of conditions during low flow years. There are periods during the winter, when the tailwater elevation is slightly lower than this, however it rarely drops below 639.4 . For these lower water surface elevations project discharges may be decreased. However, once the project is in place, the additional flows will probably result in decreased ice thicknesses.

Project Discharges With Webb Slough Dredging

To minimize the impacts of ice formation or vegetation growth in the summer, a 5 foot deep channel with a bottom width of 10 feet could be dredged in Webb Slough. The purpose of the dredging is to increase channel conveyance, especially during ice covered conditions. Webb Slough would be chosen over Big Marsh Slough mainly because Webb Slough is the main outlet for water from Long Lake during low flow conditions. Also, the amount of dredging that would be required to provide a relatively open path to the river is significantly less. To simulate the effects of Webb Slough Dredging, channel conveyance in the analytical model in Webb Slough was increased to account for dredging. This is summarized in Table A-13.

TABLE A-13

Project Discharges With Webb Slough Dredging

Condition	Inlet Channel Alternative	Inlet Ch. Flow (cfs)	Big Marsh Slough Flow (cfs)	Webb Slough Flow (cfs)
Proposed	1(No Ice)	11.6	11.7	23.3
Proposed	1(Ice)	10.0	2.0	12.0

Note: 1. A 10' BW channel with 1:2.5 side slopes and bottom elevation of 634 was assumed.

Conclusion of Project Discharges

Table A-14 reiterates the information presented in previous tables.

TABLE A-14

Summary of Project Discharges

Condition	Inlet Channel Alternative	Inlet Ch. Flow (cfs)	Big Marsh Slough Flow (cfs)	Webb Slough Flow (cfs)
		No Ice		
Existing		0	12	12
Proposed	1	8	10	18
Proposed	2	10	9	19
		With Ice		
Existing		0	2.7	2.7
Proposed	1	6.5	2	8.5
Proposed	2	7.5	1.5	9
		With Webb Slough Dredging		
		No Ice		
Proposed	1	11.6	11.7	23.3
		With Ice		
Proposed	1	10.0	2.0	12.0

As stated previously, these results are based on the stage data obtained in 1988 and it was assumed that this data would apply for conditions when ice covers the channels. This assumption is somewhat justified by the fact that the average tailwater elevation at Lock and Dam 6 for the 1988 data was 639.65 which is fairly close to the average tailwater of 639.68 for the months of December, January, and February of 1987, 1988, and 1989 which are 3 fairly low flow years. There are periods when water surface elevations are slightly lower than this (ie. 639.3 to 639.5) and this will result in decreased project discharges, and in some cases, may result in a flow reversal with flow leaving Long Lake through the inlet channel. Based on the information contained in this appendix, it seems that a reasonable range of project discharges for low flow conditions excluding flow reversals is 2 or 3 cfs on the low side up to 8 or 10 cfs on the high side. This wide range of discharges is mainly due to the highly variable head differentials that may occur for a given total river discharge, and the effects of varying ice thicknesses.

