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US Army Corps
of Engineers
St. Paul District

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM

DEFINITE PROJECT REPORT
ENVIRONMENTAL ASSESSMENT (SP-9)

LANSING BIG LAKE

HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 9
UPPER MISSISSIPPI RIVER
ALLAMAKEE COUNTY, IOWA

MARCH 1991

TABLE OF CONTENTS

(Continued) - TABLE OF CONTENTS

(Continued) - TABLE OF CONTENTS

PLATES (Continued)

List of Tables

List of Attachments

EXECUTIVE SUMMARY

This study concentrates on 9,755 acres of backwaters, known as Lansing Big Lake, located in pool 9 of the Upper Mississippi River between river miles 664 and 670. The Lansing Big Lake area provides valuable and highly productive habitat for wildlife, including waterfowl, wading birds, muskrats, eagles, and a variety of fish. This backwater area is especially critical as a resting and feeding area during migration for diving ducks, tundra swans, Canada geese, and other waterfowl.

Since inundation in the 1930's, there is documented evidence that sediment has filled in aquatic habitat in the Lansing Big Lake backwater area which has resulted in a dramatic loss of important aquatic habitat and an increase in less valuable marsh and bottomland forest habitat. It is projected that if historical habitat conversion rates continue, by the year 2040, existing aquatic habitat in the Big Lake area will decline by over 35%. However, there is evidence that the side channel openings which allow sediments to enter the backwaters are now eroding at a rapid rate which is allowing increasing amounts of sediment to enter and be deposited in the backwaters. The accumulative loss in aquatic habitat in the Lansing Big Lake area is a serious threat to fish and wildlife.

In order to meet the overall goal of preserving and enhancing the existing aquatic habitat in the Lansing Big Lake area, it was determined that remedial actions should be taken to reduce the rate of backwater sedimentation. The plan formulation process considered a number of possible measures and then evaluated in detail 5 alternative plans for reducing sediment inflows to the project area. These alternatives presented an array of plans for reducing and stabilizing backwater inflows and evaluated the outputs and environmental effects of each plan. The selected plan, alternative #5, was found to best meet the project goal and objectives with miniminal adverse environmental effects. Construction of the selected plan would effectively return the Big Lake backwater inflow capacity to a pre-1980 condition and prevent further future side channel erosion. The selected plan reduces the sediments that are allowed to enter the Lansing Big Lake area by constructing side channel closures at 7 existing side channel openings and by stabilizing 3 side channels with rock liners. These structures are designed to restrict the inflows of sediment laden waters to the Lansing Big Lake backwaters up to an 80,000 cfs discharge on the Mississippi River which is equivalent to a 66% annual discharge frequency. By implementing the selected plan, 150 acres of critical aquatic habitat in the Lansing Big Lake area will be preserved during the project life (through year 2040). Beyond the project life, additional positive outputs of the project will also result. Specifically, at the end of the project life, the remaining aquatic habitat in Lansing Big Lake would be deeper. In addition to this, the sedimentation rate into the future years beyond 2040 would be substantially reduced as compared to the without project condition. This would result in project outputs benefiting fish and wildlife well beyond the year 2040.

Total direct construction costs of the selected project are $546,000. Indirect costs for advanced engineering and design work and construction supervision and administration bring the total cost to $694,300. Average annual operation and maintenance costs of the project are estimated to be $2,500 and would be the responsibility of the U.S. Fish and Wildlife Service, in cooperation with the non-Federal sponsor, the Iowa Department of Natural Resources.

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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). This report includes the environmental assessment and Finding of No Significant Impact. The proposed project would be funded and constructed under the authorization. Section 1103 is summarized as follows:

<u>Section 1103. UPPER MISSISSIPPI RIVER PLAN</u>

(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, 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....

A design memorandum 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 which follow.

<u>Project Eligibility Criteria</u>

a. (First Annual Addendum). The Master Plan report... and 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 criterion should be that a direct relationship should exist between the project and the central problem as defined in the Master Plan; i.e., the sedimentation of backwaters and the side channels of the Upper Mississippi River System (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....

b. (Second Annual Addendum).

(1) 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.

(2) A number of innovative structural and nonstructural solutions that 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 and the U.S. Fish and Wildlife Service 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 Channel Maintenance Forum (CMF) 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 were 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 ranking was forwarded to the CMF for consideration of the broader policy perspectives of the agencies involved. The CMF submitted the coordinated ranking to the District and each agency officially notified the District of its views on the ranking.

The District then formulated and submitted a program consistent with the overall program guidance as described in the UMRS-EMP General Plan, Annual Addendums, and additional 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.

Past technical studies of the Big Lake area have shown substantial evidence that the Big Lake backwater area has a sedimentation problem. This has alarmed many river resource managers and has contributed to the interagency selection of the Lansing Big Lake project for habitat rehabilitation and enhancement.

Through this screening and selection process, the Lansing Big Lake project was recommended and supported as capable of providing significant habitat benefits because it would directly address the major problem of backwater sedimentation.

PARTICIPANTS AND COORDINATION

Participants in project planning included the Iowa and Wisconsin Departments of Natural Resources, the U.S. Fish and Wildlife Service (Upper Mississippi River Wildlife and Fish Refuge and Region 3 Office), and the St. Paul District, Corps of Engineers. The U.S. Fish and Wildlife Service was a cooperating agency throughout the process because: 1) the project would be located on refuge lands administered by the U.S. Fish and Wildlife Service (USFWS), and 2), the project would be operated and maintained by the USFWS. The USFWS is a cooperating agency as defined in regulations developed by the Council on Environmental Quality for the implementation of the National

Environmental Policy Act (40 CFR 1500-1508). The study participants met at the project site and other locations to discuss the details of the problem at Lansing Big Lake and to define specific project objectives. This information was documented in an interagency working paper known as the "Problem Appraisal Report". Additional interagency meetings were then conducted and correspondence was transmitted between the agencies to coordinate formulation of solutions to the problems at Big Lake. Documentation of these efforts was contained in rough drafts of this Definite Project Report which were sent to the USFWS and the States of Iowa and Wisconsin for review and comment. The comments received and the results of meetings with these agencies were used to identify and refine the selected plan and prepare this report.

PROJECT LOCATION

The project area is located in the northeastern corner of Iowa in Allamakee County (see plate 1 for vicinity map). The project area encompasses Big Lake and the associated backwaters that surround Big Lake (see plate 2). This area is referred to by a variety of names including: Lansing Big Lake area, Lansing Big Lake backwaters, Lansing Big Lake complex, Big Lake backwaters, Big Lake bottoms, and Big Lake area. For this report, the name Lansing Big Lake area will be most frequently used.

The Lansing Big Lake area is relatively large, extending from river mile (RM) 664 to river mile 670 and approximatedly 3 miles wide. This project area includes 9,755 acres. The project area is bounded on the west by Highway 26, on the east and south by the main channel of the Mississippi River, and on the north by the Upper Iowa River.

PROJECT SCOPE

The primary focus of the Lansing Big Lake project is to protect and preserve existing high quality backwater habitat from future cumulative degradation associated with ongoing backwaters sedimentation. The historic sedimentation rate in Lansing Big Lake has averaged between 0.5 inch and 1.0 inch per year (Aspelmeier, pers comm, Eckblad, 1981). Previous studies have estimated that approximately 1,000 acres of aquatic habitat was converted from open water to emergent aquatic or terrestrial habitat from 1937 to 1973 (source: GREAT 1, 1980). Since 1973, resource managers have observed that increased sedimentation has occurred in the project area (see plate 3 for display of this trend).

In very general terms, this study formulated and evaluated a combination of features, such as dikes/levees, side channel closures and partial closures, and sediment traps that would decrease the amount of sediments entering the Lansing Big Lake area from the Mississippi River and/or Upper Iowa River. These project structures/features could result in a decrease in the future sedimentation rate within Lansing Big Lake area and would, therefore help to preserve and/or enhance high quality aquatic habitat in the project area.

RESOURCE MANAGEMENT GOALS AND PLAN

Two resource master plans, prepared by the managing Federal agencies, have provided an overall management framework for most management decisions affecting the Lansing Big Lake area. The Corps of Engineers and the U.S. Fish and Wildlife Service jointly prepared the Land Use Allocation Plan for the Upper Mississippi River. This land use plan became the basis for the Corps of Engineers Master Plan for Public Use Development (Part III) and for the U.S. Fish and Wildlife Service's Refuge Master Plan for the Upper Mississippi Wildlife and Fish Refuge. The Land Use Allocation Plan designated most of the Big Lake backwater area as 'Wildlife Management' lands. This designation provides for fish and wildlife as the primary emphasis. This Land Use Plan reconfirmed previous agreements between the Corps of Engineers and the U.S. Fish and Wildlife Service which authorize the Fish and Wildlife Service to manage all Federal lands in the Big Lake area as part of the Upper Mississippi River National Wildlife and Fish Refuge. The Corps Master Plan for Public Use Development recommended that the Big Lake backwater area be managed for fish and wildlife and that no recreation facilities be developed in the Big Lake area. The Master Plan for Public Use Development recommended significant upgrading of the Blackhawk Park area located immediately upstream of and across the main channel from the project area.

The U.S. Fish and Wildlife Service's Refuge Master Plan specifically recommended that remedial action be taken in the Lansing Big Lake area to limit future backwater sedimentation. The Refuge Master Plan also established general management objectives to be followed when managing the entire Upper Mississippi River Wildlife and Fish Refuge. The refuge-wide management objectives that most directly apply to the Big Lake project area include:

+ Restore species that are in critical condition (e.g., canvasbacks) and achieve national population or distribution objectives.
+ Maintain or improve habitat of migrating waterfowl using the Upper Mississippi River.
+ Contribute to achievement of national population and distribution objectives identified in the North American Waterfowl Management Plan and flyway management plans.
+ Maintain and enhance, in cooperation with the States, the habitat of fish and other aquatic life on the Upper Mississippi River.

EXISTING CONDITIONS

PHYSICAL SETTING

Pool 9 was created in 1938 by Corps of Engineers construction of lock and dam 9. The pool extends over 31 miles and has the largest federally managed surface area of any pool in the Upper Mississippi River system. Wisconsin is located on the left descending riverbank and Minnesota and Iowa are on the right bank. The Mississippi River valley in this pool is about 1 to 3 miles wide and is bordered on either side by weathered bluffs. In the project reach, the main channel generally parallels the Wisconsin shoreline until the village of De Soto, where the channel swings toward the Iowa shoreline. The main channel abuts the Iowa shoreline at Lansing, Iowa, where it then turns south and follows the Iowa shoreline for some distance.

Within the project area, Lansing Big Lake is a large open body of water found near the downstream end of the study area. In the 1920's, an earthen dam was constructed in Lansing Big Lake (see plate 2 for the location of this dam). The remnants of this structure still exist and are now approximately 1 foot below the water surface at normal pool (Eckblad, 1977). The remainder of the project area is backwater bottoms comprised of an irregularly braided slough system dividing lowland marshes and floodplain forests/swamps.

Along the right bank of the Mississippi River is a long natural levee/island barrier which lies between the Mississippi River main channel and Lansing Big Lake and its associated backwaters. Plate 2 shows existing and historic project area features. This natural levee/island barrier is substantial in area but is only a few feet higher in elevation than the normal main channel water elevation. This natural barrier has numerous channels cut through it which allow water to flow from the main channel of the Mississippi River into the Lansing Big Lake backwaters (see side channel opening sites 1 through 15 on plate 2 for the specific locations of existing openings).

The Upper Iowa River now forms the northern boundary of the area. In 1959, a flood control channelization and diversion project altered the course of the Upper Iowa River channel from the Lansing Big Lake backwaters to its current discharge point into the Mississippi River immediately upstream of the Lansing Big Lake area. Note the old Upper Iowa River channel alignments as shown on plate 2.

WATER RESOURCES

Upper Mississippi River

The Mississippi River is the most significant water resource associated with this project. Pool 9 of the Mississippi River is approximately 31 river miles in length with an average pool elevation of 620.0 feet. The pool has a meandering outer perimeter shoreline length of approximately 90 miles. The water surface slope of pool 9 is approximately 0.00003 ft/ft. Water quality in this pool is relatively good and supports diverse uses of the resource.

Lansing Big Lake is the largest backwater lake in pool 9. Although the lake is a natural body of water that predates the construction of pool 9, it became about 78 percent larger in size with construction of lock and dam 9. According to Eckblad's studies (done in 1973), Lansing Big Lake proper has approximately 630 acres of open water, is shallow with a mean depth of about 35 inches and a maximum depth of approximately 75 inches, and has a volume of only 1,842 acre-feet of water. Today, Lansing Big Lake is somewhat shallower and smaller due to continued sedimentation.

Lansing Big Lake has a relatively short residence time of 10.9 hours and the water quality is usually relatively good. It is affected by wind driven wave action which has resulted in some lakeshore erosion. The lake and its associated backwater areas are too shallow and windblown to stratify.

The numerous side channel openings that connect the Lansing Big Lake backwaters to the Mississippi River main channel vary greatly in width and depth; some are over 100 feet wide and have depths greater than 30 feet and others resemble small seasonal creeks. For Mississippi River discharges up to approximately a 1- year flood event (80,000 cfs), most of the inflows enter the backwaters through these sloughs. During Mississippi River discharges in excess of 80,000 cfs, portions of the natural levee are overtopped and flows into the project area occur at many sites. Four major sloughs exist in this backwater area: Big Slough at RM 670.6 (site 1); Little Slough at RM 670.1 (site 2); an unnamed slough at RM 669.5 (site 6); and Hummingbird Slough at RM 666.1 (site 15). These four sloughs account for 25 percent of total Mississippi River flow when the river is at a 60,000 cfs flow and 16 percent when the river is at a 30,000 cfs flow.

Historically, Big Slough (site 1) has been the largest slough into the Lansing Big Lake area. In recent years, the size and capacity of other side-channel openings leading into the Lansing Big Lake backwaters have gradually increased, and now allow more water to enter the backwaters. Specifically, the unnamed slough located at RM 669.5 (site 6) has eroded and enlarged to the point where it now accounts for most of the increase in flow to the Big Lake backwaters. Aerial photographs taken in 1984 compared to 1975 aerial photographs show a dramatic increase in width of this slough. This increase is substantiated by discharge measurements taken in 1989. Based on hydraulic evaluations (see appendix A for details), a 5% to 10% increase in side channel discharges leading into the Lansing Big Lake backwaters has occurred in the past decade. Most of this increase is attributable to the increased size of site 6. However, site inspections and review of historical mapping and photographs show that Little Slough (site 2) has also eroded in recent years.

Another large backwater area, known as Lake Winneshiek, is located on the Wisconsin side of the main channel. This backwater area is connected to the main channel of the Mississippi River through a number of side channel openings. The largest of these side channel openings is Winneshiek Slough. Winneshiek Slough has its confluence with the main channel at approximately river mile 666.1 which is across the river from Hummingbird Slough (site 15).

Upper Iowa River

The Lansing Big Lake area has historically been and continues to be strongly affected by the Upper Iowa River. Flows from the Upper Iowa River enter the backwaters in several ways. First, flood events on the Mississippi River cause high stages in the Upper Iowa River. In this instance, Upper Iowa River discharges will directly enter the Lansing Big Lake backwaters when the Mississippi River discharge exceeds 86,000 cubic feet per second (cfs). At this point, the tailwater on the Mississippi River causes the Upper Iowa River to overtop its right bank (at water surface elevation 626) and directly enter the Lansing Big Lake area.

Second, some flood events on the Upper Iowa River overtop the right bank of the Upper Iowa River; however, in most instances this corresponds with a high flow event on the Mississippi River.

Third, and most significant, Upper Iowa River flows enter the Mississippi River and then follow the right bank of the Mississippi River where portions of the flow are drawn into the side channels that lead into the Lansing Big Lake area. Lessons learned from studies done on pool 20 of the Mississippi River (Nakato and Kennedy, 1977) indicate that a high percentage of Upper Iowa River waters would be expected along the right bank of the Mississippi River throughout the study area. This is significant because the Upper Iowa River has higher sediment concentrations than those of the Mississippi River and water quality is not as good as that of the Mississippi River.

GEOLOGY AND SOILS

Geology

The most significant geologic event explaining the nature of the Mississippi River within pool 9 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 postglacial 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 impoundment of pool 9 in 1937, the river floodplain 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, and/or sands has been deposited over most of the river bottom within the pool. The depth of sedimentation is generally greater in the slow moving backwater areas than in the major sloughs and main channel portions of the impounded area.

Soils

The composition of the upper soil strata within the project area is expected to reflect the sediment carrying capabilities associated with differing flow velocities. Coarse-grained material (sand) is expected and has been observed within the higher velocity sloughs, while fine-grained material (silt and clay) is expected to predominate in the upper strata of the low velocity backwater areas. Coarse-grained material is also expected to predominate within the upper strata of the natural levee separating Lansing Big Lake from the main channel of the Upper Mississippi River.

Sediments

Rada, et al., (1980) did extensive sediment sampling in the project area. Sand, silt, and clay was found within defined sloughs, while finer silt and clay material was found in marshy backwater areas.

Field reconnaissance of the area during the present study showed that both coarse material and fine sediments contribute to sediment deposition in the Lansing Big Lake backwater area. In the extreme upstream end of Big Slough (first mile), coarse to fine sand, along with clay and organics, was found in the deposition area. Fine sand and silt was found along the thalweg of Big Slough for a distance of approximately 5 miles downstream from the Mississippi River main channel. This is approximately where Big Slough widens out into Lansing Big Lake. Sand size material was also found in several other sloughs.

Sediment samples that were taken from the area show that fine sediments are widely distributed in the open water areas of the Lansing Big Lake backwaters. Specifically, these fine sediments dominate the lake and the marshy areas off the main sloughs and are also found to some extent within the sloughs.

NATURAL RESOURCES

Habitat Types and Distribution

Pool 9 has a variety of high quality terrestrial and aquatic habitats. These habitats support a diverse and productive fishery and provide important waterfowl nesting, feeding, and resting areas. The Lansing Big Lake backwater area comprises 9,755 acres and is one of the major geographical components of the pool 9 system. A similar backwater area which is a geographically important component of pool 9 is Lake Winneshiek. As stated previously, Lake Winneshiek is located downstream of Lansing Big Lake and on the Wisconsin side of the main channel.

The upstream portion of the Lansing Big Lake backwater area is dominated by floodplain forest habitat intermixed with sloughs and shallow marshes. The lower portion of the area is more aquatic and is dominated by Big Lake proper, the largest backwater lake (630 acres) in the pool. This lower portion also contains numerous side channels, sloughs, submerged islands, nonflowing lakes and marshes, and ponds/depressions that are landlocked at normal pool levels. The entire Lansing Big Lake backwater system is one of the most productive natural systems on the Upper Mississippi River. The U.S. Fish and Wildlife Service and the Iowa Department of Natural Resources consider the Lansing Big Lake backwater area to be a critical component pool 9 and of the Upper Mississippi River National Wildlife and Fish Refuge. They view the conversion and degradation of the aquatic environments in the Lansing Big Lake area as having significant negative impacts on the refuge system.

Vegetation

The wide variety of floodplain and riverine habitats within the project area have allowed the development of a diverse vegetative assemblage. River birch and swamp oak are the dominant species at the upland edge of the floodplain. The mature floodplain forest areas, concentrated in the upstream project area, have an overstory dominated by green ash, silver maple, cottonwood, and river birch. The understory in these areas consists primarily of tree seedlings, alder, wood nettle, poison ivy, wild grape, and woodbine. In the less successionally developed transitional zones between aquatic and terrestrial habitat (e.g., sandbars and mudflat areas), dense stands of alder, small black willow and cottonwood trees are usually found.

The lentic, open water portions of the project area have a relatively productive planktonic community dominated by diatoms and green algae. The macrophytic assemblage in the backwater area was delineated by Minor in 1977. In his mapping, based primarily on aerial photography, Minor found that, along the margins of Lansing Big Lake, American lotus was the most dominant species. In other shoreline and protected areas, burweed, arrowhead, river bulrush, and wild celery were dominant. Submerged and floating plant species found in the project area included sago pondweed, coontail, water star grass, wild celery, lotus, and pond lilies. In previously open water areas that had filled in, particularly those located on the western side of the backwater complex, arrowhead and burweed are the dominant species.

Fish and Wildlife

The diverse and productive vegetative component of the system has led to the development of a rich animal assemblage. The benthos, dominated by Sphaeridae and Ephemeridae, is very productive and provides an excellent food source for other animals. Because of the abundant sources of food, an exceptional fishery has developed. Over 80 species of fish have been found in the backwater or nearby riverine environments. These species use the backwater area to supply some or all of their life requirements. Common sport fish species frequently found in the area are bluegill, black and white crappie, largemouth bass, and northern pike. This area also provides habitat for a variety of amphibians and reptiles.

The Lansing Big Lake area provides nesting and foraging habitat for many passerine bird species. Some of these species spend the entire year in the area, while others migrate into the area at various times of the year. The area is extremely valuable to migratory waterfowl because of its large production of food organisms and its geographical location on a major migratory flyway that overlays eastern and western ranges. Areas such as the Lansing Big Lake area provide critical resting and foraging opportunities for these migratory waterfowl. In the fall and spring, ring-necked ducks, canvasbacks, and scaup use the deeper areas of the backwater, while mallards, widgeon, blue-winged teal and wood duck use the shallower areas. Canvasbacks that use this area and other similar areas in pools 7, 8, and 9 have been estimated to represent up to 90 percent of the continental population of this species east of the Rockies. Most of the eastern population of tundra swans (approximately 80,000 birds) also use these areas in pools 7, 8, and 9 during their migrations. Many varieties of raptors use the river valley as a flyway, and a number of these species, such as eagles, hawks, and owls, overwinter in these floodplain areas.

The project area provides habitat to a wide variety of mammals. White-tailed deer use the area as a food source and a wintering area. Many small carnivores such as fox, raccoon, and weasel also use the area. Rodents such as beaver, muskrat, squirrel, and numerous varieties of mice are found in the area.

Endangered Species

The following species, included on the Federal list of threatened or endangered species, has been found in the project area: threatened - bald eagle (Haliaeetus leucocephalus); endangered - peregrine falcon (Falco peregrinus) and Higgins' eye pearly mussel (Lampsilis higginsi). The bald eagle is a frequent visitor to the area and, according to river managers, an active bald eagle nest was sighted in the project area in 1989. A number of eagles commonly overwinter in the project area. The Reno Bottoms complex, located upstream of the Lansing Big Lake area, is an established breeding area for the species. The falcon was formerly found throughout the Upper Mississippi River basin but was extirpated from the entire area. Although there have been recent attempts to reintroduce the species in more northern portions of the basin, no individuals of this species have been found in the project area. Mussel surveys conducted along extensive reaches of the main channel bordering the Lansing Big Lake area by Fuller in 1978 found no Higgins' eye mussels.

CULTURAL RESOURCES

Past surveys have shown many prehistoric and historic archaeological sites on islands in the Mississippi River. There are 91 known archaeological sites and 81 historic/architectural sites in pool 9. The entire reach of pool 9 has not been systematically surveyed for cultural resources and the potential for undiscovered archaeological sites is quite high. In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places has been consulted. As of 1 March 1990, there are no sites on or determined eligible for the Register in the project area.

RECREATION/AESTHETIC RESOURCES

The natural character of this portion of the river and the relatively good water quality in pool 9 contribute to its recreational and aesthetic desirability. As a result, pool 9 is one of the most fished pools in the Upper Mississippi River; sport fishing is heavy and commercial fishing activity in this pool ranks second only to pool 4. There is a large amount of Federal land in pool 9; most of this land is managed for fish and wildlife as part of the Upper Mississippi River Wildlife and Fish Refuge. But a number of high quality recreational beaches, public day-use and camping recreation facilities, and private marina facilities are available to recreationists in the pool. Blackhawk Park, the largest developed recreation area in pool 9, is operated by the Corps of Engineers. This recreational facility is located on the Wisconsin side of the river opposite the project area. It offers boat access facilities, other day-use facilities, and a large campground. Blackhawk Park is currently being improved by filling/elevating much of the park to remove it from frequent flood events. This action will help to improve future public use and reduce operation and maintenance costs associated with flood damage and cleanup efforts. Other public recreation facilities in pool 9 include seven boat landing/parking areas which are scattered throughout the pool. Mt. Hosmer Park, located in Lansing, offers the public picnicking and scenic overlook facilities. In the summer months, the public and private access facilities adequately serve the public. These boat access points also facilitate winter hunting, trapping, snowmobiling, and ice fishing.

As a result of past channel maintenance activities, a number of sand covered island beach sites currently exist in pool 9, and most of them receive extensive recreational use. The beach maintenance plan for pool 9 endorsed by the Channel Maintenance Forum evaluated 18 beach sites in the pool. The plan recommended that most of these sites warrant some future management action to maintain them as sandy beaches. Seven of the 18 beach sites are located on the right bank of the main channel in the Lansing Big Lake project area (i.e., beach sites: 9-669.0 R, 9-667.5 R, 9-665.8 R, 9-665.4 R, 9-665.3 R, 9-664.8 R, 9-664.3 R). Four of these seven sites have been identified as needing future development actions to maintain their recreation use. The remaining three sites will require no future development actions.

Recreational activities are most concentrated in the upper two-thirds of the pool, above Lansing. Accordingly, the Lansing Big Lake area is an important recreational resource. This area is heavily used for fishing, boating, and hunting. Other important recreational activities in the project area include picnicking, camping, swimming, canoeing, and trapping. There are no existing or proposed boat launching ramps in the Big Lake backwater area and no established access roads or walking trails leading into Big Lake. A canoeing route has been designated on the Upper Iowa River and it passes through the Big Lake area. This route enters the Big Lake area at Big Slough, meanders through the backwater sloughs, and continues downstream into Big Lake.

SOCIOECONOMIC RESOURCES

The project area is located in a rural area of northeastern Iowa and west central Wisconsin. The north end of the project area is bordered by Blackhawk Park which is situated between the two small communities of Victory and DeSoto, Wisconsin. The park is a Corps of Engineers facility located approximately 25 miles downstream from La Crosse, Wisconsin. Blackhawk Park is the largest public use facility in pool 9. There are approximately 15 to 20 seasonal and/or year-round private dwellings contiguous to the north end of the park. Some of these structures have been raised to help protect against the effects of flooding, but the majority have no flood protection. The project area is bordered on the right descending bank of the Mississippi River by Lansing, Iowa, in Allamakee County. The floodplain lands in the valley are largely in public ownership or have flowage easements on them due to the navigation project. Lands adjacent to the project area, except for Lansing, Iowa, are used for agriculture. A few homesites are located along the adjacent bluffs.

FUTURE WITHOUT PROJECT CONDITIONS

HISTORICALLY DOCUMENTED CHANGES IN HABITAT

The establishment of the 9-foot navigation channel drastically modified the preimpoundment conditions in the project area. What had been an essentially free flowing river system subject to rapid changes in elevation became a series of pools which, for large portions of the year, has a relatively constant elevation. Immediately after impoundment (1939), the project area had approximately 3,800 acres of open water habitat, 2,000 acres of marsh, and 4,000 acres of woody habitat (at normal pool). The aquatic area consisted primarily of non-flowing lakes connected by side channels and sloughs. The woody habitat consisted primarily of bottomland forest with small areas of willow present.

Prior to 1959, the Upper Iowa River flowed directly through the western edge of the Lansing Big Lake backwater area. Then, as a result of flood control channel improvements that were implemented, the Upper Iowa River was redirected to its current alignment. The Upper Iowa River now flows directly into the main channel of the Mississippi River at a point immediately upstream of the project area.

Though resource managers have long recognized that the habitat in the Lansing Big Lake has been changing, the only actual documentation of the change in habitat types was by Minor, et. al., (1977) as part of the GREAT I study. Minor evaluated the change in habitat types between 1939 and 1973. See plate 3 for a display of these changes. Table 1 shows the general changes in habitat types based on Minor's work, along with projections for present day and future conditions. As can be readily seen in table 1, there has been a loss of aquatic habitat and an increase in marsh and bottomland forest habitat. This is symptomatic of the system-wide sedimentation problem on the Upper Mississippi River. Sediment is filling in aquatic habitats, resulting in successional changes to marsh and bottomland forest habitats.

Table 1. Acreage[1] of Habitat Types in the Lansing Big Lake Project Area

	1939	1973	Present[2]	2040[2]
Sloughs and Side Channels	2475	1900	1600	725
Deep Aquatic (lakes and ponds)	900	800	750	600
Shallow Aquatic	450	475	475	500
Marsh	1950	2225	2375	2800
Brush	100	100	100	100
Bottomland Forest	3875	4250	4450	5025
	9750	9750	9750	9750

[1] acres rounded to nearest 25
[2] present and 2040 projection based on 1939-73 rate of change

FACTORS INFLUENCING HABITAT CHANGE

As noted above, sedimentation of backwater habitats is a widely recognized problem on the Upper Mississippi River, and the Lansing Big Lake area is no exception. Sedimentation occurring in the Big Lake backwaters comes from water inflows originating from the Mississippi River and Upper Iowa River. The sediment load entering the backwaters is a function of the quantity of water that flows into the backwaters and the inflowing water sediment concentrations. A number of studies have been conducted to determine the sedimentation rate in the Lansing Big Lake area. Based on those studies and the efforts of this study, the general 1960-1989 sedimentation rate in the Lansing Big Lake area has been estimated to be 0.60 inch per year. However, there is significant evidence that the sedimentation rate will increase in the future because the side channel openings are continuing to increase in size which allows greater inflows of sediment laden waters to enter the backwaters. For example, observed changes in hydraulic conditions are evident at side channel site 6 that have occurred in the past decade (see Appendix A for details). Based on the rate of increase in discharge since 1980, it has been estimated that by 1995, the sedimentation rate in the Lansing Big Lake area will reach 0.65 inch per year and stabilize at that rate. The increased rate of sedimentation seems to be in response to the increased head differiential between the backwaters and the main channel which has occurred since the Upper Iowa River was rerouted in 1959. Professional judgement has been used to project when the hydraulic conditions will stabilize (see appendix A for more details).