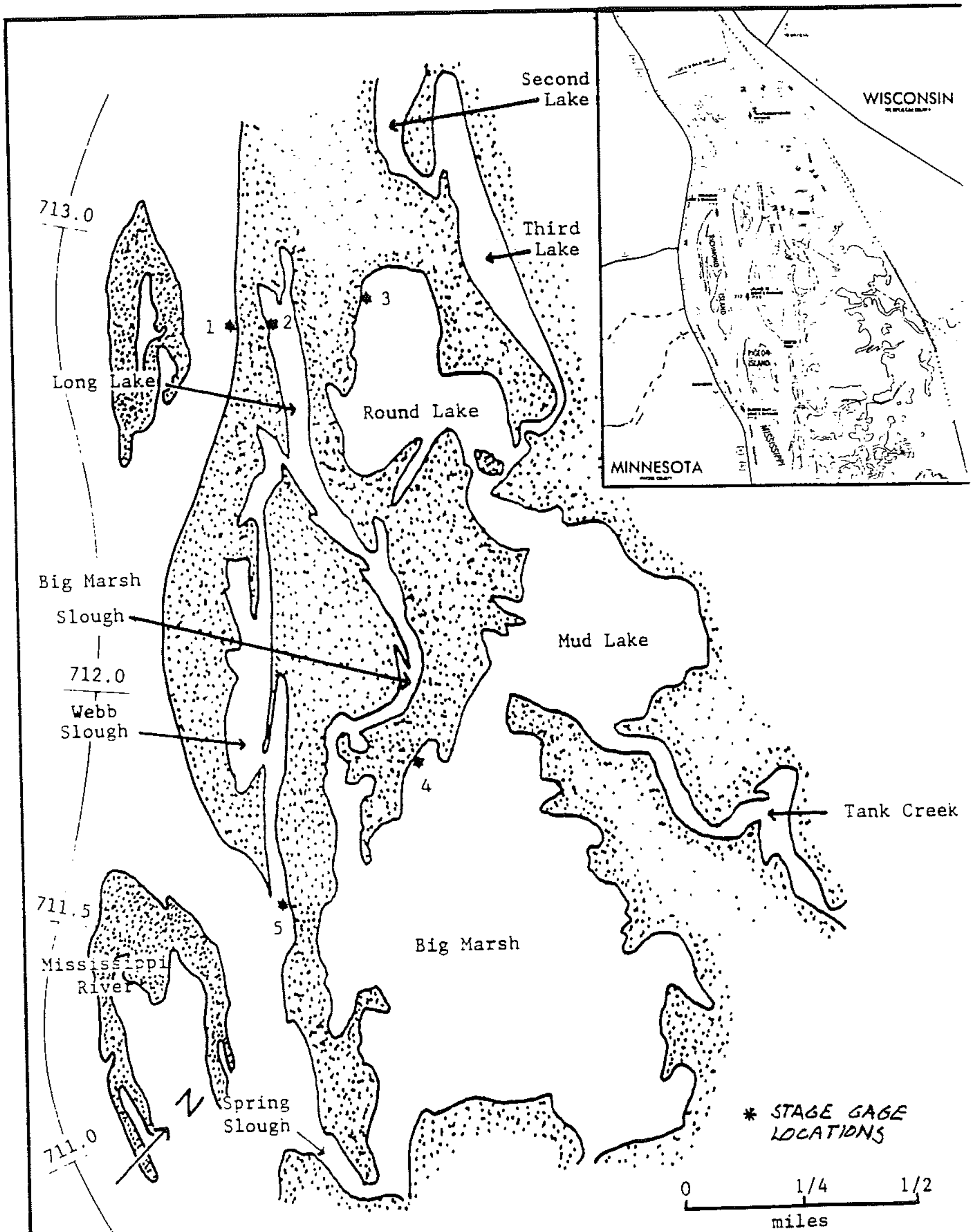


Figure A-1

Long Lake and Adjacent Water Bodies and Gage Sites

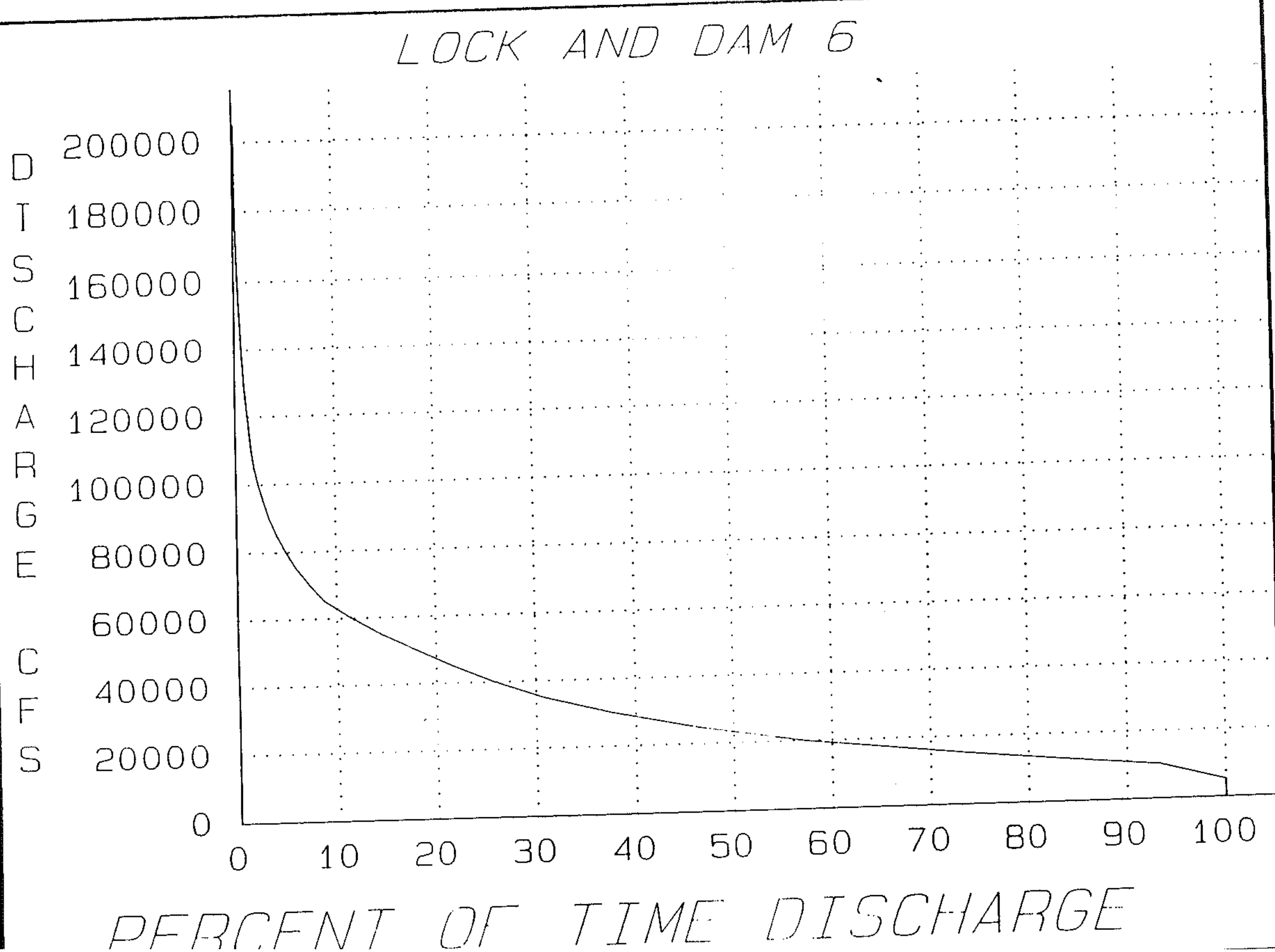


Figure A-2
Discharge Duration at Lock & Da

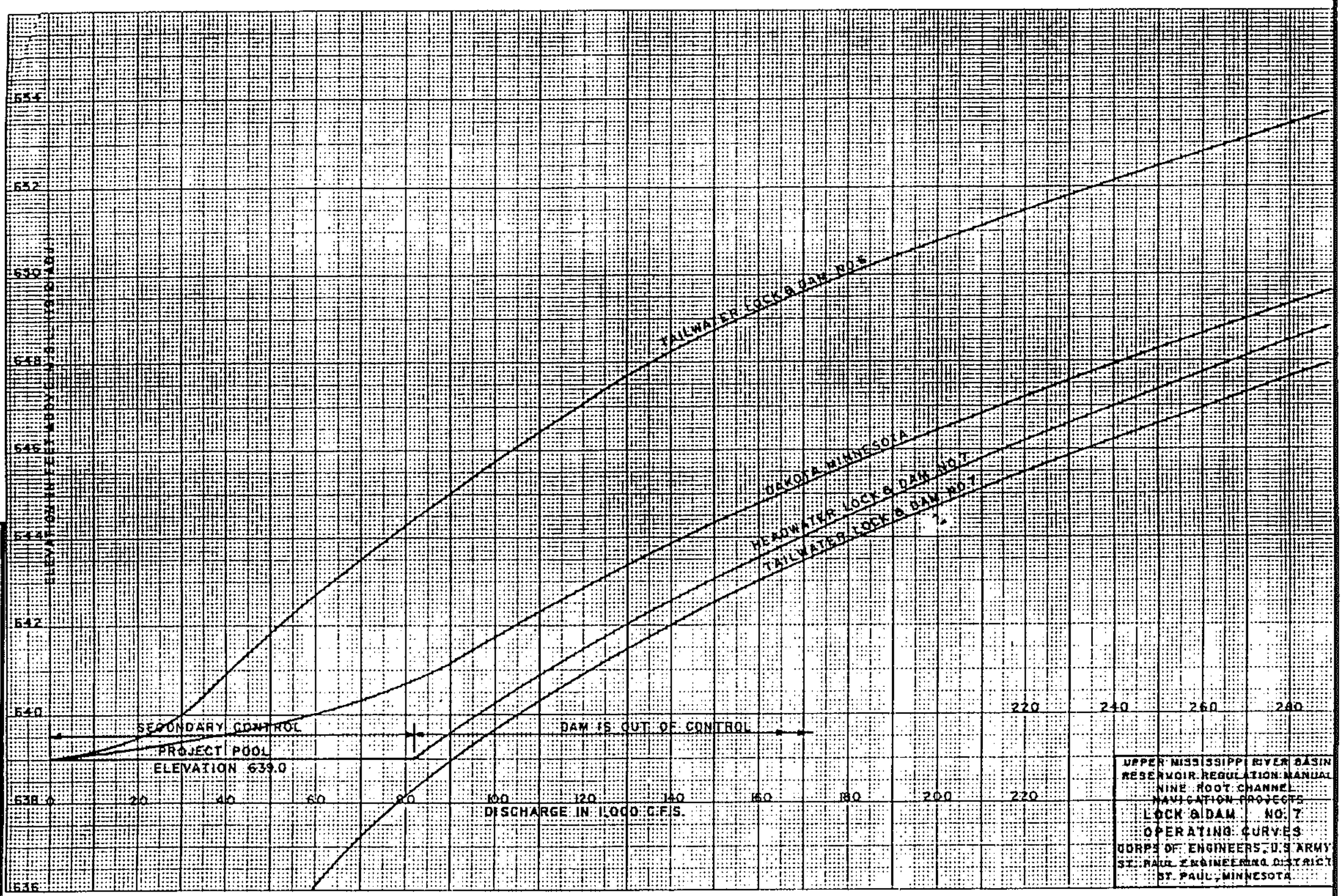


Figure A-3
Operation Curves for Lock & Dam 7

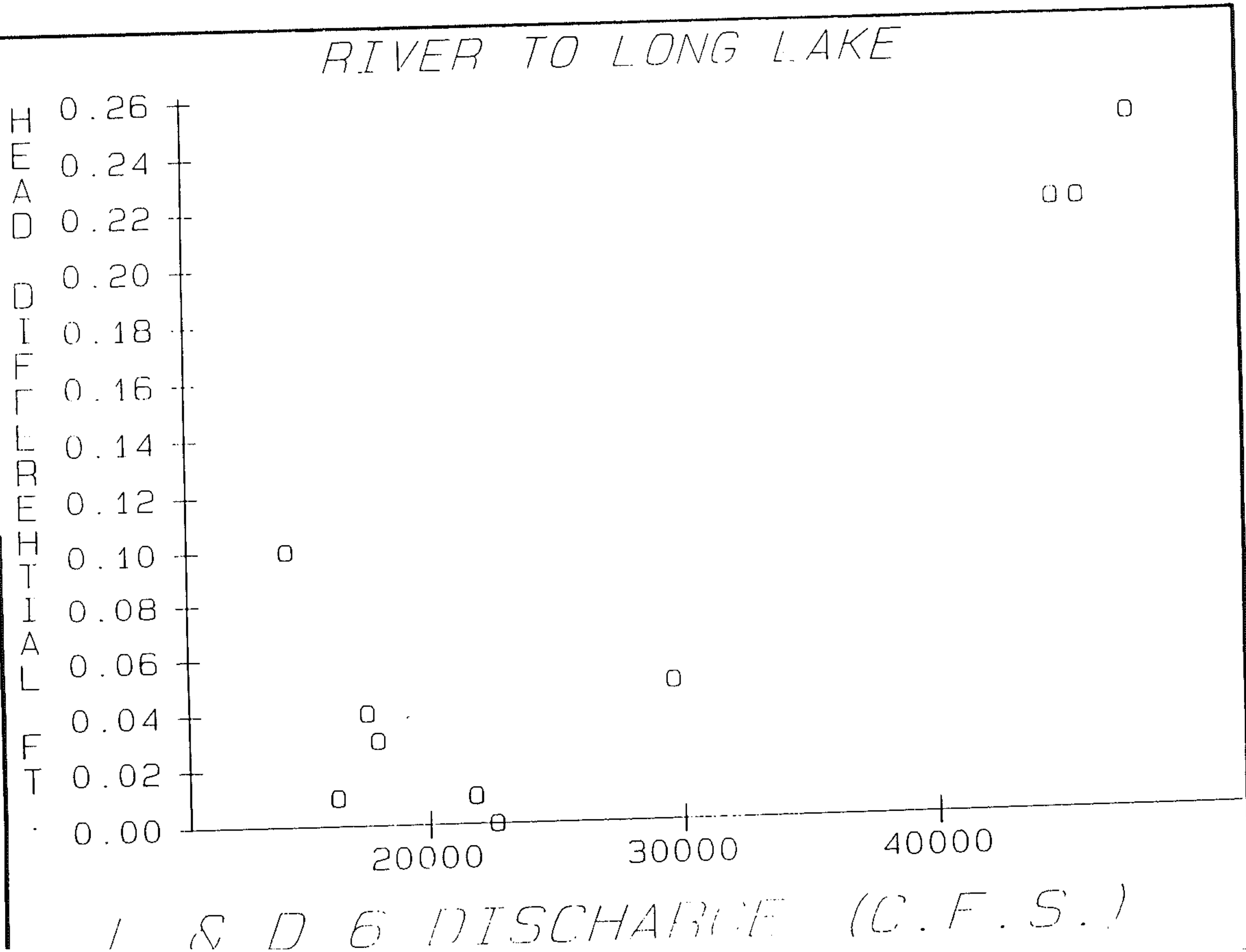


Figure A-4
Head Differential between Mississipp
River (RM. 712.75) and Long Lake

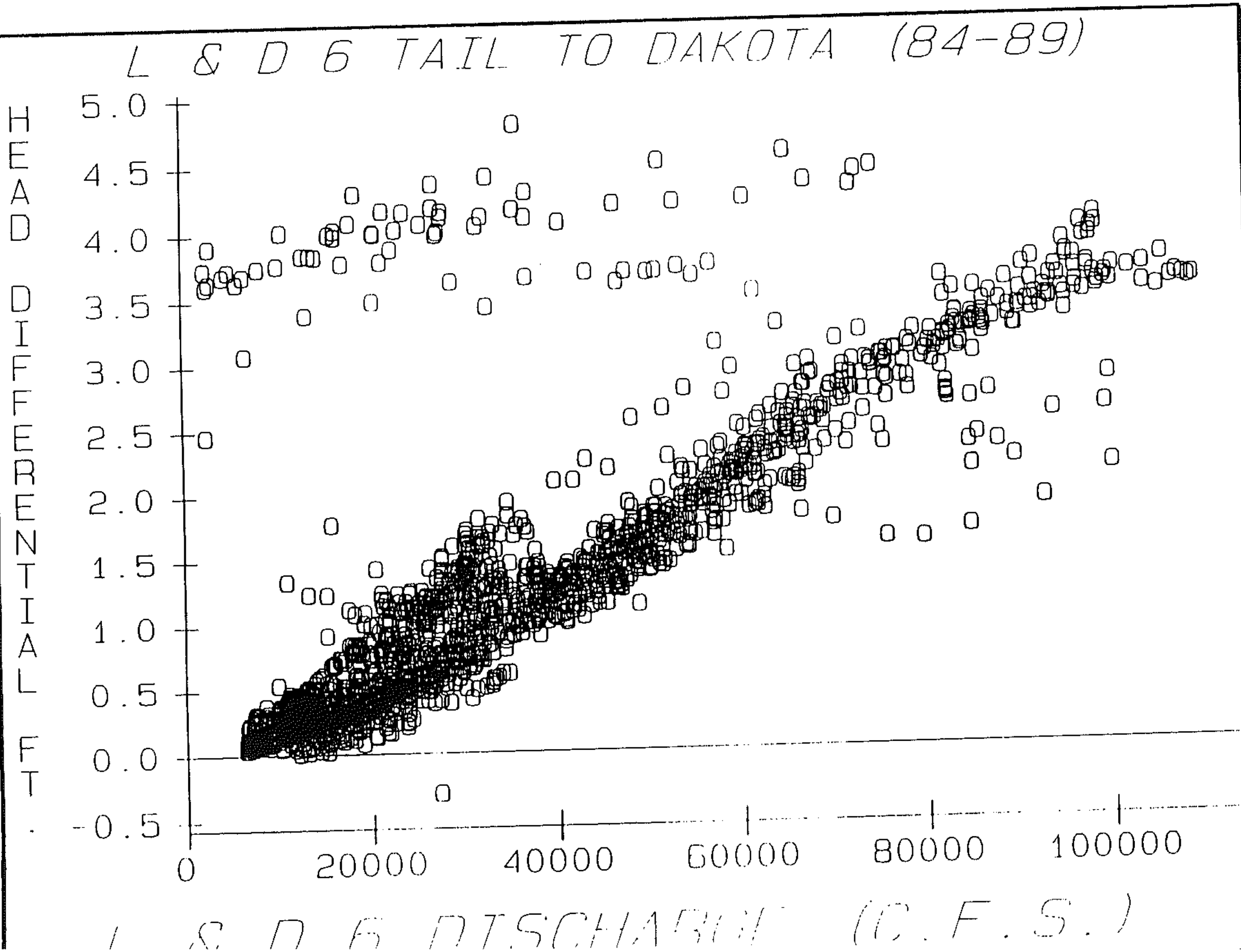
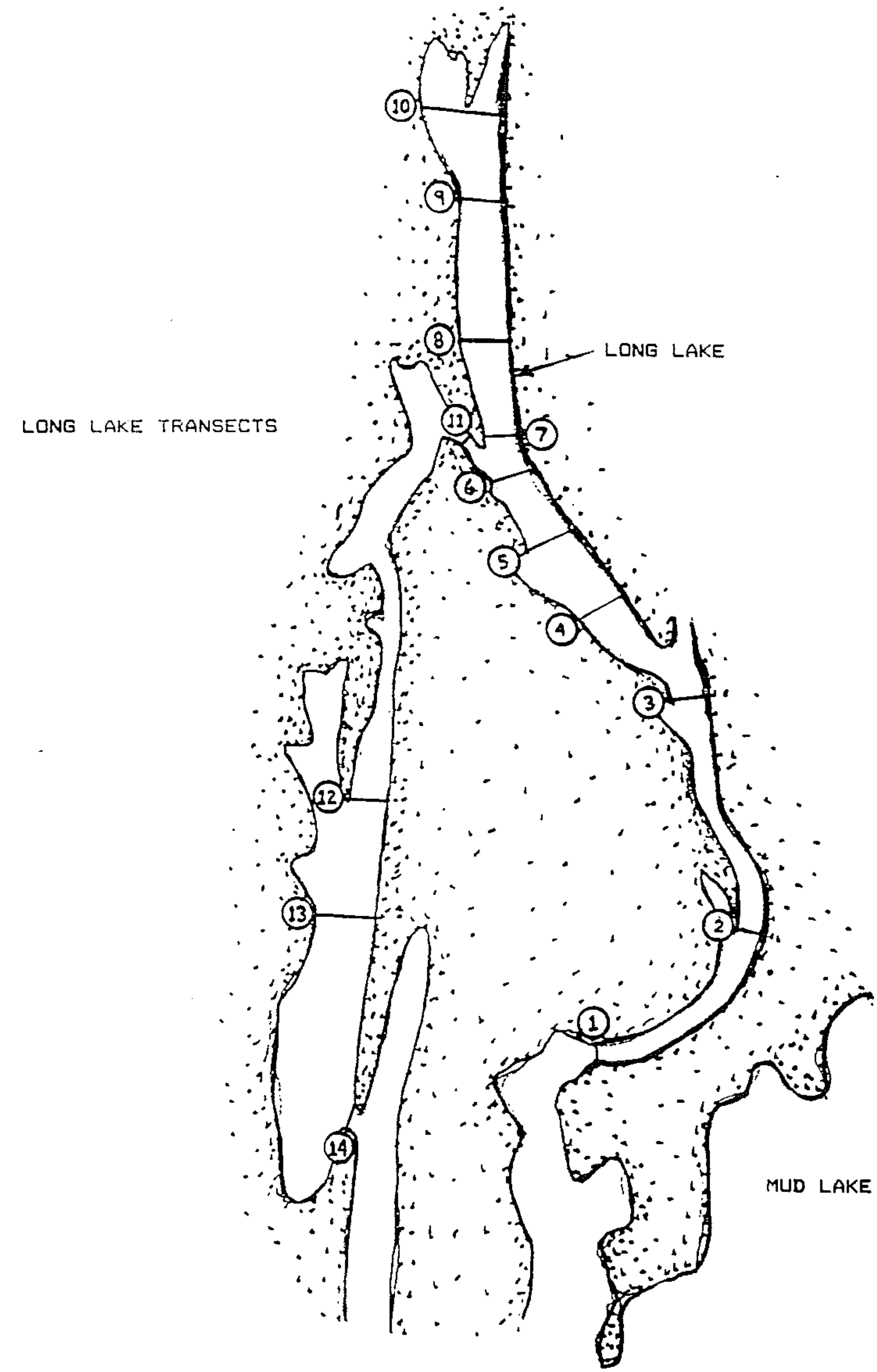