For the Lansing Big Lake area, when Mississippi River flows are below 80,000 cfs, most of the sediment entering the area comes through sloughs and low spots in the natural levee along the right bank of the Mississippi River and the right bank of the Upper Iowa River. These sloughs and low spots are labeled as "sites" on plates 2 and 4. During Mississippi River flows in excess of 80,000 cfs, portions of the natural levee on the right bank of the Mississippi River and the right bank of the Upper Iowa River are overtopped, and sediment carrying flow into the Lansing Big Lake area occurs at many sites.

An estimated 26 percent of the total sediment that enters the Lansing Big Lake area originates from the Upper Iowa River (see Appendix A for details). The two major processes resulting in inputs are as follows: First, flood events on the Mississippi River cause high stages that back up into the Upper Iowa River and overtop the right bank leading into the backwater areas. Second, sediment-laden flows from the Upper Iowa River enter the Mississippi River and then follow the right bank of the Mississippi River until they are drawn into the upper sloughs that lead into the Lansing Big Lake area. The suspended sediment concentrations in the Upper Iowa River are higher than those found in the Mississippi River. This results in the suspended sediment concentration of discharges into the upper sloughs of the Lansing Big Lake area being higher than the background concentrations in the Mississippi River. See appendix A for additional details about sedimentation analyses conducted as part of this study.

ESTIMATED FUTURE HABITAT TYPES AND DISTRIBUTION

Despite the complexity of the biological system in the project area and the large number of internal and external factors which interact with the system, it is safe to predict that the natural trend of loss of aquatic habitat due to sedimentation will continue. This will continue until much of the existing aquatic habitat is converted to floodplain forest. What will remain as aquatic habitat will consist primarily of the side channel and slough type areas. Using current sedimentation rates, this would be expected to occur in approximately 95 years.

From 1990 to 2040, backwater sedimentation will result in the conversion of 1050 acres of aquatic habitat to terrestrial habitat. Table 1 contains habitat type projections for present and the year 2040 based on the observed trends/changes during the period 1939-1973. The major assumption made in this table is that the long-term conversion of aquatic habitat to marsh and bottomland forest will occur in the future at about the same rate as observed during this historic period.

PROBLEM IDENTIFICATION

EXISTING HABITAT DEFICIENCIES

Habitat deficiencies must be viewed in the context of the desired conditions or management objectives for a particular area (see page 5 of this report for listing of management objectives). What may be viewed as a deficiency for one species may be excellent habitat for another. The management goal of the U.S. Fish and Wildlife Service and the Iowa Department of Natural Resources for the Lansing Big Lake area is to maintain a diverse system of aquatic habitats that will benefit fish, waterfowl, furbearers, wading birds, and other wildlife forms which use this type of habitat. The discussion of habitat deficiencies reflects this management goal.

The habitat changes described in the preceding sections have reduced the habitat value of the project area to both waterfowl and fish. For waterfowl, the most deleterious impacts have resulted from both the reduction in overall water surface area and a change in the vegetative species composition. The displacement of submerged plant species found in the deeper water areas (Vallisineria, etc.) by floating and emergent species has been particularly harmful to canvasbacks and other types of diving ducks. These waterfowl species use the tubers and fruiting portions of the submerged plants as an important food source. The negative aspects of the change in vegetative species composition are compounded by the loss of the open water which is also a desired habitat for diving waterfowl species.

Habitat changes have also had serious impacts on the area's fishery. The physical loss of aquatic area through the conversion of these areas to terrestrial habitat has obvious negative impacts to all aquatic species. The reduction in depth and the change in vegetative composition also reduce the area's habitat value to many of the important game fish that have used the area. This loss of deeper habitat has made the continued presence of these species in the backwater area much more difficult. The presence of more dense stands of vegetation, characteristic of floating and emergent vegetation, has also further lowered the area's habitat value to most of the important game species.

FUTURE HABITAT DEFICIENCIES

The projected future for the area is a continual degradation and loss of aquatic habitat. Similar processes are expected to degrade or replace the other existing backwater areas on the river. It can be expected that, if the present processes continue for the next 75 to 100 years, most of these open backwater areas will be converted into marsh and bottomland forest habitat. Using habitat conversion rates that occurred during the period 1939-73 as an indicator, by the year 2040, existing aquatic habitat in the project area will decline in acreage by about 35 percent.

PLANNING OPPORTUNITIES

In the broad sense, planning opportunities in the project area are limited. The capability to reverse the effects of the sedimentation that has occurred since 1939 does not exist. Planning opportunties relative to the major problem of sedimentation are restricted to attempts to reduce future sedimentation rates.

Characteristics of the project area were considered during the design phase of this study. Whenever possible, the existing physical conditions and material availability would be used to make the project less expensive.

PLANNING CONSTRAINTS

Plan formulation must recognize and adequately address a number of planning constraints, such as laws, regulations , and development guidance contained in master plans. The following specific planning constraints were instrumental in shaping plan formulation for this project.

1. Any solution must be in compliance with State and Federal floodplain laws and regulations.

2. Adequate dissolved oxygen levels in the backwaters and fish escape routes from the shallow backwaters to the main channel must be maintained.

3. Any solution cannot adversely affect operation of the 9-foot navigation channel project.

4. Any solution cannot significantly increase discharges and associated suspended sediments into the Lake Winneshiek backwater area (an increase in discharge of greater than 10% is considered significant).

5. The project must maintain adequate boating access to the Big Lake backwater areas.

PLANNING GOALS AND OBJECTIVES

The ultimate goal or purpose of the project is to protect and preserve the existing aquatic habitat in the Lansing Big Lake backwater area. Natural and man-induced sediment loads from the Upper Mississippi River and Upper Iowa River are entering the project area and are gradually degrading the physical conditions of the area. The intent of the project is to remedy this problem in the entire project area to the extent practical.

The overall management objectives for the entire Upper Mississippi River are discussed on page 5 of this document. Objectives specific to the project area include: 1) reduce future loss of aquatic habitat in the Lansing Big Lake area (i.e., reduce the quantity of fish and wildlife aquatic habitat which will be converted to terrestrial habitat), and 2) preserve existing critical migratory waterfowl habitat in Lansing Big Lake. To accomplish these objective a number of remedial actions were evaluated as part of this study. The next section of this report describes the remedial actions considered (for more details see table 2 in the "Plan Evaluation" section of this report for a summary of of project goals, objectives, and a display of the effectiveness of alternatives evaluated as part of this study).

PLAN FORMULATION

The principal purpose of plan formulation is to develop a plan that would provide the best use, or combination of uses, of water and land resources to meet the project objective outlined in the previous section of this report. Much discussion by the project team participants centered around achieving the desired project objectives with the lowest first costs and yet minimizing the project maintenance costs. The selected design project life of 50 years was an early product of the plan formulation process that helped guide the detailed design efforts.

Six possible remedial design measures/project features were identified by the project participants during the plan formulation process. These project features can be combined in various ways to make an array of possible alternative plans that would help to reduce the sedimentation problems in the project area. The possible design measures/project features identified follow.

<u>Feature 1</u> - Construct closure structures across selected side channel openings sites. These could take the form of a complete closure, a rock lined partial closure, a gated closure, or culverts. Closure structures may be rock fill, sand fill with rock protection, sand fill with culverts, or wood pilings driven across the channel cut to create a dike. Rock lining a side channel opening to keep it from eroding and increasing in flow capacity is included as a variation of this feature. These features would decrease the quantity of

sediment-laden water that would enter the backwaters and thereby decrease the sedimentation rate.

Feature 2 - Construct low levees that would add height and/or continuity to the existing natural levees located along the right banks of the Upper Iowa and Mississippi Rivers. This feature would likely be used in combination with closure structures discussed in project feature 1 above. Such a feature would increase the effectiveness of the project by reducing the frequency of overtopping of the existing natural levees.

Feature 3 - Construct a deflector structure that would result in better mixing of the Upper Iowa River inflows with Mississippi River waters, thereby reducing sediment concentrations entering the Lansing Big Lake project area.

Feature 4 - Construct scour holes and/or sediment traps immediately downstream of each side channel cut that would remain open to the backwater areas. These features would be used in combination with partial closures discussed in project feature 1. Sediment trap structures could be constructed at some of the partial closure structures by deepening and enlarging the preformed scour hole areas. These sediment traps would also provide valuable deepwater areas for fish habitat. Also important, these sediment traps and scour holes could provide a source of fill material for project levees and/or side channel closure structures.

Feature 5 - Upstream erosion control measures/features on the Mississippi River and it's tributaries (e.g., Upper Iowa River) which would reduce sediment loading/concentrations. If significant reduction in upstream erosion could be accomplished the concentration of suspended sediments flowing into the Lansing Big Lake area would be reduced and a reduced sedimentation rate would result. To accomplish this, improved watershed-wide agricultural and land use practices, massive streambank protection features, and/or very large strategically located sediment traps would need to be implemented.

Feature 6 - Backwater dredging in the Lansing Big Lake area was also a considered feature. This would involve deepening selected areas of the study area to increase water depths and thereby maintain or create aquatic habitat.

The study team evaluated the practicality of applying each of the above project features. It was determined that, of the six above described features, three features should be removed from further detailed evaluations. These were project features 3, 5, and 6. Reasons why these features were deemed not to be applicable for this project include: the Upper Iowa River flow deflector structure feature, feature 3, was found to be a significant navigation hazard and it over time would not substantially reduce sediment inputs to the Big Lake area; feature 5, upstream erosion control measures and/or sediment trapping was determined to be beyond the scope and authority of this project; and, feature 6, backwater dredging and associated dredged material disposal intended to maintain or create aquatic habitat, was determined to have unacceptable adverse impacts to the existing high quality backwater habitat and excessive implementation costs.

The three project features that were found to have merit for application on this project and should be incorporated into remedial plans were features 1, 2, and 4. These features are further detailed in the alternatives which follow in the next section of this report.

ALTERNATIVES CONSIDERED

Five design alternative plans plus the "NO ACTION" alternative have been evaluated in greater detail during this study and are presented in this section of the report. The design alternatives are labeled plans 1, 2, 3, 4, and 5.

No Action

With this alternative, no remedial actions would be implemented using Federal funds. Sedimentation would continue at a projected rate of approximately 0.65 inch per year. The effect on habitat conditions were discussed earlier under "Estimated Future Habitat Conditions and Distribution" and "Future Habitat Deficiencies."

Plan 1

This plan consists of constructing 10 complete closure structures across side channel sites 1, 2, 3, 4, 5, 5A, 6, 6A, 7, and 8. This action would completely plug and eliminate sediment transport through the upstream ten side channel sites where the head differential between the backwaters and the main channel of the Mississippi River is greatest. This plan would not control the inflow of sediments during flood events when flows on the Mississippi River exceed 80,000 cfs (i.e., at 80,000 cfs the closure structures and natural levee would be overtopped). See plate 5 for a display of this plan.

Plan 2

This plan would reduce significantly or eliminate inflows through side channel sites 1 through 19 with channel closure structures and would increase project sediment reduction effectiveness through construction of long low dikes/levees on the right banks of the Mississippi and Upper Iowa Rivers. See plate 6 for a display of this alternative. More specifically, rock lined partial closure structures would be constructed across sites 1, 2, 6, and 15 to reduce the flow capacity of these side channel openings. Preformed scour holes would be constructed immediately downstream of each of these partial closure structures, and extra holding capacity would be provided at sites 1 and 15 to form sediment traps at those sites. These sediment traps and scour hole basins would also function as the project borrow areas. Complete closure structures would be constructed across all other side channel sites.

The right bank levee along the Upper Iowa River would be raised to elevation 629 from its confluence with the Mississippi River to a point approximately 5,000 feet upstream of the confluence. The natural levee on the right bank of the Mississippi River from site 2 to the confluence of the Upper Iowa River would be raised to elevation 629 feet. At site 2, the elevation drops to 628.5 and remains at that elevation to a point 2,000 feet downstream of site 8.

Plan 3

This plan is the same as plan 2 except that the dike/levee along the right bank of the Mississippi River would be extended and built to a slightly different elevation to realize additional sedimentation reductions beyond plan 2. See plate 7 for a display of this alternative. More specifically, the natural levee on the right bank of the Mississippi River from site 2 to the confluence of the Upper Iowa River would be raised to elevation 629 feet. From site 2 downstream along the natural levee for a distance of 4,000 linear feet, the dike/levee elevation would be constructed to an elevation of 628. At this point, the levee elevation would again drop to elevation 627 and remain at that elevation until it tied into high ground at the designated dredged material disposal site downstream of site 15.

<u>Plan 4</u>

This plan is the same as plan 3 except that the rock lined closure structures at sites 1, 2, 6, and 15 would not be reduced significantly from their existing flow capacity (see plate 7). This would allow a greater inflow into the backwaters, especially during low flow periods when main channel Mississippi River flows are less than 35,000 cfs.

<u>Plan 5</u>

As compared to the other alternative plans, this plan is somewhat smaller in scope (see plate 8 for display of this alternative). This plan involves construction of rock lined side channel openings at sites 1, 2, and 6 (for details see plates 9, 10, and 11) and side channel closure structures at sites 3, 4, 5, 5A, 6A, 7, and 8. Also, a preformed scour hole would be located below side channel opening site 6 to prevent scoured material from washing downstream and settling in the backwaters. The primary intent of constructing this feature is to use the fill material removed from this scour hole to construct the side channel closure structures. This plan would return the Big Lake backwaters inflow capacity of the side channel openings to a pre-1980 hydraulic condition and prevent future side channel erosion. This date was selected based on input from river resource managers familiar with the project area. Among this group, there was general agreement that pre-1980 inflow conditions were better than current conditions in the Lansing Big Lake area.

PLAN EVALUATION

The relative merits of the six courses of action evaluated are summarized in table 2 - "Project Goals, Objectives, and Alternative Enhancement Features". A narrative summary of the how well each of the alternative plans meets project objectives follows.

<u>No Action</u>

The no action alternative would not meet the plan objective and would be considered only if no feasible action alternative could be found.

<u>Plan 1</u>

This plan would decrease the sediment load entering the Lansing Big Lake to about 0.48 inch per year. This plan, however, would have significant adverse environmental impacts to the Big Lake backwater area. The lack of freshwater inflows to the upper reach of the backwater complex would create a serious dissolved oxygen problem in a large portion of the backwater area. This would likely result in frequent fish kills and a significant degradation of the Big Lake backwater ecosystem. This plan would also have significant impacts upon the flood plain in the Blackhawk Park and Winneshiek Lake areas; This plan would substantially increase flood stages on the Wisconsin side of the main channel opposite the upper reaches of the project area and would increase discharges into Winneshiek Slough by greater than 10 percent. See Appendix A for technical details.

Plan 2

This plan would decrease the sediment load entering the Lansing Big Lake area to about 0.45 inch per year. As compared to plan 1, this plan would be more effective in reducing sediment loading to the backwaters and would greatly relieve dissolved oxygen problems. This plan would have substantial floodplain impacts (increased flood stages) on the Wisconsin side of the main channel, opposite the upper reaches of the project area, and would increase discharges into Winneshiek Slough by greater than 10 percent (see Appendix A). In addition, the low earthen dike/levee would be quite difficult to maintain due to the erosion potential during periodic overtopping.

Plan 3

This plan would decrease the sediment load entering the Lansing Big Lake area rate to about 0.38 inch per year. This plan would have many of the same benefits as plan 2 but would be somewhat larger in scale and more effective in controlling sediment inflow. As with Alternative 2, this plan would have substantial floodplain impacts on the Wisconsin side of the main channel, opposite the upper reaches of the project area, and would increase discharges into Winneshiek Slough by greater than 10 percent (see Appendix A). The low earthen dike/levee would again be extremely difficult to maintain due to periodic overtopping.

Plan 4

This plan would decrease the sediment load entering the Big Lake area by to about 0.49 inch per year. As compared to plans 2 and 3, alternative plan 4 has a reduced overall effectiveness in decreasing sedimentation, but it does maintain low flows into the backwaters at an inflow similar to existing conditions. From a dissolved oxygen standpoint, maintaining such a backwater inflow is an important factor in maintaining the viability of the backwater fishery. This plan would have substantial floodplain impacts on the Wisconsin side of the main channel, opposite the upper reaches of the project area, and would increase discharges into Winneshiek Slough by greater than 10 percent (see Appendix A). In addition, the low earthen dike/levee would be extremely difficult to maintain due to periodic overtopping.

Plan 5

This plan would decrease the sediment load entering the Lansing Big Lake area to about 0.55 inch per year. Plan 5 is not expected to have the significant adverse impacts with regard to flood plain impacts and flow increases to the Lake Winneshiek area which are impacts associated with plans 1 through 4. Although this plan meets the planning constraints, there is a potential that the proposed action could cause minor increased sedimentation in Lake Winneshiek. It is our best engineering judgement that the actual rate of increase would be less than 5%.

Table 2. Project Goals, Objectives, and Alternative Enhancement Features

GOALS	OBJECTIVES	ALTERNATIVES	UNITS OF MEASURE	ENHANCEMENT POTENTIAL	
				EXISTING/FUTURE YEAR 2040	*WITH + PROJECT CONDITIONS*
MAINTAIN EXISTING AQUATIC HABITAT IN BIG LAKE BACKWATERS (ALL 2825 ACRES) BY DECREASING THE ANNUAL RATE OF SEDIMENTATION IN BIG LAKE BACKWATERS	DECREASE ANNUAL RATE OF SEDIMENTATION IN BIG LAKE BACKWATERS TO MAXIMUM EXTENT PRACTICAL (TARGET 0.38 INCHES)	BACKWATER DREDGING	ACRES AQUATIC HAB.	UP TO 2,825	NOT QUANTIFIED 1
		UPSTREAM EROSION CONTROL & SEDIMENT RETENTION TRAPS	ANNUAL SED. RATE	.60 INCHES PRESENT TO .65 INCHES FUTURE	NOT QUANTIFIED 2
		ALTERNATIVE PLAN 1	ANNUAL SED. RATE	.60 INCHES PRESENT TO .65 INCHES FUTURE	.48 INCHES
		ALTERNATIVE PLAN 2	ANNUAL SED. RATE	.60 INCHES PRESENT TO .65 INCHES FUTURE	.45 INCHES
		ALTERNATIVE PLAN 3	ANNUAL SED. RATE	.60 INCHES PRESENT TO .65 INCHES FUTURE	.38 INCHES 3
		ALTERNATIVE PLAN 4	ANNUAL SED. RATE	.60 INCHES PRESENT TO .65 INCHES FUTURE	.49 INCHES
		ALTERNATIVE PLAN 5	ANNUAL SED. RATE	.60 INCHES PRESENT TO .65 INCHES FUTURE	.55 INCHES

NOTES:

1. The increase in acres of open water would depend upon the acres dredged. This plan wasn't detailed because this alternative was screened out early in the planning process.
2. The decrease in annual sedimentation rate in the backwaters would depend upon the effectiveness of measures taken to decrease sediment concentrations.
3. This is the largest scaled alternative plan which was evaluated in detail by this study. Therefore, this is a target rate used to evaluate the effectiveness of the other alternatives.

To summarize plans 1 thru 4 would all have unacceptable adverse effects, either in the project area itself, or on adjacent and downstream areas. Plan 1 would have severe adverse fishery impacts because of induced dissolved oxygen depletion problems. Plans 1 through 4 would have substantial adverse impact on the Wisconsin side of the main channel by increasing the stages of high frequency flood events and would also result in unacceptable increases in flows to Winneshiek Slough. Attempts to reduce the increased flows into Winneshiek Slough by constructing a partial slough closure were also unacceptable because of very high costs and also because a partial closure of Winneshiek Slough would compound the upstream flooding stage problems (see table 11 of Appendix A for details). In addition, plans 2 through 4 would likely have high maintenance costs due to project induced head differentials and the associated risks of levee erosion. Because of these factors, these plans were eliminated from further consideration. Plan 5 remained the only feasible structural alternative (i.e., Plans 1 through 4 did not conform to the planning constraints identified for this project). Table 3 summarizes the sediment reduction effectiveness as measured by the reduction in annual sedimentation rates, the approximate first costs of construction for each alternative plan, and other effects of the alternative plans. As can be seen in column (a), Plan 3 would best fulfill the planning objective of reducing the sedimentation rate in the Big Lake backwater area. The least effective plan would be Plan 5.

Table 3 - Plan Comparison

	(a)	(b)				(c)
		Unacceptable Secondary Effects				
Plan	Sedimentation Rate (inches)	Diss. Oxygen	Flood-plain	Winne. Lake	Levee Stabil.	Costs
No Action	0.65	-	-	-	-	$0
Plan 1	0.48	yes	yes	yes	no	$520,000
Plan 2	0.45	no	yes	yes	yes	$2,425,000
Plan 3	0.38	no	yes	yes	yes	$3,225,000
Plan 4	0.49	no	yes	yes	yes	$3,600,000
Plan 5	0.55	no	no	no	no	$690,000

__HEP Evaluation of Plan 5__

Plan 5 was evaluated further to determine if the expected outputs justify the project costs. Habitat evaluation procedures were used to assist in quantifying project effects. The complex nature of the Lansing Big Lake project area makes it very difficult to evaluate and accurately project the benefits of implementing plan 5. Therefore, professional judgements and key basic assumptions have been used to convert the projected decrease in sedimentation that would result from implementing the project to the acres and values of desired habitates preserved. Table 4 shows a summary of the acres of desired habitat types expected to be preserved by implementing plan 5 (the present conditions and future without project conditions are based on a habitat conversion rate similiar to that which was determined for the period 1939-1973). Columns c is based on the assumption that if sedimentation rates are reduced by 15% there would be a corresponding reduction in the rate of aquatic habitat conversion to marsh and bottomland forest habitat.

Table 4. Acreage[1] of Desired Habitat Types in the Project Area

Habitat Types	(a) Present[2] 1990	(b) Future[2] Without 2040	(c) Big Lake Area Future[3] With 2040
Sloughs & Side Channels	1600	725	850
Deep Aquatic(lakes & ponds)	750	600	625
Shallow Aquatic	475	500	500
	2875	1825	1975

1 acres rounded to nearest 25
2 present and 2040 future without projection based on 1939-73 rate of change
3 assumed 15% reduction in rate of conversion.

The general habitat values developed for the Upper Mississippi River habitats by Wege and Palesh (1983) for use in dredged material disposal planning were applied. These values were derived to represent the typical high quality habitat which is found in the Upper Mississippi River Fish and Wildlife Refuge and accurately reflect the conditions present in the project area. A value of 0.80 was determined for deep aquatic habitat and 0.87 for shallow aquatic habitat. Wege and Palesh did not develop a habitat unit value for slough/side channel habitat. A HUV of 0.85 was applied to this habitat type, a value in the general range of the HUV's of deep and shallow aquatic habitats. This area will remain refuge throughout the life of the project and little change is anticipated in the quality of any of the particular types of habitat present. Because of this, the values assigned to each of the habitat types will remain the same over the life of the project and any changes in average annual habitat units (AAHU's) will be due to changes in the acreage of each habitat type.

Table 5 presents the estimated average annual habitat units (AAHU's) that would be gained for the derived habitats in Lansing Big Lake.

Table 5. Results of HEP Evaluation for Plan 5

Habitat	Big Lake Area Future Without (AAHU)	Future With (AAHU)	Change (AAHU)
Slough/Side Channel	990	1040	+ 50
Deep Aquatic	540	550	+ 10
Shallow Aquatic	425	425	0
			+ 60

Additional positive outputs of the proposed action have not been quantified or presented in tables 4 and 5. These outputs are significant, are worthy of being noted, and are discussed below. Specifically, the proposed project would result in aquatic habitats being preserved beyond the project life (50 years). The accummulative sediment reduction over the assumed 50 year project life is projected to be 5 inches. This cummulative decrease in sediment deposits will increase the water depth in the remaining 1,925 to 2,025 acres of backwater aquatic area that remain open after 50 years. This increased water depth over the remaining aquatic area will result in the preservation of many acres of critical open water habitat well beyond the economic project life. Also, with normal maintainence of project features (through the 50th year of the project) the project features are likely to persist well beyond the assumed project life. This would result in continued reductions in backwater sediment deposition, as compared to deposition that would have otherwise entered the backwaters without the project. Because these benefical outputs of the proposed project, occurring beyond the assume economic life of the project, have not been quantified or included in tables 4 and 5, the benefical habitat effects claimed in tables 4 and 5 are considered to be a conservative estimate of actual outputs of the project.

Incremental Analysis

Incremental analysis is not applicable in this instance because there is only one remaining feasible plan (Plan 5), and this plan from an engineering standpoint must be considered as a single increment. If any one of the side channel closures or hardening features of Plan 5 is eliminated, the entire plan fails as the river will exploit the unprotected side channel and erode it larger (i.e., the head differential in the upstream end of the project area causes all 10 side channel openings in that reach to need some form of erosion protection).

SELECTED PLAN OF ACTION

Plan 5 is the selected plan. No other feasible structural alternatives were identified that would provide significant benefits to the entire area without concurrent adverse impacts. The effects of only plan 5 fall within the planning constraints established for this project (see page 15, Planning Constaints for details). The benefits to Lansing Big Lake that the project would provide appear reasonable given the cost of the plan. Based on an average annual project cost of $64,700, the expected benefits would cost about $1,078/AAHU. The features of Plan 5 as shown on plates 9, 10, and 11 are:

- rock lining of the side channel openings at sites 1, 2, and 6.

- the plugging of the smaller side channel openings at sites 3, 4, 5, 5A, 6, 6A, 7, and 8 to establish a pre-1980 inflow capacity.

- a preformed scour hole located below side channel opening site 6 (this feature is intended to serve as a source of fill material for construction of the side channel closures and will not be maintained after initial construction).

Project Objective of the Selected Plan

The specific objective of the project is to decrease the sedimentation rate in the Lansing Big Lake project area, to the maximum extent practical. A target annual sedimentation rate of 0.38 inches was identified (see Table 2 for additional details). Table 6 summarizes how Plan 5 would meet the objective established for this study.

Table 6. Measurable Goals and Accomplishments of the Proposed Plan

Goal	Objective & Accomplishment	Project Feature	Remarks
Maintain existing aquatic habitat in project area (all 2825 acres)	Reduce rate of sedimentation to annual rate of 0.55 inches (target of 0.38)	Side channel closures (plugs and liners)	Estimated net 150 acres preserved aquatic habitat during project life
			Reduction of 1.2 million cubic yards of sediment

Estimated Future Habitat Conditions with the Project

The proposed project would decrease the overall sediment deposition in the Big Lake backwaters by approximately 5 inches during the 50-year project life. This equates to a reduction of 1.2 million cubic yards of sediment reduction or 250,000 tons of sediment reduction in the Lansing Big Lake area. This would result in the preservation of an estimated 150 acres of aquatic habitat in the

Lansing Big Lake project area over the 50-year project life. The preservation of this critical aquatic habitat in the project area will significantly benefit fish and wildlife, especially migratory waterfowl.

Construction Methods

On-site fill material would be mechanically excavated from trenches constructed to place the rock liners at sites 1 and 2. This excavated material would be supplemented with borrow material obtained from the borrow site below side channel opening site 6 (this borrow site secondarily serves as a preformed scour hole). Side channel opening sites 1 and 2 at Big Slough and Little Slough have been substantial flow channels for many years prior to and since impoundment of pool 9. Therefore, excavated fill materials originating from these sites is expected to have a high proportion of coarse-grained material. However, characterization of the required excavation at these sites is not critical to the constructibility of the proposed project because suitable fill material is known to be readily available from the main channel, as is discussed in paragraph D.2 on page 404-4 of this report. It also should be noted that it would be possible to construct the below-water portions of the side channel closure structures using clean coarse-grained material, and the above-water portions using fine-grained material. Fill materials would be used as fill material for the smaller side channel closures at sites 3, 4, 5, 5A, 6A, 7, and 8. See plates 9, 10 and 11 for cross-section details of the proposed side channel closures and rock liners excavations.

Topsoiling with fine grained organic soils and seeding the project lands where existing vegetation is impacted by construction is included in this project to encourage the growth of vegetation and to help stabilize exposed soils. The topsoil/fine grained organic soils would be mechanically collected from the on-site backwater borrow areas, stockpiled for dewatering, and spread over the areas to be revegetated. A ground cover of selected species such as sand dropseed, smooth bromegrass, perennial rye, switchgrass, and willows will be established by seeding these topsoiled areas.

Rock erosion protection with quarry stone would be used in construction of various project features. This material could be barged in from local sources and placed directly from the barge to minimize handling costs.