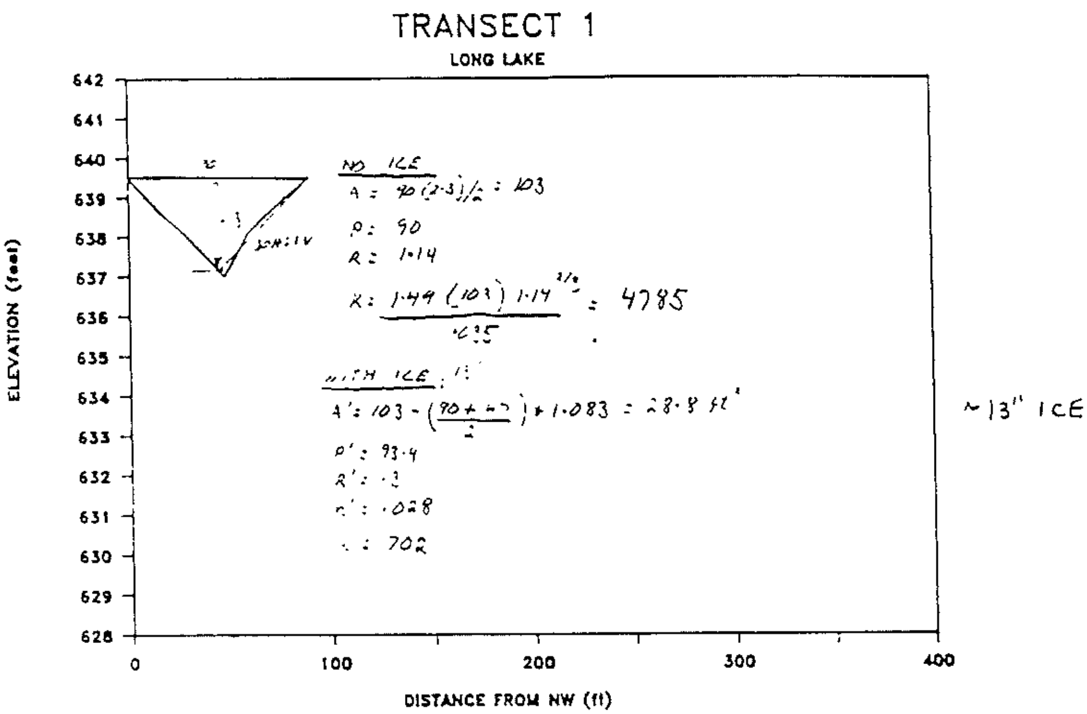
Figure A-5
Head Differential between Lock and Dam 6
(RM. 714.07) Tailwater and Dakota (RM. 707.2

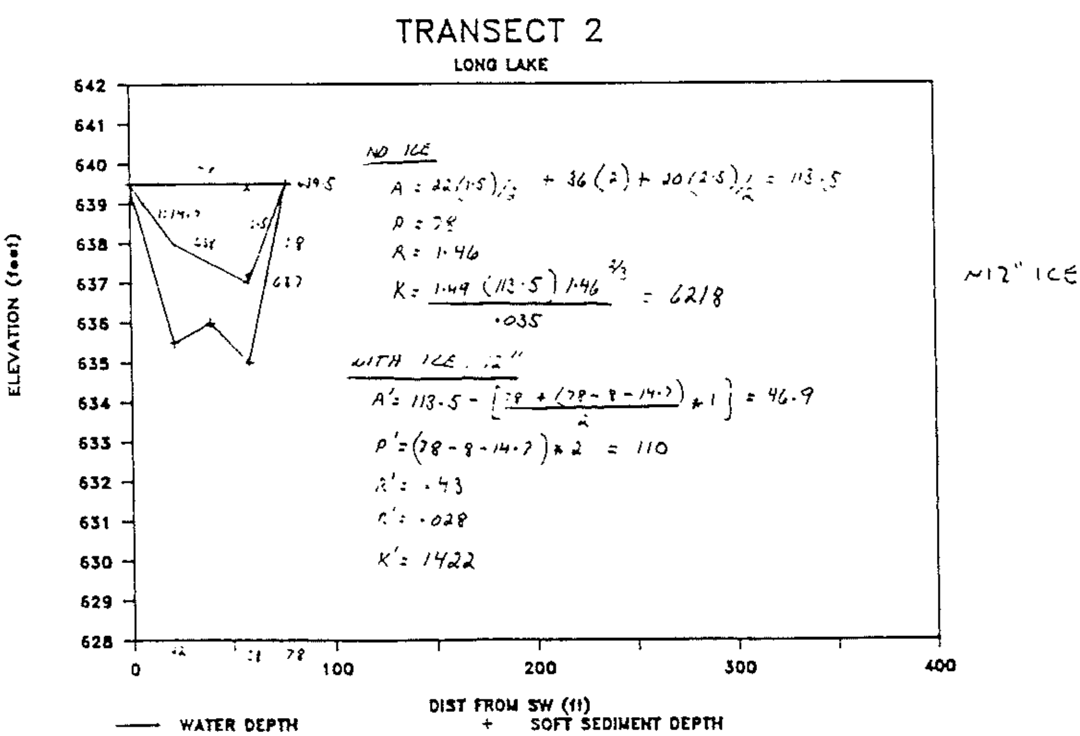


Note: Data obtained from the Wisconsin
Department of Natural Resources.

Figure A-6

Locations of Long Lake Transects

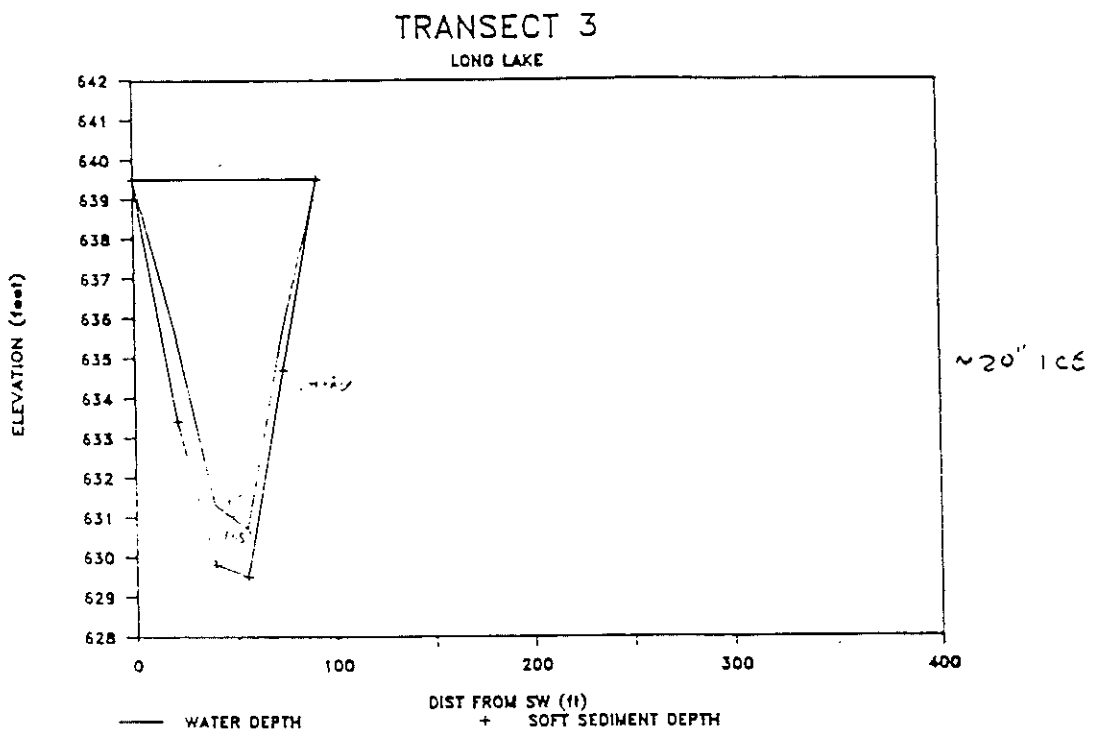


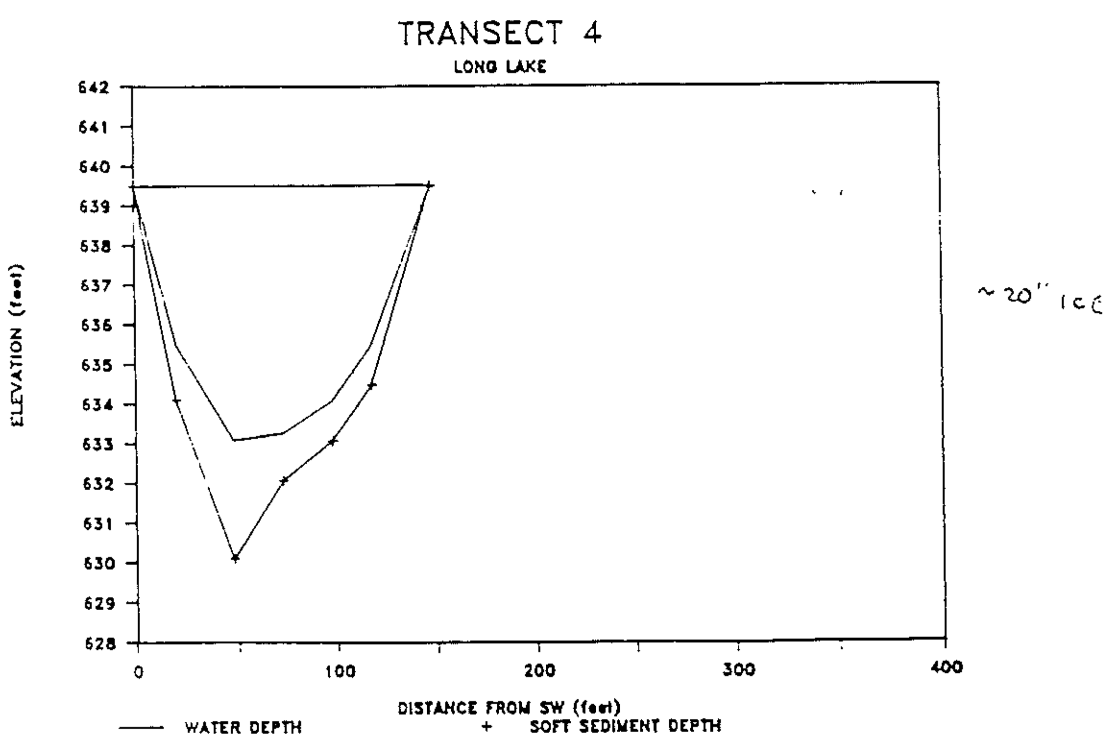


Note: Data obtained from the Wisconsin Department of Natural Resources.

Figure A-7

Long Lake Transects 1 and 2

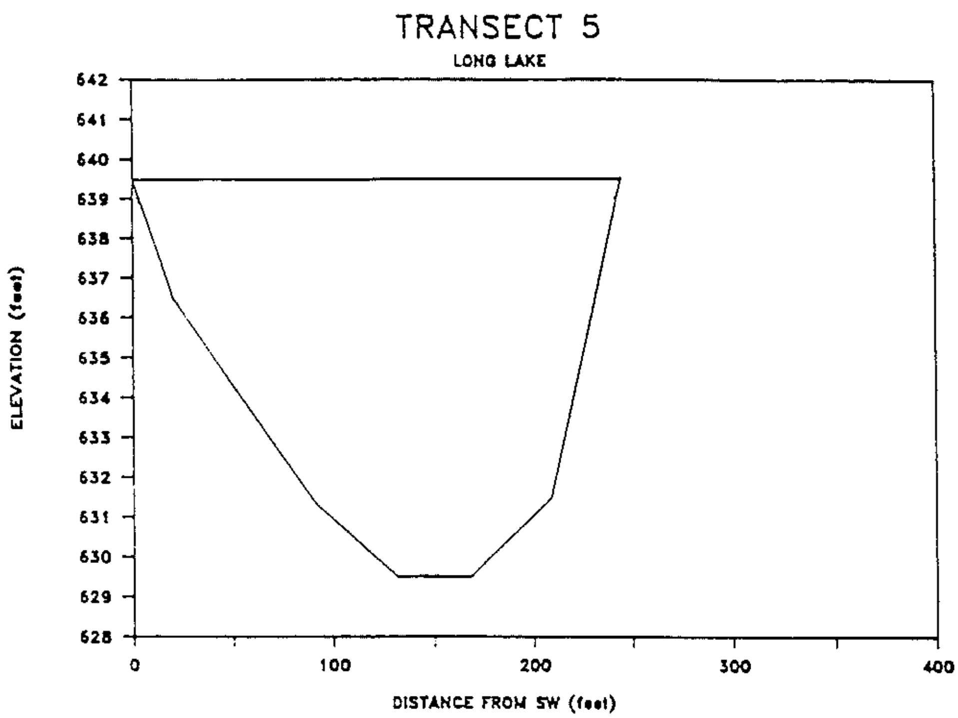




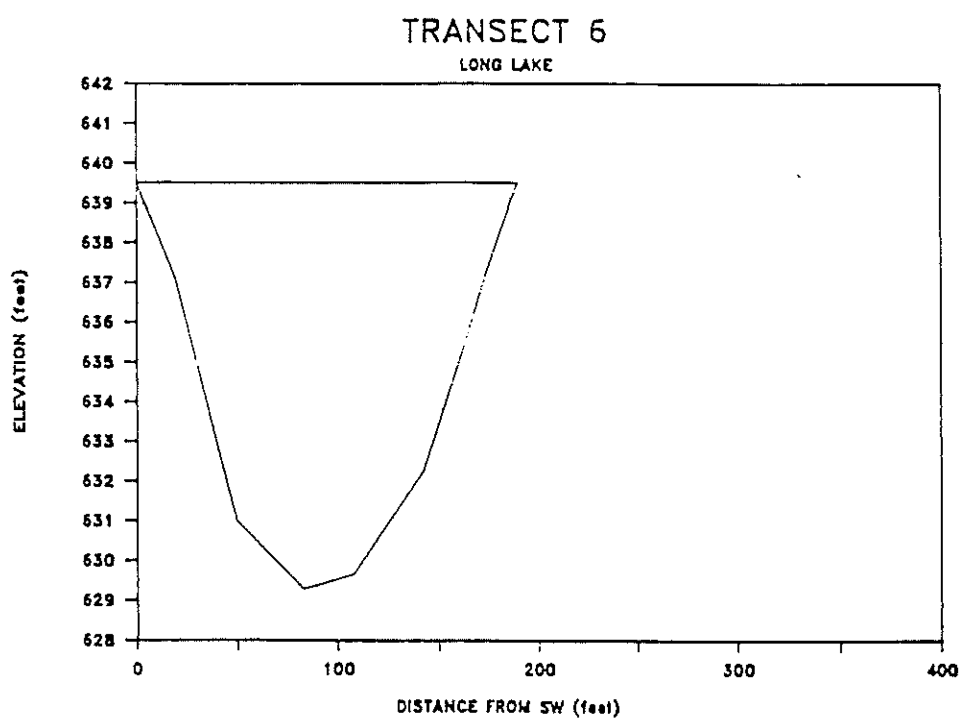
Note: Data obtained from the Wisconsin Department of Natural Resources.

Figure A-8

Long Lake Transects 3 and 4



~21" ICE

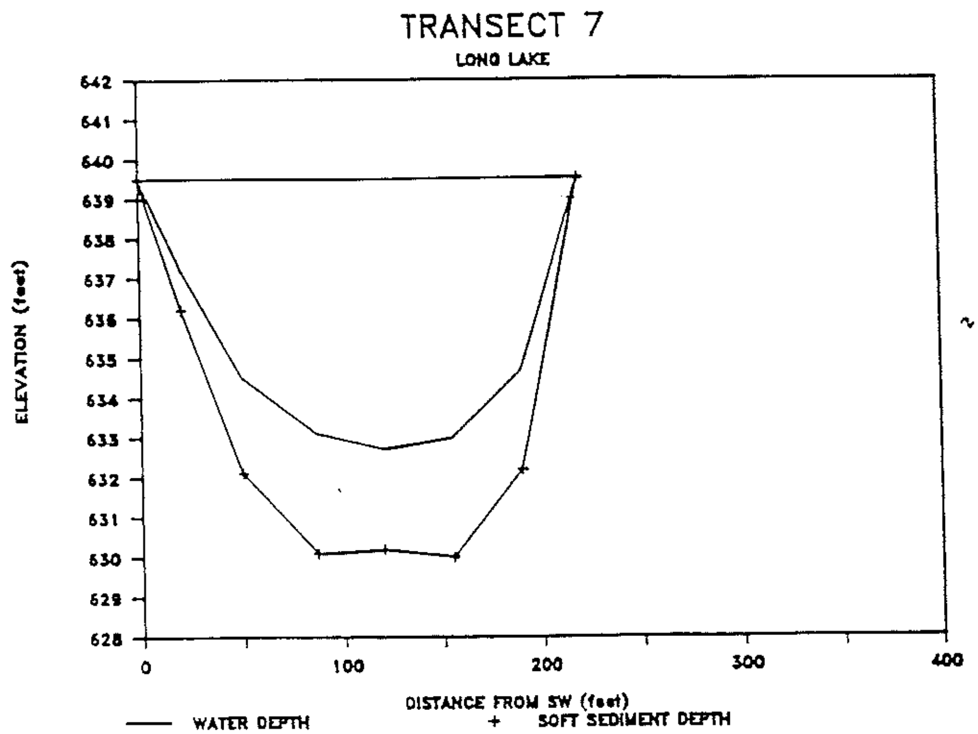


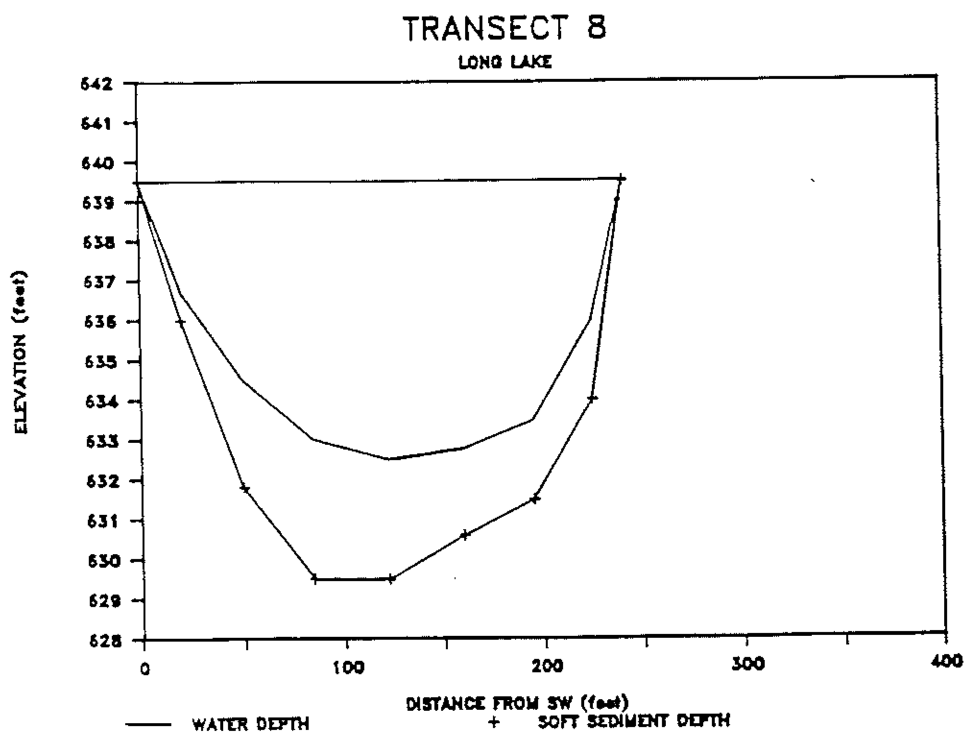
~22" ICE

Note: Data obtained from the Wisconsin Department of Natural Resources.