Real Estate Requirements

No additional land would need to be permanently acquired for the project, since the proposed project would be located on public land owned by the Federal Government. See plate 13 for display of the land ownership patterns in the project area. Appropriate agreements would be made with the U.S. Fish and Wildlife Service to construct the project on the refuge lands.

ENVIRONMENTAL ASSESSMENT

An environmental assessment has been conducted for the proposed action, and a discussion of the impacts follows (see table 7 for a summary matrix of the environmental effects of the proposed action) . As specified by Section 122 of the 1970 Rivers and Harbors Act, the categories of impacts list in table 5 were reviewed and considered in arriving at the final determination. In accordance with Corps of Engineer regulations (33 CFR 323.4 (a) (2)), a Section 404 (b) (1) evaluation has been prepared (attachment 3). Water quality certification under Section 401 of the Clean Water Act has been applied for from the State of Iowa. The Finding of No Significant Impact (attachment 2) has been signed after the public review period elapsed, the 401(a) certification received, and all issues have been resolved.

RELATIONSHIP TO ENVIRONMENTAL REQUIREMENTS

The proposed project fully complies 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).

NATURAL RESOURCE EFFECTS

Deep Wetlands/Aquatic Habitat

It is expected that the project will result in approximately 150 more acres of aquatic habitats being present in 50 years as compared to the future without project condition, about a 15 percent increase. The primary beneficiaries will be the fish and wildlife that use this type of habitat, i.e., waterfowl, wading birds, and various species of fish. An 15 percent increase in habitat availability would be important to the overall biological productivity and diversity in the Lansing Big Lake area. The habitats that would be preserved are those most critical to the long term ecological health of the Upper Mississippi River system.

Wetlands - Marsh

The net impact of the proposed action would be approximately a 75-acre reduction in the amount of marsh habitat that would exist in the project area at the end of the 50-year project life. This would be about a 3 percent reduction verses the future without project condition. This would not result from the actual elimination of marsh habitat but rather from the reduction in the conversion of aquatic area into marsh forest habitat. The overall impact on the wildlife populations depending on marsh habitat in the Lansing Big Lake area would be insignificant because of the relatively small size of the change as compared to the total amount of marsh habitat that exists in the project area.

Table 7 - Environmental Impact Assessment Matrix

ENVIRONMENTAL IMPACT ASSESSMENT MATRIX

MAGNITUDE OF PROBABLE IMPACT

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

Wetlands - Floodplain Forest

The net impact of the proposed action would be approximately a 75-acre reduction in the amount of floodplain forest that would be formed in the project area at the end of the 50-year project life. This would be about a 2 percent reduction verses the future without project condition. This would not result from the actual elimination of forest habitat but rather from the reduction in the conversion of aquatic area into floodplain forest habitat. The overall impact on wildlife populations depending on floodplain forest habitat in the Lansing Big Lake project area would be insignificant because of the relatively small size of the change as compared to total amount of the floodplain forest that exists in the project area.

Habitat Diversity and Interspersion

The dominant habitat type in the project area is presently floodplain forest, and there is a general tendency of the system towards the establishment of greater amounts of floodplain forest at the expense of the aquatic areas. These aquatic areas add substantially to the diversity of the project area, and their elimination would negatively affect this habitat characteristic. The reduction in the loss of aquatic habitat that would result from implementation of the proposed alternative would be of substantial benefit to the Lansing Big Lake area.

Endangered and/or Threatened Species

The USFWS is in agreement with the St. Paul District's determination that the proposed project would not adversely affect federally protected species, particularly the Higgin's eye pearly mussel (Lampsillis higginsi, peregrine falcon (Falco peregrinus), and the bald eagle (Haliaeetus leucocephalus). The final report will contain the necessary endangered and threatened species coordination documentation.

Impacts Outside the Project Area

The foregoing evaluation of the impacts on natural resources has focused solely on those impacts that would occur within the Lansing Big Lake area. The re-establishment of 1980 hydraulic conditions in this portion of pool 9 would theoretically result in a minor increase in the sedimentation rate in areas downstream. However it is doubtful if this could be measured at any given location.

CULTURAL RESOURCES EFFECTS

In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places has been consulted. As of 1 March 1990, there are no sites on or determined eligible for the Register in the project area. However, there are 91 known archaeological sites and 81 historic/architectural sites in Pool 9. The entire reach of Pool 9 has not been systematically surveyed for cultural resources and the potential for undiscovered archaeological sites is quite high.

This project has been coordinated with the Iowa State Historic Preservation Officer, the Iowa State Archaeologist and the National Park Service. The State Historic Preservation Officer gave project approval without the need for an archaeological survey. However, both the State Historic Preservation Officer and the State Archaeologist cautioned about the potential for disturbance of previously unknown sites if extensive earth-moving activities become necessary during construction (see coordination letters attachment in appendices of this report for details).

The construction of the closure structures would have no effect on any known cultural resources. The structures, as planned, should not impact any previously undiscovered cultural resources.

SOCIOECONOMIC RESOURCE EFFECTS

The proposed project was reviewed in accordance with Public Law 91-611; Section 122. The project would have no appreciable effects on socioeconomic parameters, other than a minor increase in the water surface elevations at Blackhawk Park and private residences located north of the park (i.e., the project would return river conditions to pre-1980 conditions). Hydraulic estimates of these effects indicate minor or negligible effect would be induced only during low flood events (i.e., at the 100 year flood no change in the flood stage would be induced by the proposed project).

The initial construction would result in some minimal adverse impact on aesthetic values as a result of construction activities. This temporary impact would be primarily visual and limited to boat traffic using the project area. The location of the project away from major highways would help minimize these short-term visual impacts. Over the long term, the project is expected to have a positive effect by adding to the visual diversity of the site and by preserving high quality visual resources located in the Big Lake backwaters area.

The impact of the short-term construction activities associated with this project should be minimal to recreationists because boating access into the backwaters would not be cutoff during construction. Also, once the project is completed, the project would maintain boat access channels into the backwaters at site 1 and site 6. These rocklined side channel openings will allow for traditional recreational use of the project area. Implementation of the project would extend the life of valuable aquatic fish and wildlife habitat in the Big Lake area. This would maintain the moderate historical rate of recreation use in the project area and help to maintain the high quality of the recreation experience. Maintaining historic levels of recreational activity in the project area is not expected to create a fish and wildlife management problem.

PROJECT REQUIREMENTS

OPERATION AND MAINTENANCE

After construction of the project, annual operation and maintenance of the project would be performed by the U.S. Fish and Wildlife Service. Generally, it is anticipated that these requirements would include annual inspection and periodic minor repairs to project structures and filling and stabilizing of any new "blowout" areas which are identified during the inspection. An operations manual detailing the specific operations and maintenance required for this project would be prepared by the Corps during the plans and specifications phase of this project. This operations manual would be coordinated intensively with the Iowa Department of Natural Resources and the U.S. Fish and Wildlife Service. Over the 50-year project life, the average cost of operating and maintaining the project is estimated to be $2,000 per year. Therefore, the total O & M for this project, over the entire 50-year project life, is expected to be approximately $100,000 ($2,000 X 50). A rough listing of the annualized costs is shown below.

Inspection and report writing/evaluations	$ 500
Riprap replacement (20 CY @ $50/CY)	$1,000
Erosion repairs (50 CY @ $20/CY)	$1,000
TOTAL ANNUAL COST =	$2,500

COST ESTIMATE

A narrative report for the cost estimate and tabular detailed cost estimate for the project is shown in table 8. Total construction costs, including engineering and design and construction management, for implementing the selected plan are $694,300. Quantities and unit costs will be updated during final design and construction.

Annualized first costs, using first construction costs and general design expenditures (based on a 50-year economic/project life and an 8-7/8 % discount rate) would amount to $62,700. With the addition of annual operation and maintenance costs of $2,500, the total average annual costs are estimated to be $64,700.

Table 8 - Detailed Cost Estimate for Selected Plan

NARRATIVE REPORT FOR

COST ESTIMATE

BIG LAKE EMP, DEFINITE PROJECT REPORT

POOL 9, UPPER MISSISSIPPI RIVER, LANSING, IOWA

1. DESCRIPTION OF PROJECT. This project is for construction of several closures to reduce and control flows from the main channel into Big Lake. Fill will be dredged material. Rockfill and seeding will be used for stabilization.

2. CONSTRUCTION METHODS. Two barge mounted excavators with attendant plant can accomplish the work. One excavator will dredge and the second place the fill. Rockfill sources are abundant in the area. Barges can be loaded at Lansing and rockfill placed with one excavator. Organic soils for seeding will be placed, left to drain and spread with a small dozer prior to seeding.

3. UNIT COST ANALYSIS. Unit costs have been derived based on labor, equipment and material costs. A copy of the M-CACES estimate is on file at the St. Paul District, Corps of Engineers.

4. PLANNING, ENGINEERING, DESIGN AND CONSTRUCTION MANAGEMENT COSTS. 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 Chiefs.

5. CONTINGENCY ANALYSIS. The contingencies shown were arrived at as follows:

a. Mobilization and Demobilization. The 20% contingency is for additional time that may be required for site preparation, surveys, etc.

b. Access and Site Preparation. The estimated amount is for one day to leave one site and set up at the next. Dredging up to 100 feet for access is included. The 50% contingency is for an additional half day.

c. Rockfill and Fill. The contingency is 5% for the unit price, 5% for unknowns and 10% for quantity variations, except as follows. Fill contingencies for site #6A, #7 and #8 represent 20% plus cost and contingency for 3,350 cubic yards of additional fill that may be needed to connect the sites.

d. Shaping and Seeding. The contingency is 15% for unit price because of the small quantities involved and because a second mobilization may be necessary to allow time for the soil to drain. The remainder of the contingency is for quantity variations including additional seeding for the additional fill between site #6 and #8 as described in paragraph 5.c.

(Continued) Table 8 - Detailed Cost Estimate for Selected Plan

ED-C(WMO) LANSING BIG LAKE, EMP 11/14/90

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
11.0.A.-	MOBILIZATION AND DEMOBILIZATION	JOB	1	35,000	35,000	7,000	20%	1
11.0.1.-	SITE #1							
11.0.1.B	MOBILIZATION AND SITE PREPARATION	JOB	1	3,000	3,000	1,500	50%	1,2
11.0.1.B	EXCAVATION (PRICED IN FILL)	CY	1,000	0	0	0		
11.0.1.B	ROCKFILL	CY	1,000	30.00	30,000	6,000	20%	2,3,4
11.0.1.B	SHAPING AND SEEDING	ACRE	0.03	6,000	200	100	50%	3,4
11.0.1.-	SITE #2							
11.0.1.B	MOBILIZATION AND SITE PREPARATION	JOB	1	3,000	3,000	1,500	50%	1,2
11.0.1.B	EXCAVATION (PRICED IN FILL)	CY	1,950	0	0	0		
11.0.1.B	ROCKFILL	CY	1,950	30.00	58,500	11,700	20%	2,3,4
11.0.1.B	SHAPING AND SEEDING	ACRE	0.10	6,000	600	200	33%	3,4
11.0.1.-	SITE #3							
11.0.1.B	ACCESS AND SITE PREPARATION	JOB	1	6,000	6,000	3,000	50%	1,2
11.0.1.B	FILL	CY	1,370	10.00	13,700	2,700	20%	3,4,5
11.0.1.B	SHAPING AND SEEDING	ACRE	0.25	6,000	1,500	500	33%	3,4
11.0.1.-	SITE #4							
11.0.1.B	ACCESS AND SITE PREPARATION	JOB	1	6,000	6,000	3,000	50%	1,2
11.0.1.B	FILL	CY	525	10.00	5,300	1,100	21%	3,4,5
11.0.1.B	SHAPING AND SEEDING	ACRE	0.15	6,000	900	300	33%	3,4
11.0.1.-	SITE #5							
11.0.1.B	ACCESS AND SITE PREPARATION	JOB	1	6,000	6,000	3,000	50%	1,2
11.0.1.B	FILL	CY	1,325	10.00	13,300	2,700	20%	3,4,5
11.0.1.B	SHAPING AND SEEDING	ACRE	0.25	6,000	1,500	500	33%	3,4
11.0.1.-	SITE #5A							
11.0.1.B	ACCESS AND SITE PREPARATION	JOB	1	6,000	6,000	3,000	50%	1,2
11.0.1.B	FILL	CY	850	10.00	8,500	1,700	20%	3,4,5
11.0.1.B	SHAPING AND SEEDING	ACRE	0.10	6,000	600	200	33%	3,4
11.0.1.-	SITE #6							
11.0.1.B	ACCESS AND SITE PREPARATION	JOB	1	6,000	6,000	3,000	50%	1,2
11.0.1.B	ROCKFILL	CY	3,670	30.00	110,100	22,000	20%	2,3,4
11.0.1.B	SHAPING AND SEEDING	ACRE	0.15	6,000	900	300	33%	3,4
11.0.1.-	SITE #6A							
11.0.1.B	ACCESS AND SITE PREPARATION	JOB	1	6,000	6,000	3,000	50%	1,2
11.0.1.B	FILL	CY	1,395	10.00	14,000	14,800	106%	3,4,5,6
11.0.1.B	SHAPING AND SEEDING	ACRE	0.25	6,000	1,500	3,300	220%	3,4,7
11.0.1.-	SITE #7							
11.0.1.B	ACCESS AND SITE PREPARATION	JOB	1	6,000	6,000	3,000	50%	1,2
11.0.1.B	FILL	CY	2,000	10.00	20,000	16,000	80%	3,4,5,6
11.0.1.B	SHAPING AND SEEDING	ACRE	0.25	6,000	1,500	8,500	567%	3,4,7
11.0.1.-	SITE #8							
11.0.1.B	ACCESS AND SITE PREPARATION	JOB	1	6,000	6,000	3,000	50%	1,2
11.0.1.B	FILL	CY	2,650	10.00	26,500	17,300	65%	3,4,5,6

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(Continued) Table 8 - Detailed Cost Estimate for Selected Plan

ED-C(WMO) LANSING BIG LAKE, EMP 11/14/90

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	CONTINGENCIES PERCENT	REASON
11.0.1.8	SHAPING AND SEEDING	ACRE	0.50	6,000	3,000	900	30%	3,4
	SUBTOTAL, CONSTRUCTION COSTS				401,000	145,000	36%	
30.-.-.-	ENGINEERING AND DESIGN (THROUGH CONSTRUCTION)							
30.D.-.-	ENVIRONMENTAL	JOB	1	5,000	5,000			8
30.E.-.-	HYDRAULICS	JOB	1	10,000	10,000			8
30.E.-.-	GEOTECHNICAL	JOB	1	7,500	7,500			8
30.E.-.-	SURVEYS	JOB	1	2,000	2,000			8
30.E.-.-	BORINGS	JOB	1	9,000	9,000			8
30.H.-.-	PROJECT MANAGEMENT	JOB	1	3,000	3,000			8
30.H.-.-	GENERAL ENGINEERING	JOB	1	43,500	43,500			8
30.H.-.-	SPECIFICATIONS AND TECHNICAL	JOB	1	32,300	32,300			8
30.M.-.-	COST ENGINEERING	JOB	1	3,400	3,400			8
	SUBTOTAL, ENGINEERING AND DESIGN				115,700			
31.-.-.-	CONSTRUCTION MANAGEMENT (S & I)	JOB	1	32,000	32,000			8
	SUBTOTAL, CONSTRUCTION MANAGEMENT				32,000			
	SUBTOTAL				549,300			
	SUBTOTAL CONTINGENCIES					145,000		
	TOTAL ESTIMATED COST					694,300		

REASONS FOR CONTINGENCIES

1. UNKNOWN DISTANCE
2. UNKNOWN SITE CONDITIONS
3. QUANTITIES
4. UNIT PRICE
5. UNKNOWN SOIL CONDITIONS
6. ADDITIONAL FILL MAY BE NEEDED TO RAISE THE BERM AND CONNECT SITES 6 THRU 8
7. ADDITIONAL FILL WILL REQUIRE ADDITIONAL SEEDING
8. APPROXIMATELY 15% CONTINGENCY INCLUDED IN AMOUNT

Notes

1. Extensions are rounded to the nearest $100
2. Totals are rounded to the nearest $1000
3. General design (planning) allocations have totaled $195,000

PERFORMANCE EVALUATION

A monitoring plan to evaluate the ongoing performance of the project has been designed to measure the degree of attainment of project goals. The measurement intervals for performing several of the monitoring techniques will likely increase in the future as results of the monitoring become a basis of research.