Figure A-9

Long Lake Transects 5 and 6

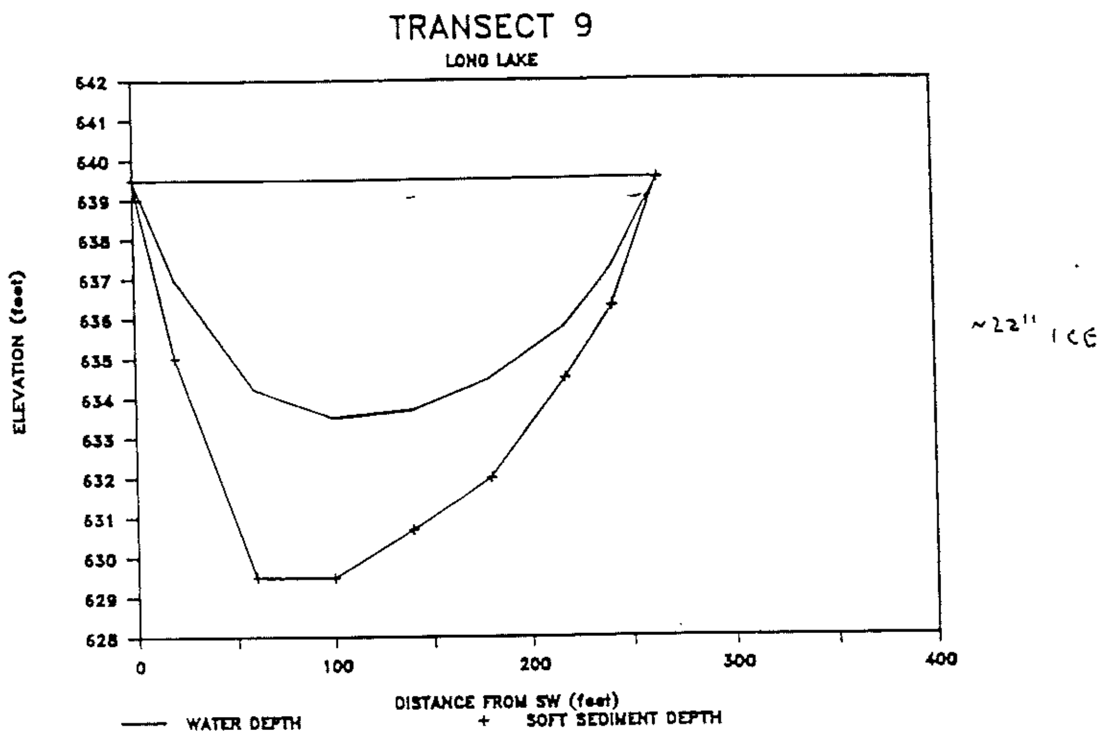


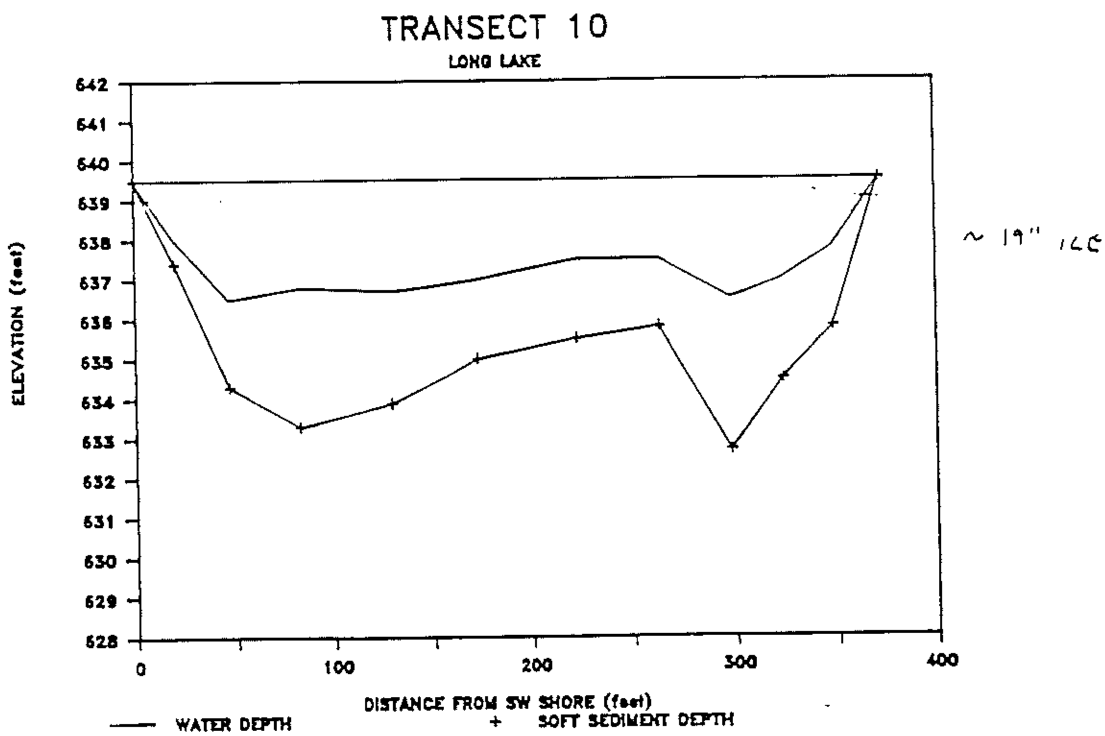


Note: Data obtained from the Wisconsin Department of Natural Resources.

Figure A-10

Long Lake Transects 7 and 8

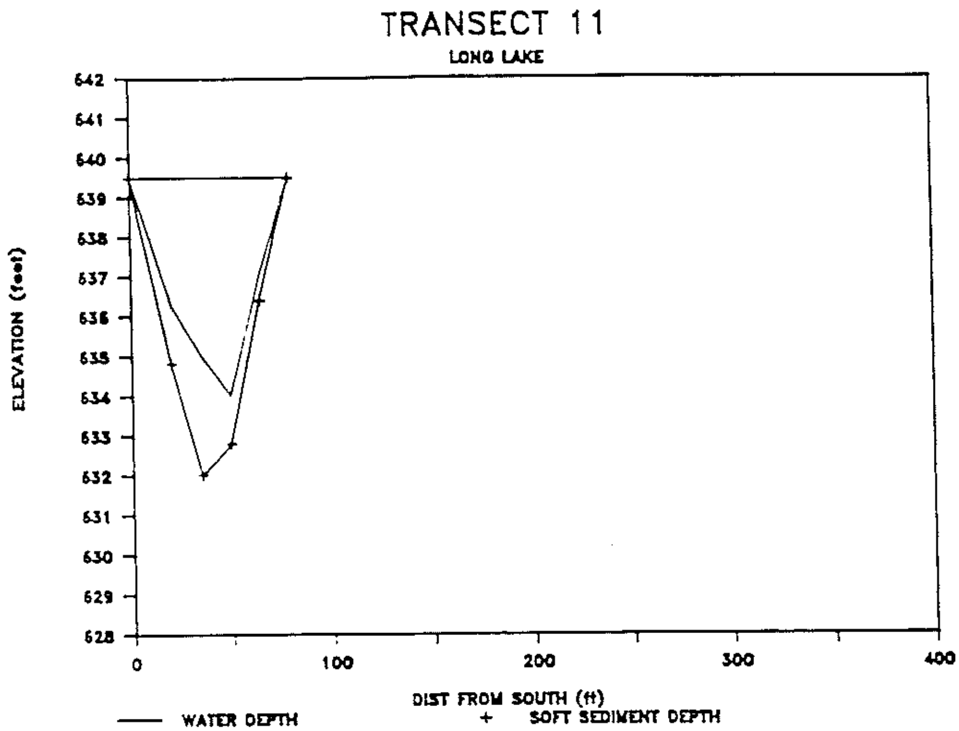




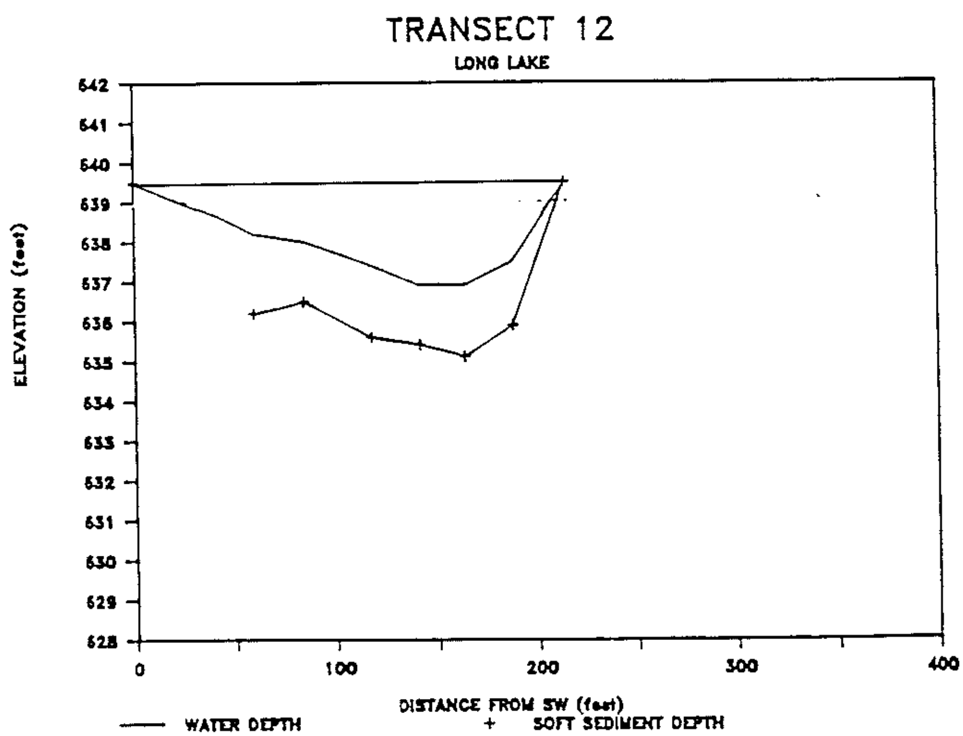
Note: Data obtained from the Wisconsin Department of Natural Resources.

Figure A-11

Long Lake Transects 9 and 10



~ 20" ice

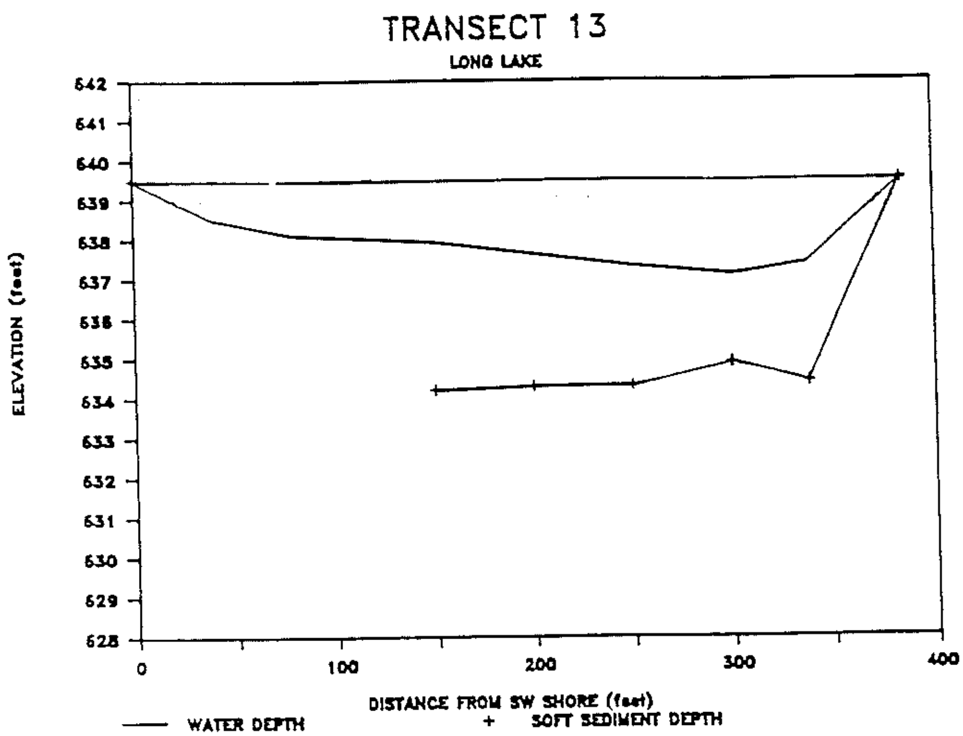


~ 15" ice

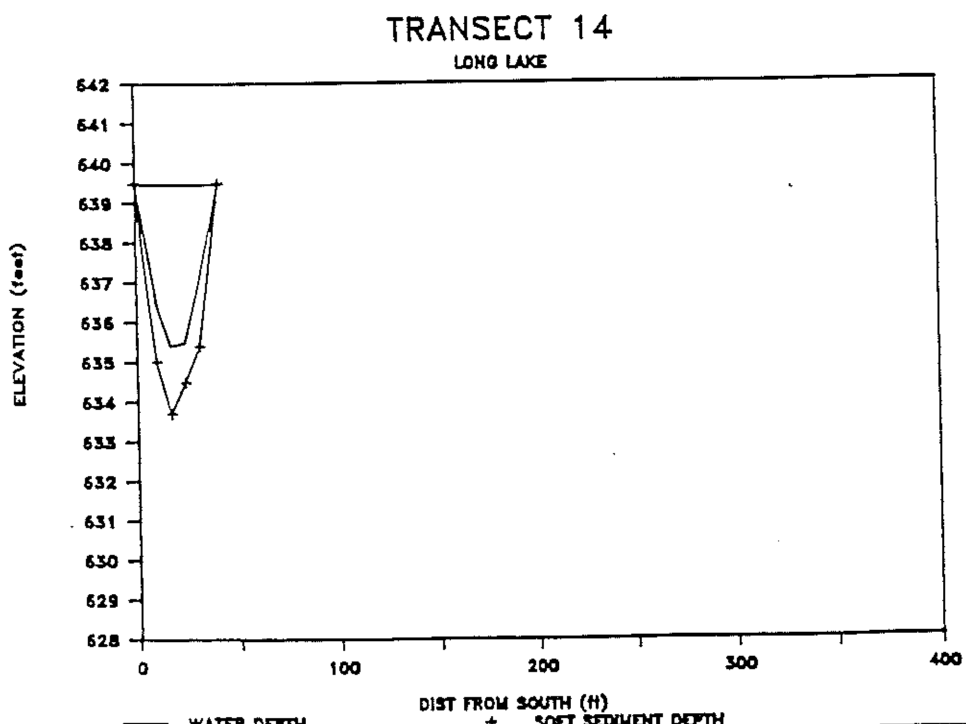
Note: Data obtained from the Wisconsin Department of Natural Resources.

Figure A-12

Long Lake Transects 11 and 12



~18" ICC



~12" ICC

Note: Data obtained from the Wisconsin Department of Natural Resources.

Figure A-13

Long Lake Transects 13 and 14

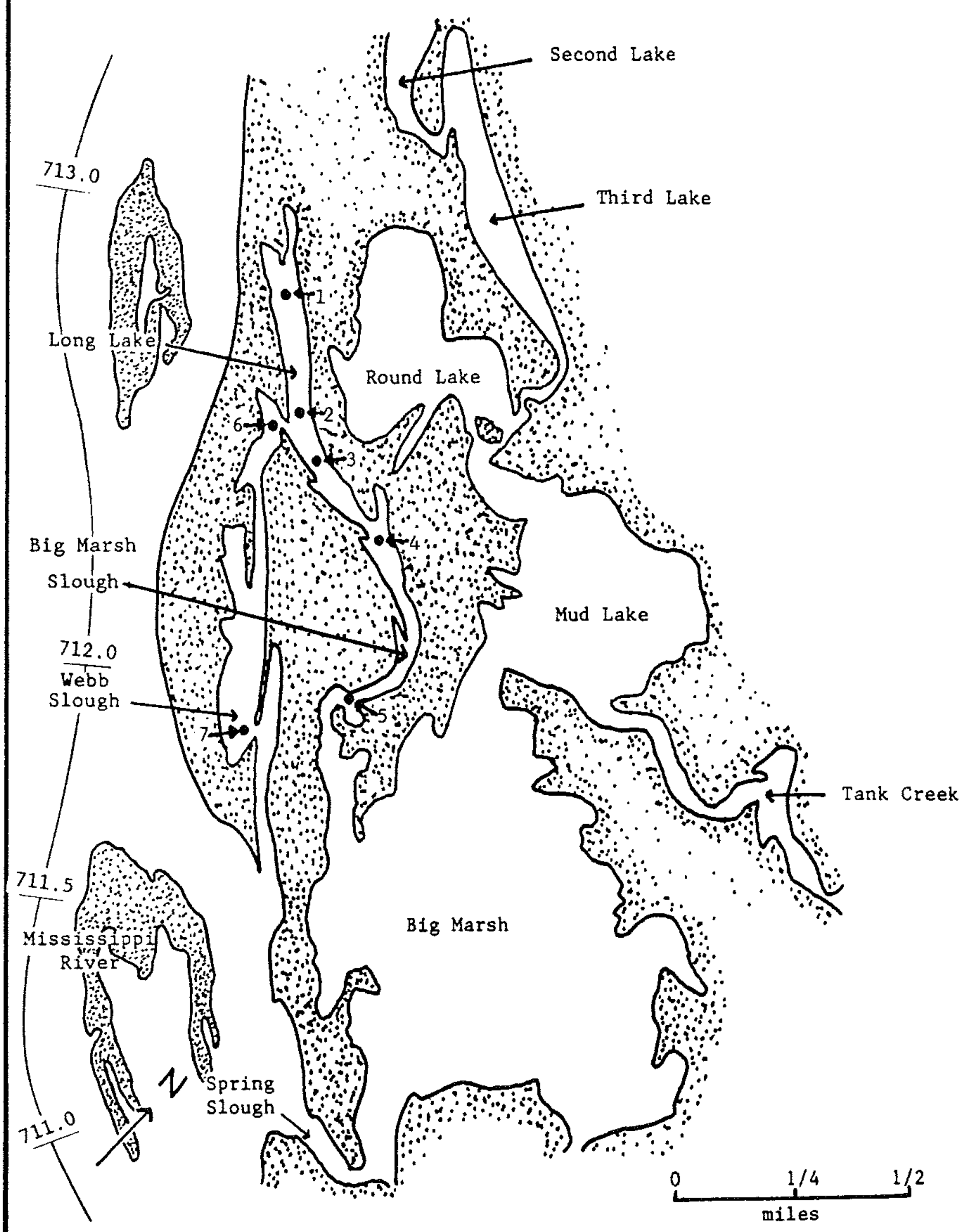


Figure A-14

Location of WDNR stations where Ice Thickness was Obtained in the Project Area

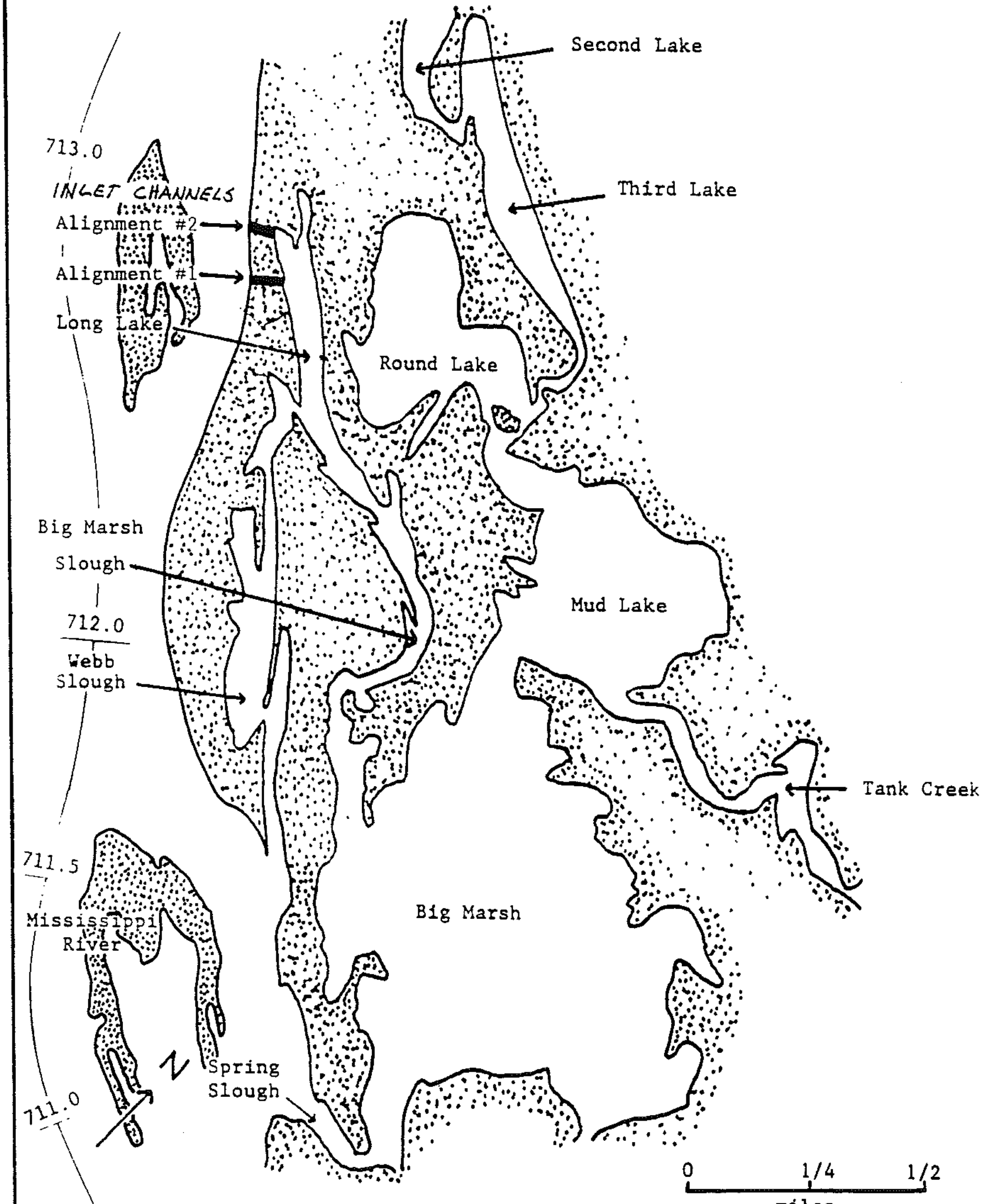


Figure A-15

Plan View of Project Features

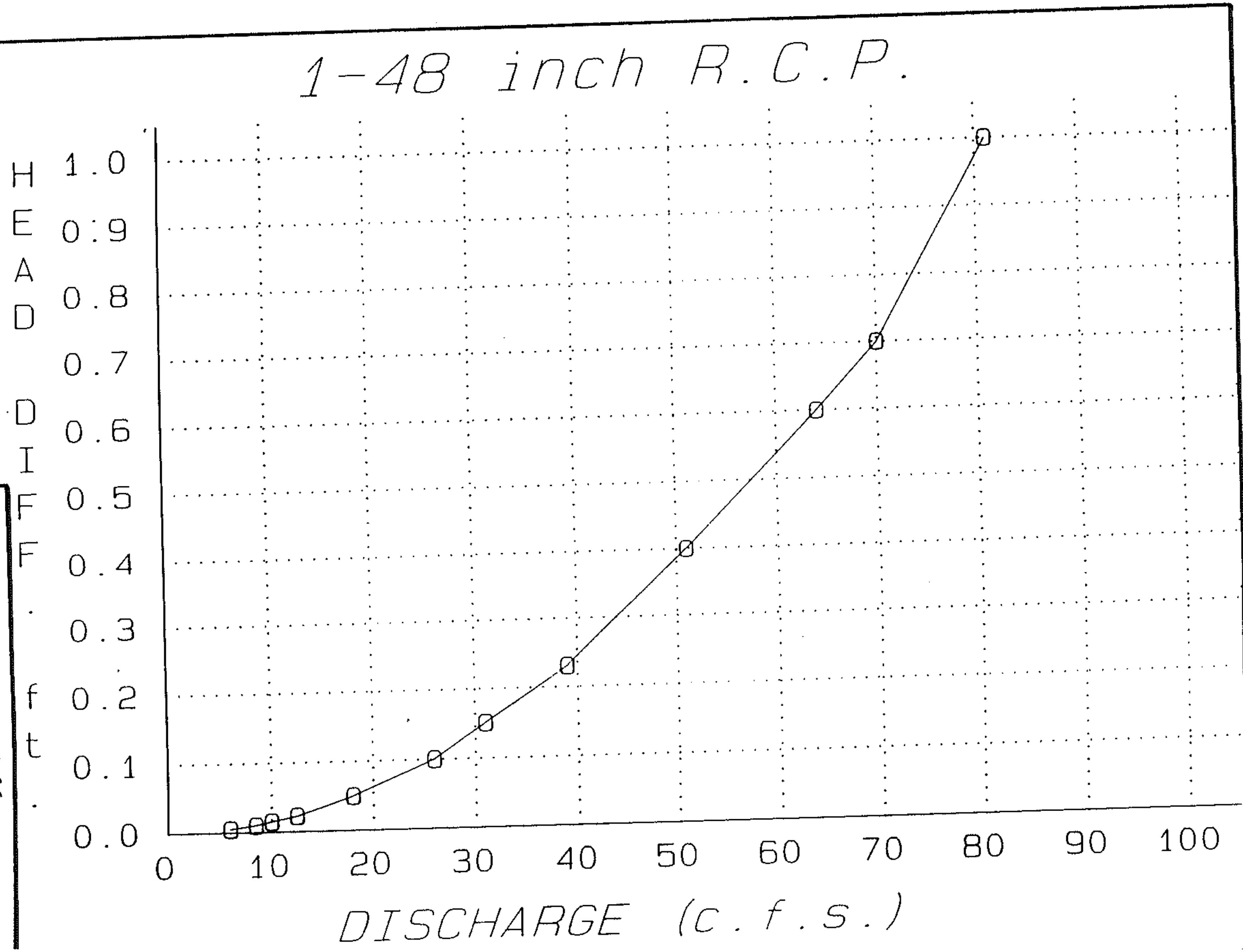


Figure A-16
Project Discharge versus Head Differenti
from Mississippi River to Long Lake

Attachment 5

Coordination/Distribution List

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Upper Mississippi River Refuge Complex
51 East 4th Street
Winona, Minnesota 55987

IN REPLY REFER TO:

May 15, 1991

Ms. Mary Schommer
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
180 E. Kellogg Boulevard
St. Paul, Minnesota 55101

Dear Ms. Schommer:

This provides U.S. Fish and Wildlife Service (Service) comments on the preliminary draft Definite Project Report and Environmental Documentation (SP-13) for the Long Lake Habitat Rehabilitation and Enhancement Project. This project will benefit the fishery resources of the Upper Mississippi River National Wildlife and Fish Refuge (Refuge).

The project is being built on federal lands managed as part of the Refuge, therefore, a Refuge compatibility determination and Refuge approval is required before the project can be constructed. The compatibility determination for the selected alternative discussed in this draft report is attached. Approval of the project will be formally provided by the Regional Director after completion of the final Definite Project Report (DPR).