Baseline and periodic aerial photography will be taken of the Big Lake project area and the Lake Winneshiek backwaters area to accurately establish base conditions and to provide future comparative habitat type acreage data over the project life.

The annual cost of implementing the project performance monitoring and evaluation program is summarized in table 9 and totals $2,000. Table 9 also contains a complete listing of monitoring parameters, measurement intervals, and associated annual costs. Transects that are to be set up as monitoring sites are shown on Plates 12 and 13. These cross sections were chosen to duplicate previous surveys or studies in the area of Pool 9. Before the actual survey effort is done, an inhouse effort should be made to identify and duplicate, to the extent possible, the exact locations of these previous survey cross sections.

Table 9. Project Performance Evaluation

Goal	Monitoring Accomplishment	Unit of Measure	Monitoring Plan	Monitoring Interval	Cost/ Effort
Protect & preserve existing aquatic habitat in the Big Lake Area	Measure sedimentation in the Big Lake & Winnesheik Lake areas	inch	Measure sedimentation at cross sections established by IDNR (Aspelmeier) Includes sites 5, 6, 9, and 16.	1, 5, 10, 20, 30, 40, and 50 years	$2,000
			Measure sedimentation at cross sections at sites 10, 11, 12, 13, and 14 (duplicates the transects B,C,D,E, and F done by Eckblad in 1973 and 1974.	1, 5, 15, 25, 35, & 50 years	$2,500
			Measure sedimentation at cross sections at sites 3, 4, and 20.	1, 5, 15, 25, 35, & 50 years	$2,000
			Measure sedimentation at cross sections at sites 21, 22, & 23 (sites located outside the immediate project site). These correspond to transects 10 and 11 of study done by Sedimentation Laboratory, Oxford Mississippi, McHenry and Ritchie, 1977.	1, 5, 15, 25, 35, & 50 years	$2,000
	Measure change in secondary channel geometry and capacity at key locations	c.f.s.	Measure change in channel capacity at sites 1, 2, 4, 7, 15, 17, 18, and 19. Use broad sweep fathometer system for sites 17 & 18. Duplicate pool 9 Study (Rada) for cross section 19. Sites 7, 8, and 15 duplicates previous LBL survey.	2, 5, 15, 25, 35, and 50 years	$3,000

Continued - Table 9. Project Performance Evaluation

Goal	Monitoring Accomplishment	Unit of Measure	Monitoring Plan	Monitoring Interval	Cost/ Effort
	Establish the base condition habitat (include Big Lake and Winnesheik areas	acre	Use aerial photos to map pre-project vegetation and use GIS to analyze habitat areas. Includes LBL area and adjacent downstream areas.	initial year	$15,000
	Measure loss of aquatic habitat	acre	Use aerial photos and GIS to identify and evaluate post project habitat changes. Includes sites 1 through 23.	Every 10 years	$3,500

PROJECT IMPLEMENTATION

DIVISION OF PLAN RESPONSIBILITIES

The responsibility for plan implementation and construction would fall to the Corps of Engineers as the lead Federal agency. "After construction of the project, annual operation and maintenance of the completed project would be the responsibility of the U.S. Fish and Wildlife Service. Should rehabilitation of the project, which exceeds the annual maintenance requirements, be needed (as a result of a specific storm or flood event), the Federal share will be the responsibility of the Corps." Project performance evaluation would be the responsibility of the Corps of Engineers. Project performance monitoring field work could be accomplished by the Iowa Department of Natural Resources during normal management efforts in the area. This will be more specifically coordinated and defined in the future O & M manual.

COST APPORTIONMENT

Construction

All project construction activities would be conducted on the Upper Mississippi River National Wildlife and Fish Refuge. Therefore, in accordance with Section 906(e)(3) of Public Law 99-662, the first costs for construction of the project would be 100-percent Federal and would be borne by the Corps of Engineers.

Operation and Maintenance

After construction of the project, annual management operations would be conducted by the U.S. Fish and Wildlife Service. A draft Memorandum of Agreement for operation and maintenance is included as attachment 6. The U.S. Fish and Wildlife Service would assure that non-Federal operation and maintenance responsibilities are in conformance with Section 906(e) of the Water Resources Development Act of 1986. The non-Federal sponsor is the Iowa Department of Natural Resources. Specific operation and maintenance features would be defined in a project operation and maintenance manual which would be prepared by the Corps of Engineers and coordinated with the involved agencies during the plans and specifications phase.

STEPS PRIOR TO PROJECT 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 soil boring and testing at the proposed borrow sites and closure sites. The current schedule is to prepare plans and specifications and advertise, award, and initiate a construction contract in fiscal year 1991. Construction would be completed in fiscal year 1992.

CONCLUSIONS AND FINDINGS

1. The Lansing Big Lake backwater area provides a valuable and highly productive aquatic habitat which is critical to fish and wildlife, especially migratory waterfowl.

2. Sedimentation has become a serious problem in the Lansing Big Lake backwater area and the rate of sedimentation is projected to increase unless remedial actions are taken.

3. A variety of potential remedial actions to solve the sedimentation problem were considered during this study. Five alternative plans were evaluated in detail and a selected plan was identified and designed. A performance evaluation monitoring program was also designed which would provide baseline and post-project data to determine the effectiveness of the project.

4. The selected plan would reduce and stabilize the overall rate of sedimentation in the project area. Outputs of the proposed project include the preservation of 150 acres of aquatic habitat during the assumed project economic life. This equates to a sediment reduction of 1.2 million cubic yards of sediment or 250,000 tons of sediment. In addition, after the economic life of the project, reduction in the backwater sedimentation rates would result in unquantified future project induced outputs. These project induced conditions would benefit fish and wildlife during and well beyond the assumed project economic life.

5. This plan has the full support of the public and managing agencies. However, public and river resource managing agencies wish more could be done to preserve and enhance the Lansing Big Lake area and they have recommended future studies be conducted to see if management of flows within the Lansing Big Lake area might further benefit fish and wildlife resources. Therefore, after the 5th year of project performance monitoring an analysis of data collected should be conducted to determine if additional habitat enhancement features could be implemented at specific sites within the Big Lake backwaters area. At that time, a review of project related impacts outside of the project area should be reassessed.

RECOMMENDATIONS

I have weighed the accomplishments to be obtained from construction of this 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 this side channel closure and protection project for the Lansing Big Lake area in Allamakee County, Iowa. The total estimated construction cost of the project is $694,300, which amount would be a 100-percent Federal cost according to Section 906(e)(3) of Public Law 99-662. I further recommend that funds be allocated in fiscal year 1991 for preparation of plans and specifications and initiation of project construction.

Roger L. Baldwin
Colonel, Corps of Engineers
District Engineer

PLATES

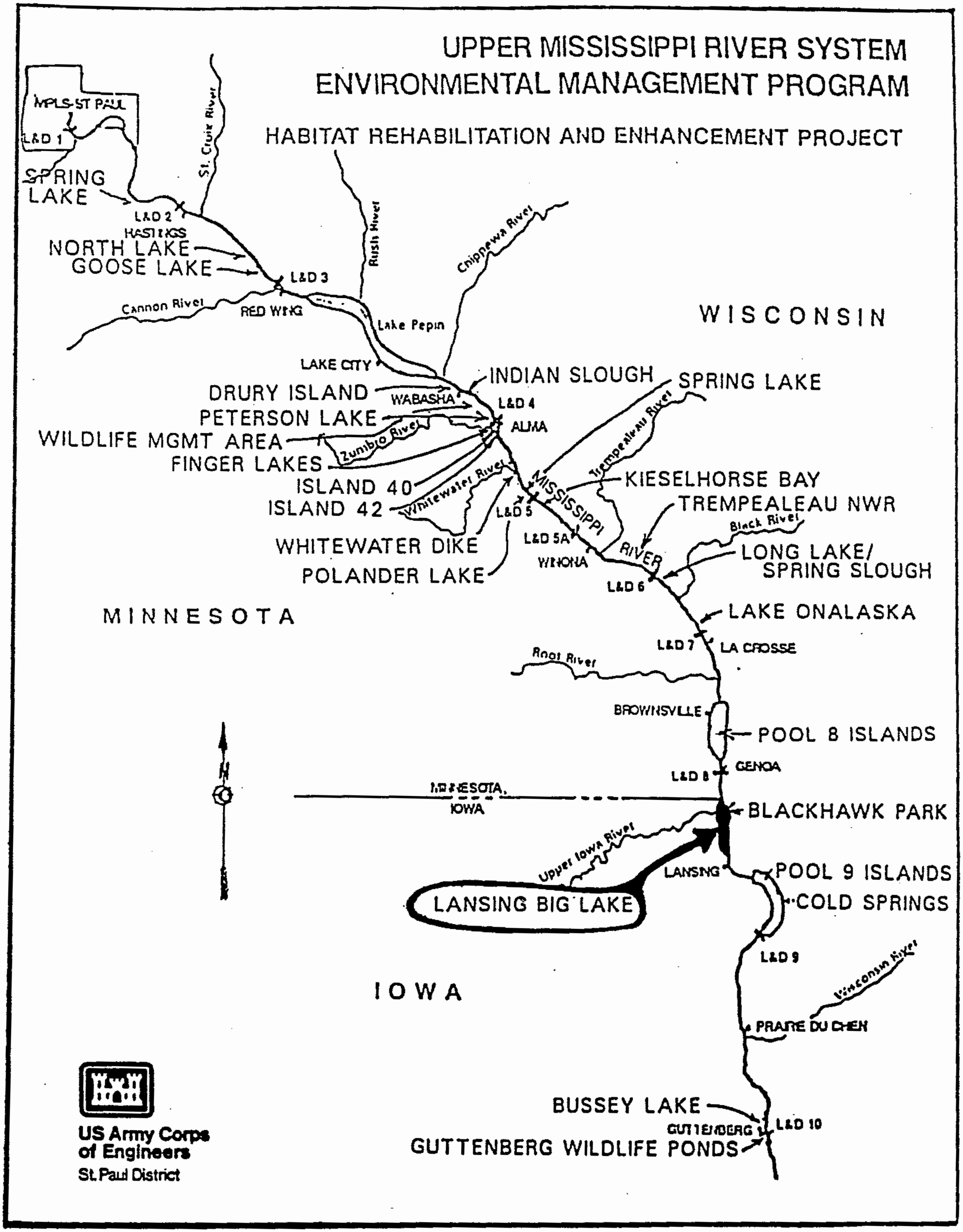

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
MPLS-ST PAUL
L&D 1
SPRING LAKE
L&D 2
HASTINGS
NORTH LAKE
GOOSE LAKE
L&D 3
St. Croix River
Rush River
Chippewa River
Cannon River
RED WING
Lake Pepin
WISCONSIN
LAKE CITY
INDIAN SLOUGH
SPRING LAKE
DRURY ISLAND
WABASHA
L&D 4
PETERSON LAKE
ALMA
WILDLIFE MGMT AREA
Zumbro River
Trempealeau River
FINGER LAKES
KIESELHORSE BAY
ISLAND 40
Whitewater River
MISSISSIPPI RIVER
ISLAND 42
L&D 5
TREMPEALEAU NWR
Black River
WHITEWATER DIKE
L&D 5A
LONG LAKE/
SPRING SLOUGH
WINONA
POLANDER LAKE
L&D 6
MINNESOTA
LAKE ONALASKA
L&D 7
LA CROSSE
Root River
BROWNSVILLE
POOL 8 ISLANDS
GENOA
L&D 8
MINNESOTA
IOWA
BLACKHAWK PARK
Upper Iowa River
LANSING
POOL 9 ISLANDS
LANSING BIG LAKE
COLD SPRINGS
L&D 9
IOWA
Wisconsin River
PRAIRE DU CHEN
US Army Corps
of Engineers
St. Paul District
BUSSEY LAKE
GUTTENBERG
L&D 10
GUTTENBERG WILDLIFE PONDS

PLATE 1

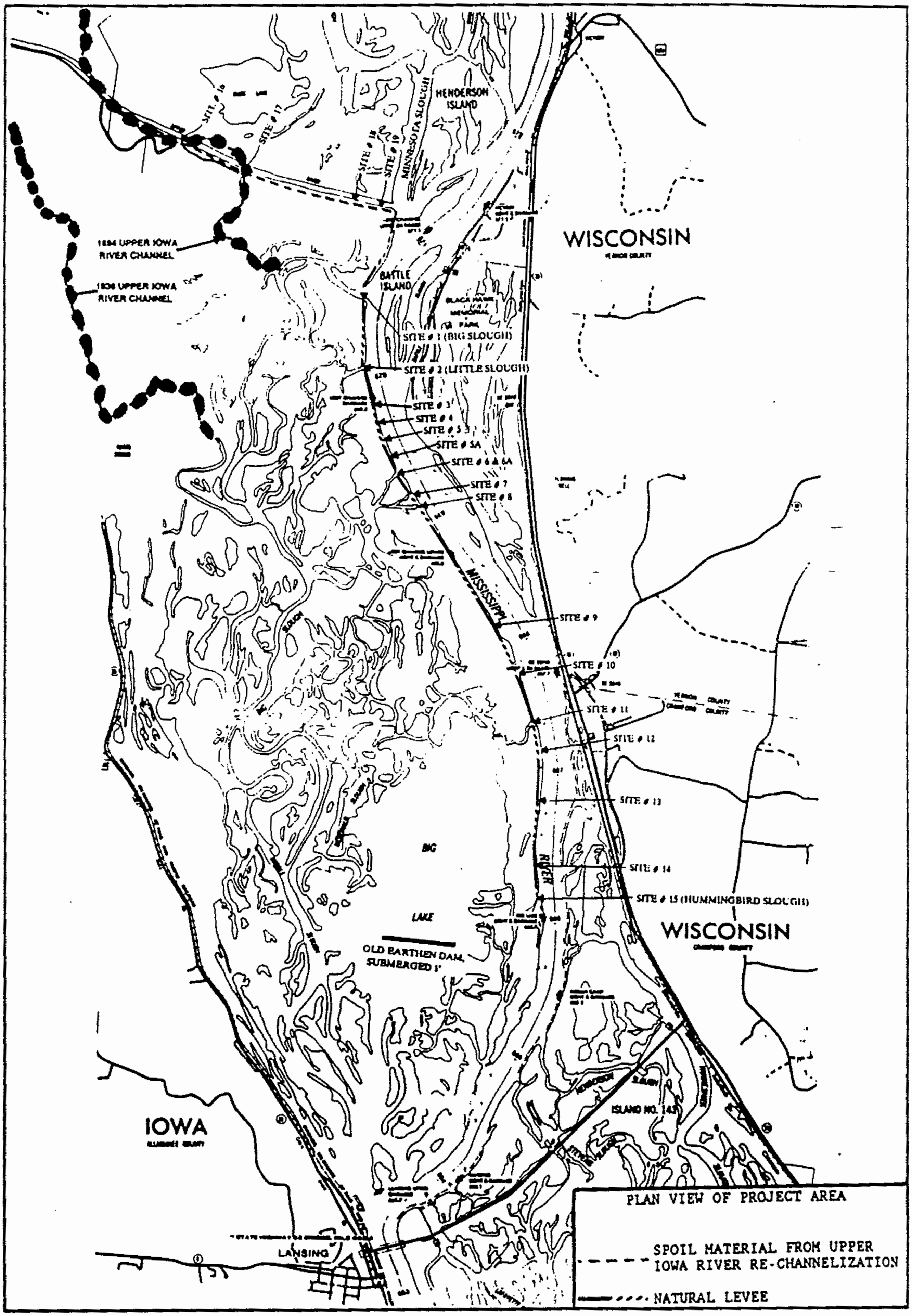

HENDERSON ISLAND
MINNESOTA SLOUGH
SITE # 16
SITE # 17
SITE # 18
SITE # 19
1894 UPPER IOWA RIVER CHANNEL
1836 UPPER IOWA RIVER CHANNEL
BATTLE ISLAND
BLACK HAWK MEMORIAL PARK
WISCONSIN
SITE # 1 (BIG SLOUGH)
SITE # 2 (LITTLE SLOUGH)
SITE # 3
SITE # 4
SITE # 5
SITE # 5A
SITE # 6 & 6A
SITE # 7
SITE # 8
MISSISSIPPI
SITE # 9
SITE # 10
SITE # 11
SITE # 12
SITE # 13
SITE # 14
SITE # 15 (HUMMINGBIRD SLOUGH)
WISCONSIN
BIG
LAKE
OLD EARTHEN DAM, SUBMERGED 1'
RIVER
ISLAND NO. 143
IOWA
LANSING
PLAN VIEW OF PROJECT AREA
SPOIL MATERIAL FROM UPPER IOWA RIVER RE-CHANNELIZATION
NATURAL LEVEE

PLATE 2

TITLE: Aquatic Habitat Change From 1939 to 1973
LOCATION: Lansing Big Lake - Pool 9 UMR

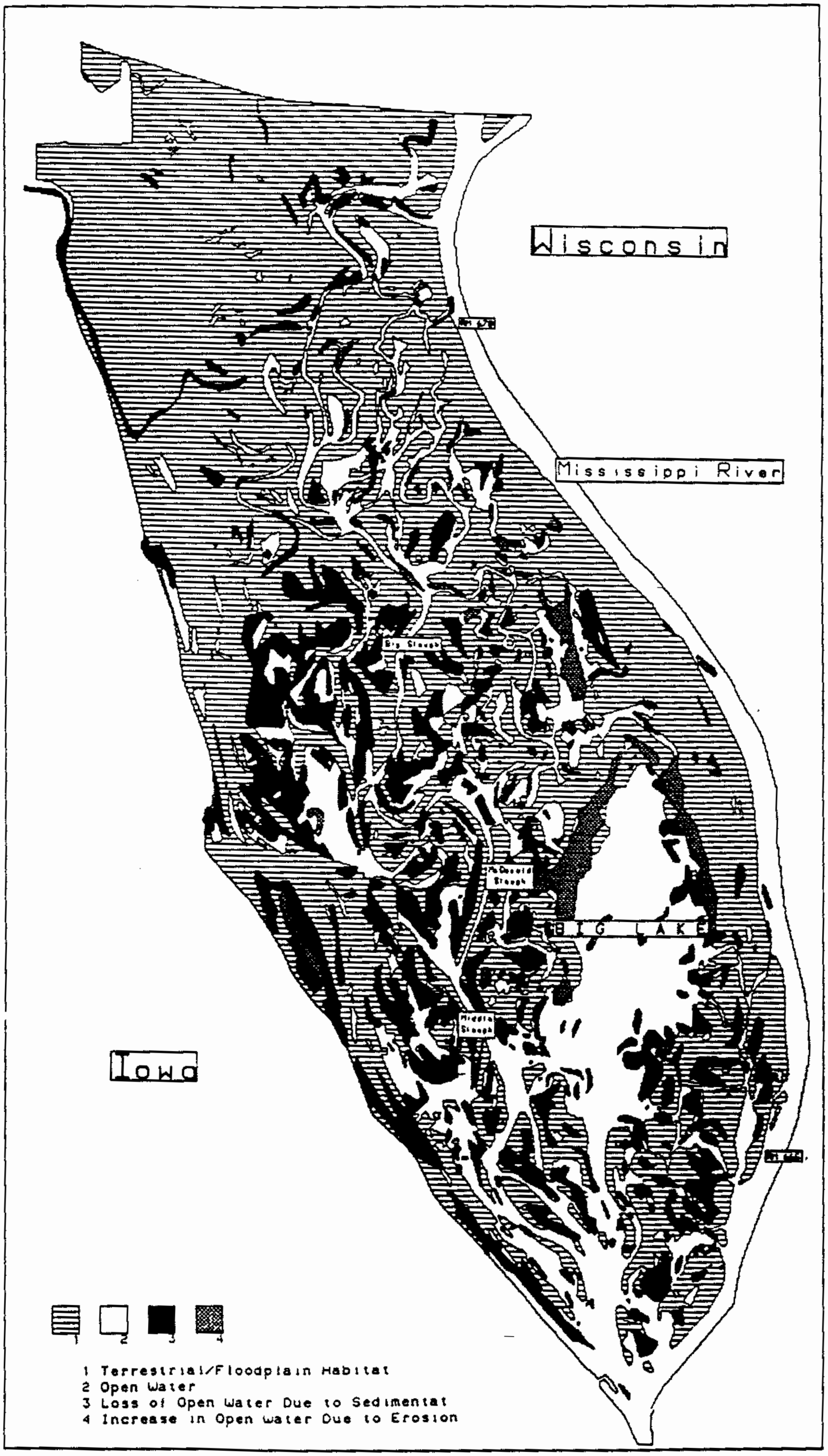
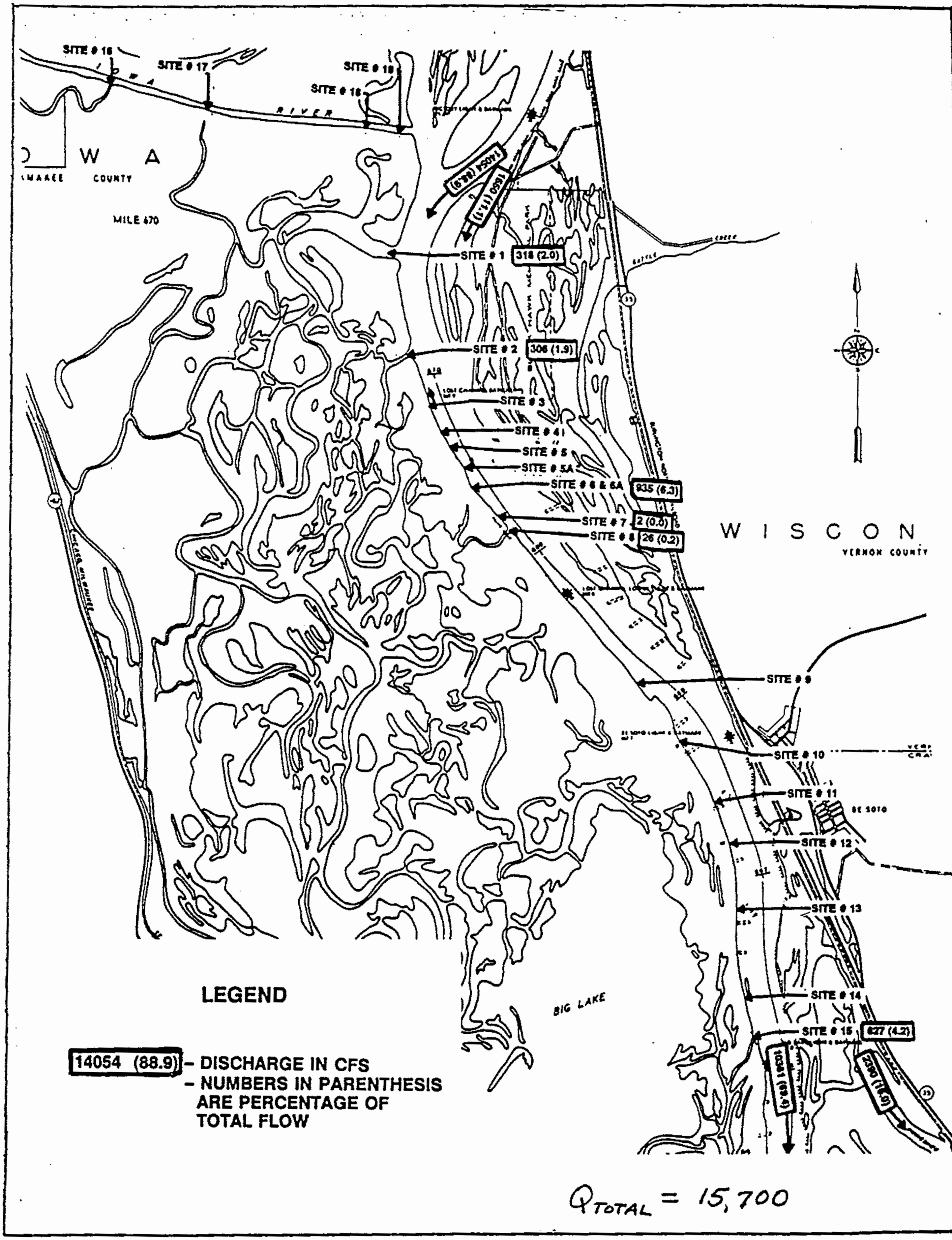
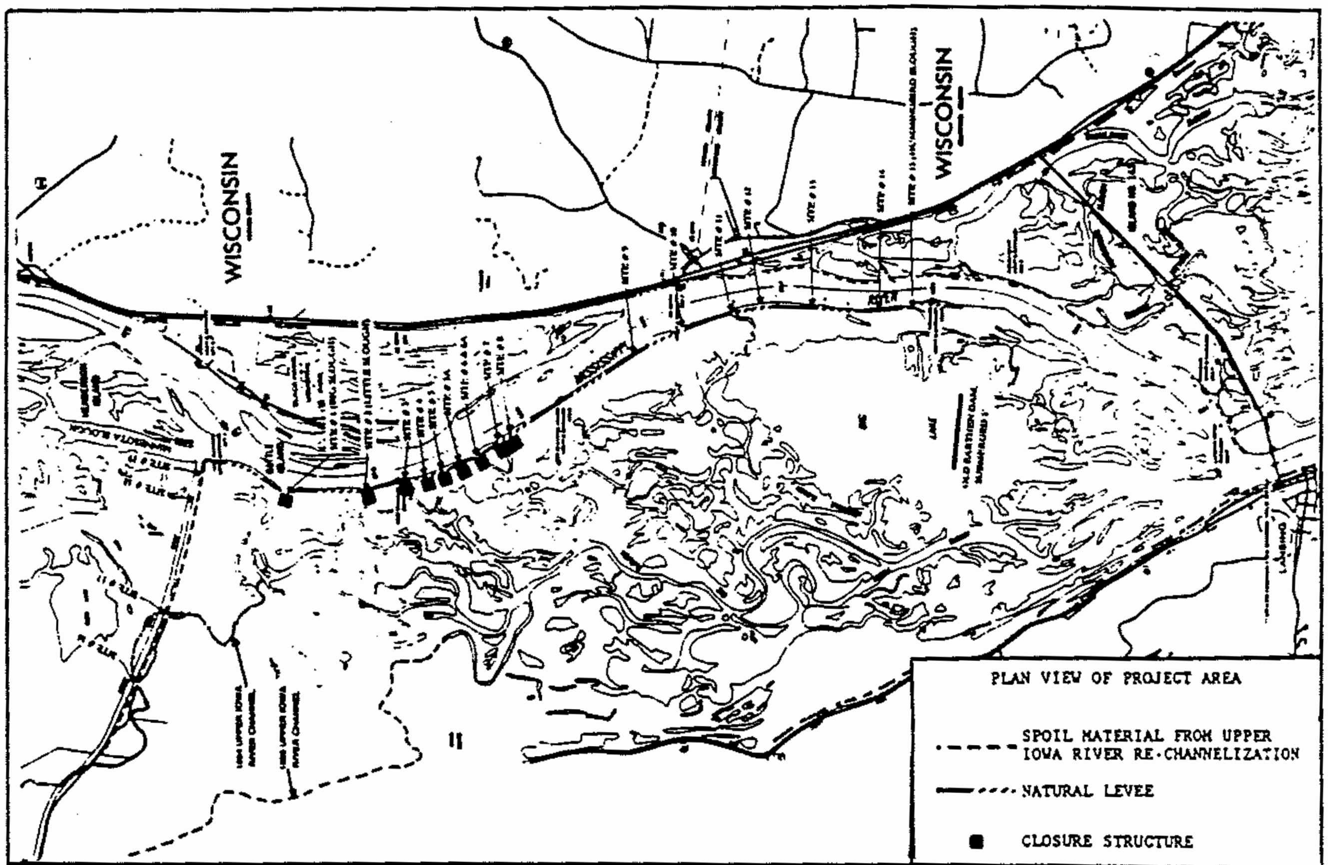