The final draft DPR must include a copy of the draft Memorandum of Agreement for the operation, maintenance, and rehabilitation of this project. In accordance with the Fifth Annual Addendum, the Service will cover operation and maintenance costs as discussed in this report. The Regional Director's letter on the final draft DPR will include the certification of support for operation and maintenance.

Before construction of the project occurs a permanent access easement must be obtained. Actions toward obtaining the necessary access easements should get started in the near future.

Page 34, Real Estate Requirements, states the land ownership incorrectly. The land in question is owned by the Corps and managed by the Service.

Based on information contained in the review documents and the nature of the proposed project, its location, and the habitat requirements of the federally threatened bald eagle (*Haliaeetus leucocephalus*), endangered Higgin's eye pearly mussel (*Lampsilis higginsi*), and peregrine falcon (*Falco peregrinus*), we support your determination that the proposed project will not affect federally listed endangered or threatened species. This precludes the need for further action on this project as required under Section 7 of the Endangered Species Act of 1973, as amended. Should this project be modified or new information indicate that the listed species may be affected, consultation with the Service's Twin Cities Field Office should be reinitiated.

These comments are provided under the authority of and in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the Endangered Species Act of 1973, as amended, and the Service's Mitigation Policy, and are consistent with the intent of the national Environmental Policy Act of 1969.

This report illustrates the cooperation evident between the U.S. Army Corps of Engineers and the Service. These efforts at working together on this project, as well as the environmental management program as a whole, help ensure the success of mutual concerns for improvements on the Upper Mississippi River System.

Sincerely,

Richard F. Berry

Richard F. Berry
Complex Manager

Enclosure

cc: TCFO, Bloomington
LTRM, Onalaska
FAO, Winona
WDNR, La Crosse
La Crosse District
R.O.--SS
MDNR, Lake City

UPPER MISSISSIPPI RIVER NATIONAL
WILDLIFE AND FISH REFUGE
Established 1924

Compatibility Study
LONG LAKE HABITAT REHABILITATION PROJECT

Establishment Authority:

Public Law No. 268, 68th Congress, The Upper Mississippi River Wildlife and Fish Refuge Act.

Purpose for Which Established:

"The refuge shall be established and maintained (a) as a refuge and breeding place for migratory birds included in the terms of the convention between the United States and Great Britain for the protection of migratory birds, concluded August 16, 1916, and (b) to such extent as the Secretary of Agriculture may, by regulations, prescribe, as a refuge and breeding place for other wild birds, game animals, fur-bearing animals, and for the conservation of wild flowers and aquatic plants, and (c) to such extent as the Secretary of Commerce may, by regulations, prescribe a refuge and breeding place for fish and other aquatic animal life."

Description of Proposed Use:

The proposal is a Habitat Rehabilitation and Enhancement project authorized by the Water Resource Development Act of 1986 (Pub. L. 99-662). The project will be constructed in Long Lake, a backwater lake located on the Wisconsin side of the main channel of the Upper Mississippi River between R.M. 712 and 713. The lake lies approximately 1.5 miles downstream of Lock and Dam 6. The nearest city is Trempealeau, Wisconsin, located immediately adjacent to the lock and dam.

The physical characteristics of Long Lake in terms of water depths and protection from current are such that the lake would provide above average backwater fish habitat if a dissolved oxygen problem did not exist. During summer, and especially the winter, the lake suffers from severe dissolved oxygen depletion events. This limits the use of the habitat by fish and other aquatic life. The habitat goal of this project is to eliminate as much as possible this dissolved oxygen depletion as a limiting factor on the habitat quality of the lake for fish.

The project consists of construction of a culvert/channel system from an Upper Mississippi River side channel to Long Lake which would supplement flows (and dissolved oxygen) into the lake. Most of this system would be an open channel with a single gated culvert to control the amount of water that could enter the lake.

The channel would have a bottom width of about 10 feet, 1 vertical on 2.5 horizontal side slopes and would have a bottom elevation of 634 feet

(NGVD, 1912). The bottom width was selected to keep head losses at a minimum through the inlet channel. The alignment for the channel follows the Federal property line as closely as possible while trying to take maximum advantage of the surrounding topography in order to minimize costs. Therefore, the channel would be constructed along existing depressions for portions of its length. It is estimated that 10,200 cubic yards of material would be excavated in order to construct the proposed channel.

More details of the project, including maps and engineering drawings are contained in the draft report entitled, "Upper Mississippi River System Environmental Management Program Definite Project Report With Integrated Environmental Assessment (SP-13) Long Lake Habitat Rehabilitation and Enhancement, Pool 7, Upper Mississippi River, Trempealeau and La Crosse Counties, Wisconsin," prepared by the St. Paul District, Corps of Engineers.

Anticipated Impacts on Refuge Purposes:

As a result of the project fish populations should increase which will be a direct benefit toward maintaining and accomplishing refuge purposes. The above-mentioned report contains detailed information on the project's impacts.

Justification:

The proposed project works toward the accomplishment of the stated objectives of the refuge.

Determination:

The proposed project is compatible with purposes for which the refuge was established.

Determined by: James R. Lennartson — Project Leader — Date: 3/18/91

Richard F. Berry — Complex Manager — Date: 3/18/91

Reviewed by: Ed Crozier — WAM 1 — Date: 3/26/91

Concurred by: [signature] — Regional Director — Date: 3/28/91

RECEIVED
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FISH & WILDLIFE SERVICE
UPPER MISS. RIVER NWL & FR

FWS/ARW-SS

MAY 8 - 1991

Colonel Roger L. Baldwin
District Engineer
U. S. Army Engineering District, Saint Paul
1421 U. S. Post Office and Custom House
Saint Paul, Minnesota 55101-1479

Dear Colonel Baldwin:

Thank you for your letter dated March 29, 1991, requesting our comments on the draft Definite Project Report/Environmental Assessment (SP-13), "Long Lake Habitat Rehabilitation and Enhancement Project." This project would be located on the Wisconsin side of Pool 7 at Mississippi River miles 712-713. The Refuge Manager, Upper Mississippi River National Wildlife and Fish Refuge, will be providing additional comments for your consideration.

The Fish and Wildlife Service (Service) will assure operation and maintenance requirements of the project will be accomplished in accordance with Section 906(e) of the Water Resources Development Act of 1986, provided a permanent access easement is obtained. Actions toward obtaining the necessary access easements should get started in the near future. In accordance with the policies stated in the Fourth Annual Addendum, the Service will perform the operation and maintenance requirements for this project as listed on pages 29-30.

This project is located on refuge lands. Therefore, the Service will complete a finding of no significant impact upon learning from you that the public review period produced no substantive changes in the Definite Project Report/ Environmental Assessment.

We look forward to continued cooperative efforts in developing habitat rehabilitation and enhancement projects under the Environmental Management Program.

Sincerely,

Thomas J Kerze
Acting Regional Director

bcc: ✓UMR
SS
AFWE

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny, Secret
Box 792.
Madison, Wisconsin 53707
TELEFAX NO. 608-267-2750
TDD NO. 608-267-6897

April 3, 1991

IN REPLY REFER TO: 1490

Colonel Roger L. Baldwin
District Engineer
U. S. Army Corps of Engineers, St. Paul District
1421 U. S. Post Office & Custom House
St. Paul, MN 55101-1479

Dear Colonel Baldin:

The Wisconsin Department of Natural Resources supports construction of the Long Lake Habitat Rehabilitation and Enhancement Project as described in the draft Long Lake Definite Project Report. This project is located on National Wildlife System lands. However, I understand you still require a letter of support from our department.

Upon completion and final acceptance of the project by the Corps of Engineers and the Fish and Wildlife Service, the Wisconsin Department of Natural Resources will cooperate with the Fish and Wildlife Service to assure that operation and maintenance, as described in the Definite Project Report, and any mutually agreed upon rehabilitation, will be accomplished in accordance with Section 906(e) of the Water Resources Development Act of 1986 and the current guidance contained in the Fifth Annual Addendum, May 1990, Attachment 4, Section III, A, 7 (pp. 19-20).

I look forward to seeing the project completed and the benefits it will provide to the Mississippi River System.

Sincerely,

CD Besadny

C. D. Besadny
Secretary

cc: James Gritman - USFWS
District Director - WD
Terry Moe - La crosse
Doug Fendry - PM/4

APR 15 1991

Berwick

THE STATE HISTORICAL SOCIETY OF WISCONSIN

H. Nicholas Muller III, Director

816 State Street
Madison, Wisconsin 53706
608/262-3266

January 18, 1991

Mr. Robert J. Whiting
St. Paul District, Corps of Engineers
1421 U.S. Post Office and Custom House
St. Paul, Minnesota 55101-1479

SHSW: 88-1671
RE: EMP Funded Long Lake-Spring Slough

Dear Mr. Whiting:

We have reviewed the report entitled, "A Phase I Cultural Resources Investigation Of A Proposed Channel Excavation Near Long Lake, Trempealeau and La Crosse Counties, Wisconsin," prepared by Mr. Randall Withrow. The archeological survey procedures were both appropriate and thorough, and support the conclusion that there are no archeological sites eligible for listing on the National Register of Historic Places in the areas surveyed.

It is always possible that an accidental discovery of archeological material may occur during construction. If archeological material is discovered, please stop all construction in that area and call me directly at 608-262-2970. Should human bone be discovered you must contact the Burial Sites Preservation Office at 1-800-342-7834 for compliance with S157.70, Wis.Stats. which provides for the protection of human burial sites.

This completes our review of this project with this letter constituting our final comments. Thank you for your cooperation in considering cultural resources in the development of this project. If your project plans are modified in the future, please submit the revised plan for review and allow us an opportunity to comment. Please contact me at the number referenced above if I can provide any additional assistance.

Sincerely,

Jennifer L. Kolb
Archeologist, Compliance Section
DIVISION OF HISTORIC PRESERVATION

cc: Dave Berwick

Attachment 6

Memorandum of Agreement

MEMORANDUM OF AGREEMENT

BETWEEN

THE UNITED STATES FISH AND WILDLIFE SERVICE

AND

THE DEPARTMENT OF THE ARMY

FOR

ENHANCING FISH AND WILDLIFE RESOURCES

OF THE

UPPER MISSISSIPPI RIVER SYSTEM

AT THE

LONG LAKE

TREMPEALEAU AND LACROSSE COUNTIES, WISCONSIN

I. PURPOSE

The purpose of this Memorandum of Agreement (MOA) is to establish the relationships, arrangements, and general procedures under which the U.S. Fish and Wildlife Service (FWS) and the Department of the Army (DOA) will operate in constructing, operating, maintaining, repairing, and rehabilitating the Long Lake separable element of the Upper Mississippi River System - Environmental Management Program (UMRS-EMP).

II. BACKGROUND

Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662, authorizes construction of measures for the purpose of enhancing fish and wildlife resources in the Upper Mississippi River System. The project area is located on lands managed as a national wildlife refuge. Therefore, under conditions of Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, all construction costs of those fish and wildlife features for the Long Lake Project are 100% Federal, and all operation, maintenance, repair, and rehabilitation costs are to be cost shared 75% Federal and 25% non-Federal.

III. GENERAL SCOPE

The Long Lake project would introduce flow into the lake thereby increasing dissolved oxygen. This would improve fish habitat in the lake which currently suffers both wintertime and summertime dissolved oxygen deficiencies.

IV. RESPONSIBILITIES

A. DOA is responsible for:

1. Construction: Construction of the Project which consists of sharing in the excavating a channel and building a gated control structure.

2. Major Rehabilitation: The Federal share of any mutually agreed upon rehabilitation of the project that exceeds the annual operation and maintenance requirements identified in the Definite Project Report and that is needed as a result of specific storm or flood events.

3. Construction Management: Subject to and using funds appropriated by the Congress of the United States, DOA will construct the Long Lake project as described in the Definite Project Report, Long Lake, Habitat Rehabilitation and Enhancement, dated July 1991, applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The FWS will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. If DOA encounters potential delays related to construction of the Project, DOA will promptly notify FWS of such delays.

4. Maintenance of Records: DOA will keep books, records, documents, and other evidence pertaining to costs and expenses incurred in connection with construction of the Project to the extent and in such detail as will properly reflect total costs. DOA shall maintain such books, records, documents, and other evidence for a minimum of three years after completion of construction of the Project and resolution of all

relevant claims arising therefrom, and shall make available at its offices at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the FWS.

B. FWS is responsible for:

1. Operation, Maintenance, and Repair: Upon completion of construction as determined by the District Engineer, St. Paul, the FWS shall accept the Project and shall operate, maintain, and repair the project as defined in the Definite Project Report entitled "Long Lake Habitat Rehabilitation and Enhancement," dated July 1991, in accordance with Section 906(e) of the Water Resources Development Act, Public Law 99-662.

2. Non-Federal Responsibilities: In accordance with Section 906(e) of the Water Resources Development Act, Public Law 99-662, the FWS shall obtain 25% of all costs associated with the operation, maintenance, and repair of the Project from the Wisconsin Department of Natural Resources.

V. MODIFICATION AND TERMINATION

This MOA may be modified or terminated at any time by mutual agreement of the parties. Any such modification or termination must be in writing. Unless otherwise modified or terminated, this MOA shall remain in effect for a period of no more than 50 years after initiation of construction of the Project.

VI. REPRESENTATIVES

The following individuals or their designated representatives shall have authority to act under this MOA for their respective parties:

FWS: Regional Director
U.S. Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

DOA: District Engineer
U.S. Army Engineer District, St. Paul
1421 U.S. Post Office and Custom House
St. Paul, Minnesota 55101-9808

VII. EFFECTIVE DATE OF MOA

This MOA shall become effective when signed by the appropriate representatives of both parties.

THE DEPARTMENT OF THE ARMY

BY:

(signature)
RICHARD W. CRAIG
Colonel, Corps of Engineers
St. Paul District

Date

THE U.S. FISH AND WILDLIFE SERVICE

BY:

(signature)
JAMES C. GRITMAN
Regional Director
U.S. Fish and Wildlife Service

Date

Attachment 7

Performance Evaluation Plan

LONG LAKE
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
PROJECT PERFORMANCE EVALUATION PLAN

INTRODUCTION

Description of Project Area

Long Lake is a 21.6-acre backwater lake located on the Wisconsin side of the Upper Mississippi River in the upper reaches of pool 7. The lake is connected to the river by Webb Slough, and by a series of other sloughs and marshes exiting to the river via Spring Slough. Long Lake is long and narrow, with typical depths in the 5 to 7-foot range, and a maximum depth of 13 feet. The lake has a relatively small littoral zone around it's perimeter.

Existing Habitat Conditions

Long Lake suffers from dissolved oxygen depletion during the late summer (July-August), and during the winter. This is the primary limiting factor that prevents the lake from being high quality habitat for backwater fish species such as black crappie, largemouth bass, and bluegill.

Project Objective for Habitat Improvement

The proposed plan of improvement is to introduce water to Long Lake from the Upper Mississippi River via a constructed channel. The objective is to provide 5 mg/l or greater dissolved oxygen in the upper one-third of the lake's water column during the critical late summer and winter periods.

MONITORING PLAN

Parameters to be Measured

The primary parameter to be measured is dissolved oxygen concentration. Water temperature is an important ancillary measurement and will be monitored concurrently with dissolved oxygen.

During the winter current can have a marked effect on habitat useability by backwater species. Because flow will be introduced into Long Lake by the proposed project current velocity measurements will be collected to determine project effects on this important parameter.

Measurement Methodology

Summer dissolved oxygen measurements will be taken using a continuous monitor, supplemented by readings using a portable dissolved oxygen meter. Both the continuous monitor and the portable meter have the capability to take temperature measurements.

Winter dissolved oxygen and temperature measurements will be taken using a portable dissolved oxygen meter. Current velocity measurements will be taken with a portable current meter.

Spatial Monitoring Design

The spatial monitoring design has not been developed at this time. This will be accomplished once the final design of the project has been completed. At present two options are being considered. The first is to establish fixed stations along transects perpendicular to the long axis of the lake. The second option is to establish stations along transects radiating from the point where the introduced flow enters Long Lake.

The summer continuous dissolved oxygen monitor would be located within one meter of the surface at a fixed station. The readings at the other stations would consist of surface to bottom profiles for both dissolved oxygen and temperature.

The winter dissolved oxygen and temperature readings would be taken within one foot of the bottom, at mid-depth, and immediately below the ice at each station.

The current velocity measurements would be taken at fixed stations. A current profile from surface to bottom would be taken at at least one station. The need for additional measurements would be determined in the field.

Temporal Monitoring Design

Daily - The continuous monitor used for summer dissolved oxygen monitoring would operate around the clock. The spot readings taken at the other stations would be taken in the early mornings at the low point of the daily diel dissolved oxygen fluctuation.

Winter dissolved oxygen measurements would be taken in the morning to reflect the low point of what diel dissolved oxygen fluctuation may be present (if any).during the winter.

Seasonal - Summer monitoring would take place during one week in late July-early August as this is the most critical open water period for dissolved oxygen.

Winter monitoring would begin as soon as ice conditions permit and continue until spring breakup. Sampling would take place every three weeks unless conditions would indicate more frequent sampling was necessary.

Products to be Used for Project Evaluation

The dissolved oxygen data will be used to evaluate how effective the introduced flows are at reducing or eliminating dissolved oxygen depletion below the 5 mg/l level in Long Lake. Maintaining 5 mg/l or greater dissolved oxygen in the upper 1/3 of the water column over the entire lake would be considered 100 % success in terms of meeting the project objective.

MONITORING SCHEDULE

This schedule is based on the assumption that the project would be constructed during the summer of 1993.

Winter Dissolved Oxygen Monitoring - This monitoring would occur during the winters of 1993-94, 1994-95, and 1995-96.

Winter Current Velocity Monitoring - This moniroitng would occur during the winter of 1993-94. The need for further current velocity monitoring would be evaluated at that time.

Summer Dissolved Oxygen Monitoring - This monitoring would occur during the summers of 1994, 1995, and 1996.

SCHEDULE OF PROJECT EVALUATION REPORTS

Interim reports would be prepared for the 1995 and 1996 Annual Addendums. A final evaluation report would be completed December 1996.

COST ESTIMATE

This cost estimate (December 1990 dollars) is based on the Corps of Engineers operating out of the St. Paul District Office doing all of the monitoring. A two-person field crew was assummed. The winter monitoring estimate assumes five samplings per winter.

Summer Monitoring (one year)

Preparation time	$ 960
Field time (including travel)	3,200
Mileage, per diem	700
Equipment service	640
	$5,500

Winter Monitoring (one year)

Preparation time	$2,400
Field time (including travel)	6,400
Mileage, per diem	1,500
Equipment service	320
	$10,620

Summary

Summer monitoring (3 years)	$16,500
Winter monitoring (3 years)	31,860
1994 Interim Report	1,000
1995 Interim Report	1,000
1996 Final Report	3,200
Total Cost	$53,560

It is expected that the cost of monitoring would be substantially reduced if conducted by LTRM or State personnel located in the area.

COMMITTTMENTS FOR CONDUCT OF MONITORING

The St. Paul District is responsible for insuring that the monitoring takes place and the reports are prepared. The field monitoring is likely to be contracted or conducted by other agency personnel under an interagency agreement.

Attachment 8

Detailed Cost Estimate

NARRATIVE REPORT FOR

LONG LAKE EMP, DEFINITE PROJECT REPORT

POOL 7, UPPER MISSISSIPPI RIVER, TREMPEALEAU, WISCONSIN

1. <u>DESCRIPTION OF PROJECT</u>. This project is for construction of a channel and control structure to permit controlled flow from the river to the upper end of Long Lake. The control structure is reinforced concrete pipe with a gatewell and sluice gate. Access for construction is available by land. Temporary easements will be required.

2. <u>CONSTRUCTION METHODS</u>.

a. Channel. The work is routine excavation. Access by land is available. Cleared and grubbed materials can be left at the site. An excavator can load directly into trucks for haul to disposal. Maximum depth is approximately 1 foot below normal low pool. Disposal will be less than 5 miles from the site. The material is assumed to be sand and silts, rock is not expected.

b. Control Structure. The work is routine concrete and drainage construction. Dewatering will be required.

<u>UNIT COST ANALYSIS</u>. Unit costs have been derived based on labor, equipment and material costs.

4. <u>PLANNING, ENGINEERING, DESIGN AND CONSTRUCTION MANAGEMENT COSTS</u>. Amounts shown are based on estimates of time and materials. Estimates for the cost of this work have been done, or have been reviewed by the appropriate Section or Branch Chiefs.

5. <u>CONTINGENCY ANALYSIS</u>. The contingencies shown were arrived at as follows:

a. Excavation, fill quantities are from recent survey of the area. 15% used for quantity variations, 10% for unit price variations (primarily disposal.)

b. Dewatering is 50% to account for typical unknowns.

c. Concrete structures and drainage pipe, 25% to account for uncertainties in design and unit prices.

ED-C(WMO) LONG LAKE EMP, DPR ESTIMATE 2/25/91

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	CONTINGENCIES PERCENT	REASON
01.D.-.-	ACQUISITION							
01.D.-.-	ACQUISITION - FEDERAL REVIEW/ASSISTANCE	JOB	1	6,000.00	6,000	1,200	20%	1,2
01.M.-.-	PAYMENTS							
01.M.3.-	LAND PAYMENTS	OSP	1	1,200.00	1,200	200	20%	1,2
09.0.A.-	MOBILIZATION/DEMOBILIZATION & SITE PREP	JOB	1	1,500.00	1,500	400	26.7%	1,2
09.0.2.-	CHANNEL							
09.0.2.B	CLEARING AND GRUBBING	ACRE	1.4	2,500.00	3,500	900	25.7%	1,2
09.0.2.B	EXCAVATION	CY	10,200	4.00	40,800	10,200	30.0%	1,2,3,4
09.0.2.B	REINFORCED CONC CULVERTS (48" DIAM.)	LF	74	80.00	5,900	1,500	25.4%	1,2
09.0.2.B	RCP END SECTIONS (48" DIAM.)	EA	2	800.00	1,600	400	25.0%	1,2
09.0.2.B	ADD TO RCP FOR DEWATERING AND ROCK	LF	74	20.00	1,500	800	53.3%	1,2,4
09.0.2.C	CONCRETE GATEWELL	CY	40	300.00	12,000	3,000	25.0%	1,2
09.0.2.C	ADD FOR DEWATERING	JOB	1	5,000.00	5,000	2,500	50.0%	1,2,4
09.0.2.C	SLUICE GATE	EA	1	10,000.00	10,000	2,500	25.0%	1,2
09.0.2.B	BACKFILL FOR PIPE AND STRUCTURE	CY	1,500	3.00	4,500	1,100	24.4%	1,2
09.0.2.E	MISCELLANEOUS METALS	JOB	1	1,000.00	1,000	300	30.0%	1,2
09.0.2.E	ALUMINUM STOP LOGS AND HOOKS	JOB	1	4,000.00	4,000	1,000	25.0%	1,2
09.0.2.E	CHAIN LINK FENCE, 5' HIGH	LF	36	30.00	1,100	300	27.3%	1,2
09.0.2.E	TRASH GUARD, 48" RCP END SECTION	EA	2	1,800.00	3,600	900	25.0%	1,2
16.-.-.-	BANK STABILIZATION							
16.0.1.B	SEEDING	ACRE	1.0	2,500.00	2,500	600	24.0%	1,2
16.0.1.B	BEDDING FOR RIPRAP	CY	65	20.00	1,300	300	23.1%	1,2
16.0.1.B	RIPRAP	CY	125	30.00	3,800	1,000	26.3%	1,2
30.-.-.-	PLANNING, ENGINEERING AND DESIGN	JOB	1	53,300.00	53,300	5,300	9.9%	1
31.-.-.-	CONSTRUCTION MANAGEMENT	JOB	1	14,200.00	14,200	0	0.0%	1
	SUBTOTAL				178,300			
	CONTINGENCIES				19.3%	34,400		
	TOTAL					$212,700		

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REASONS FOR CONTINGENCIES

1. QUANTITY UNKNOWNS
2. UNIT PRICE UNKNOWNS
3. DISPOSAL AREA UNKNOWN
4. UNKNOWN SITE CONDITIONS

NOTES

1. SITES CAN BE ACCESSED BY LAND