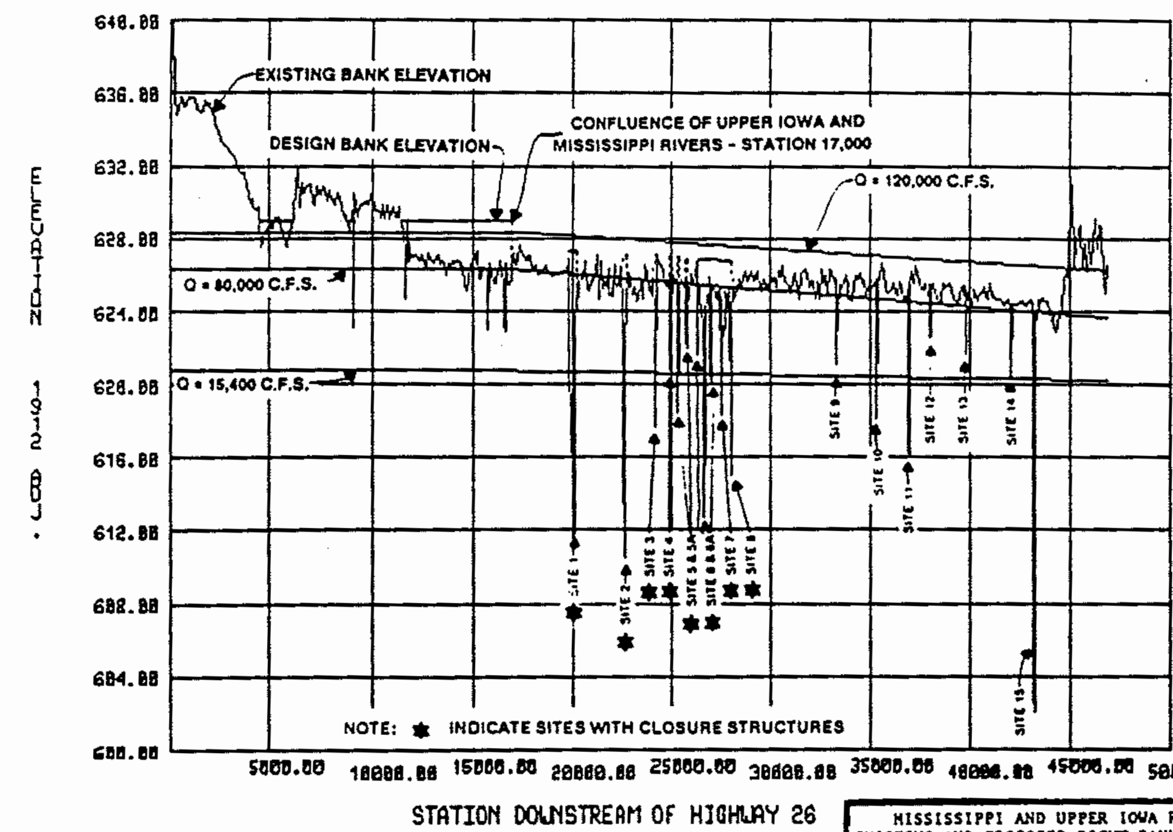
PLATE 3



SITE # 16
SITE # 17
SITE # 19
SITE # 18
IOWA RIVER
I O W A
COUNTY
MILE 670
14054 (88.9)
1650 (11.1)
SITE # 1
318 (2.0)
SITE # 2
306 (1.9)
SITE # 3
SITE # 4
SITE # 5
SITE # 5A
SITE # 6 & 6A
935 (6.3)
SITE # 7
2 (0.0)
SITE # 8
26 (0.2)
W I S C O N
VERNON COUNTY
SITE # 9
SITE # 10
SITE # 11
DE SOTO
SITE # 12
SITE # 13
SITE # 14
SITE # 15
627 (4.2)
BIG LAKE
LEGEND
14054 (88.9) - DISCHARGE IN CFS
- NUMBERS IN PARENTHESIS ARE PERCENTAGE OF TOTAL FLOW
Q_{TOTAL} = 15,700

PLATE 4



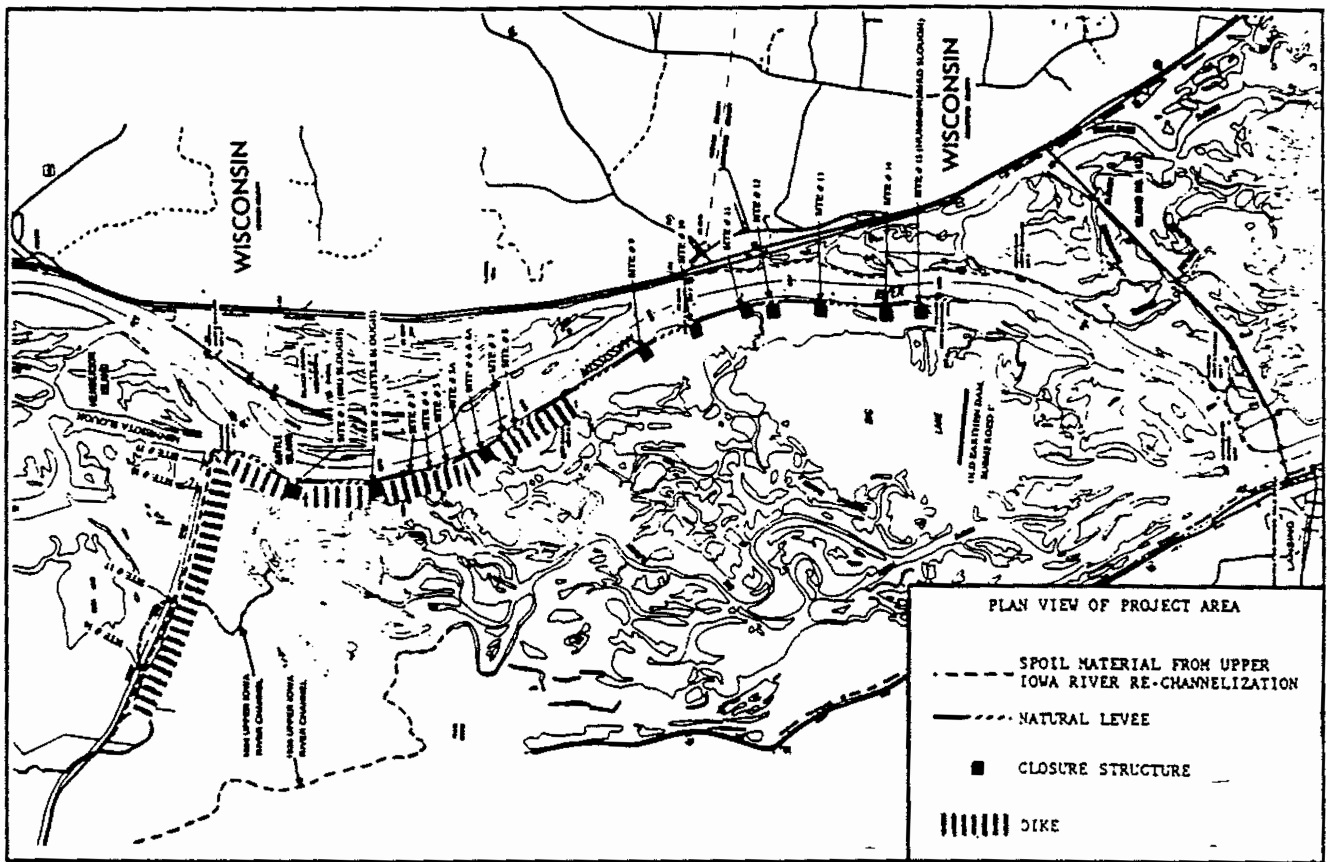


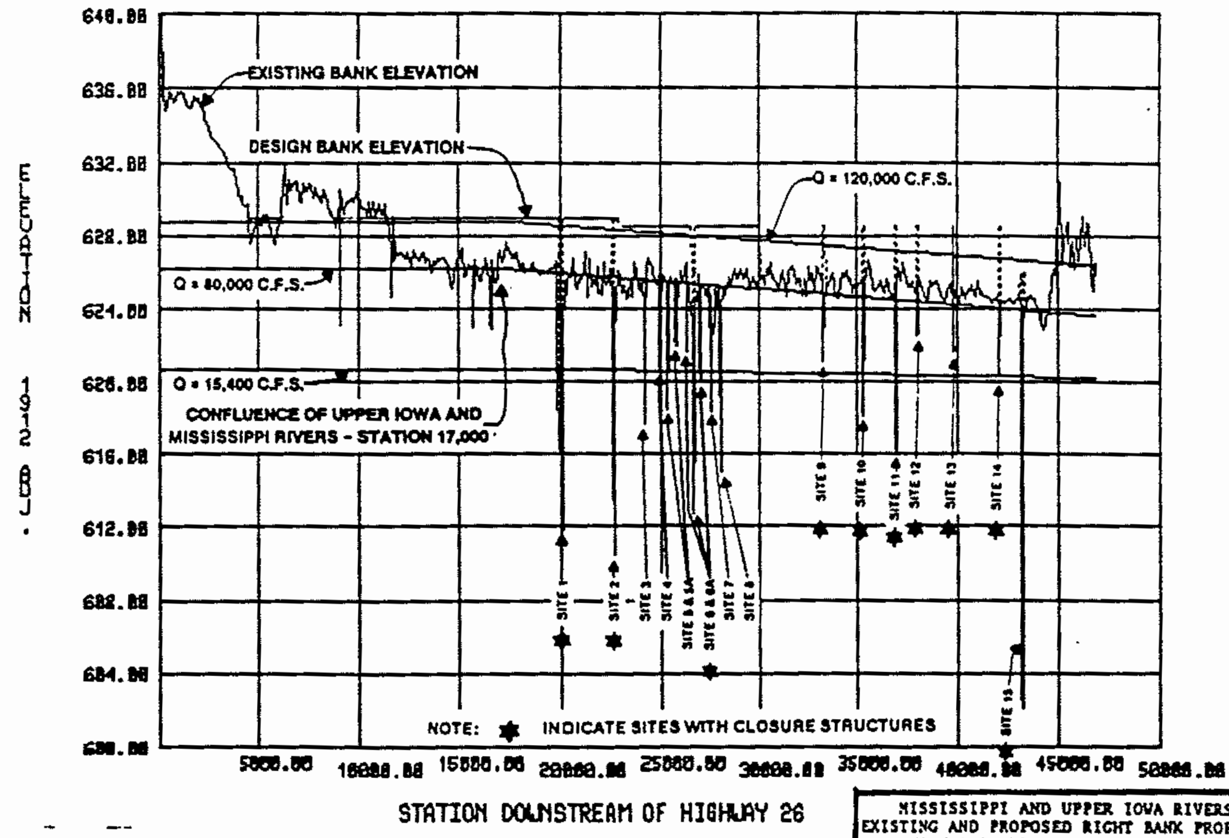
MISSISSIPPI AND UPPER IOWA RIVERS
EXISTING AND PROPOSED RIGHT BANK PROFILES
AND WATER SURFACE PROFILES, PLAN 1

PLAN 1

PLAN AND SECTION VIEW

PLATE 5



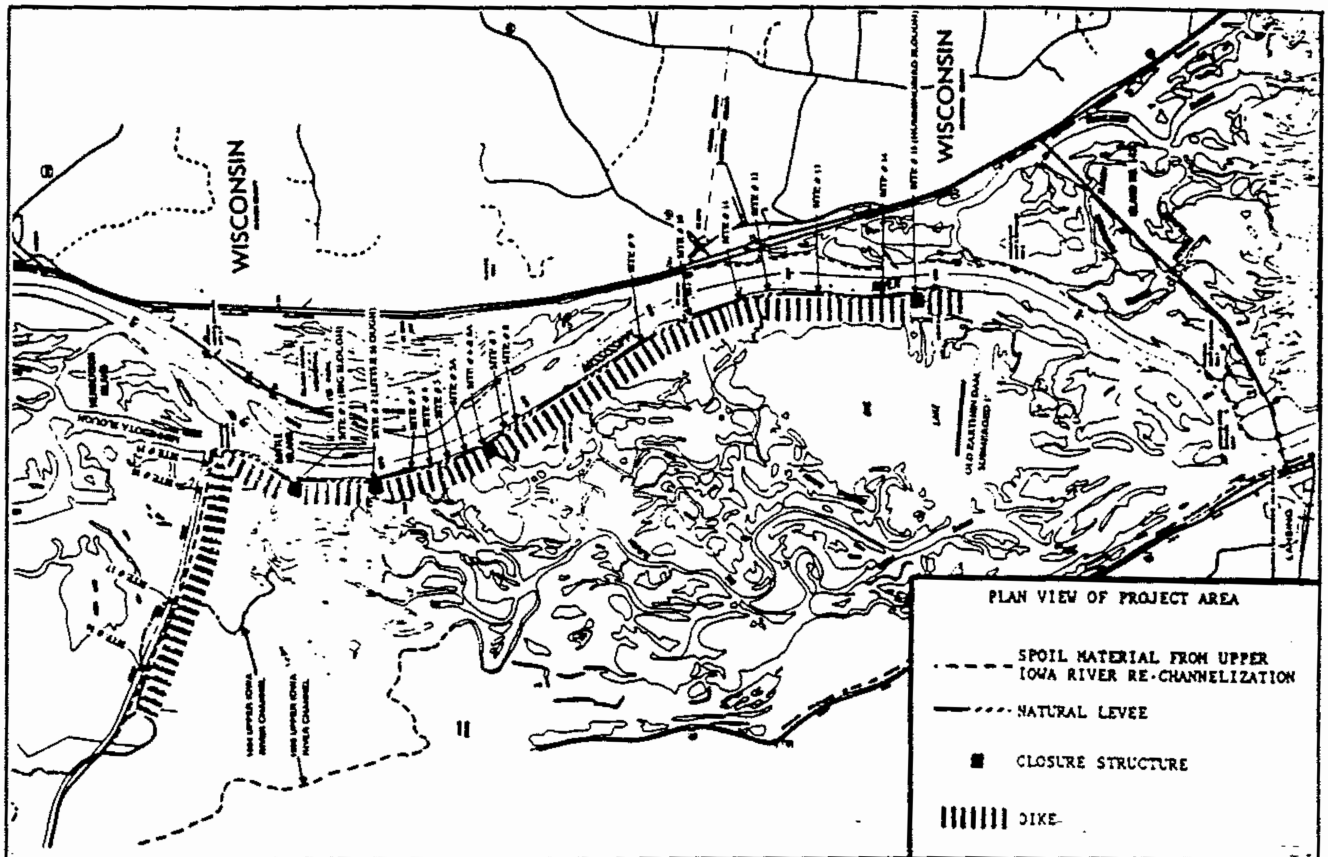


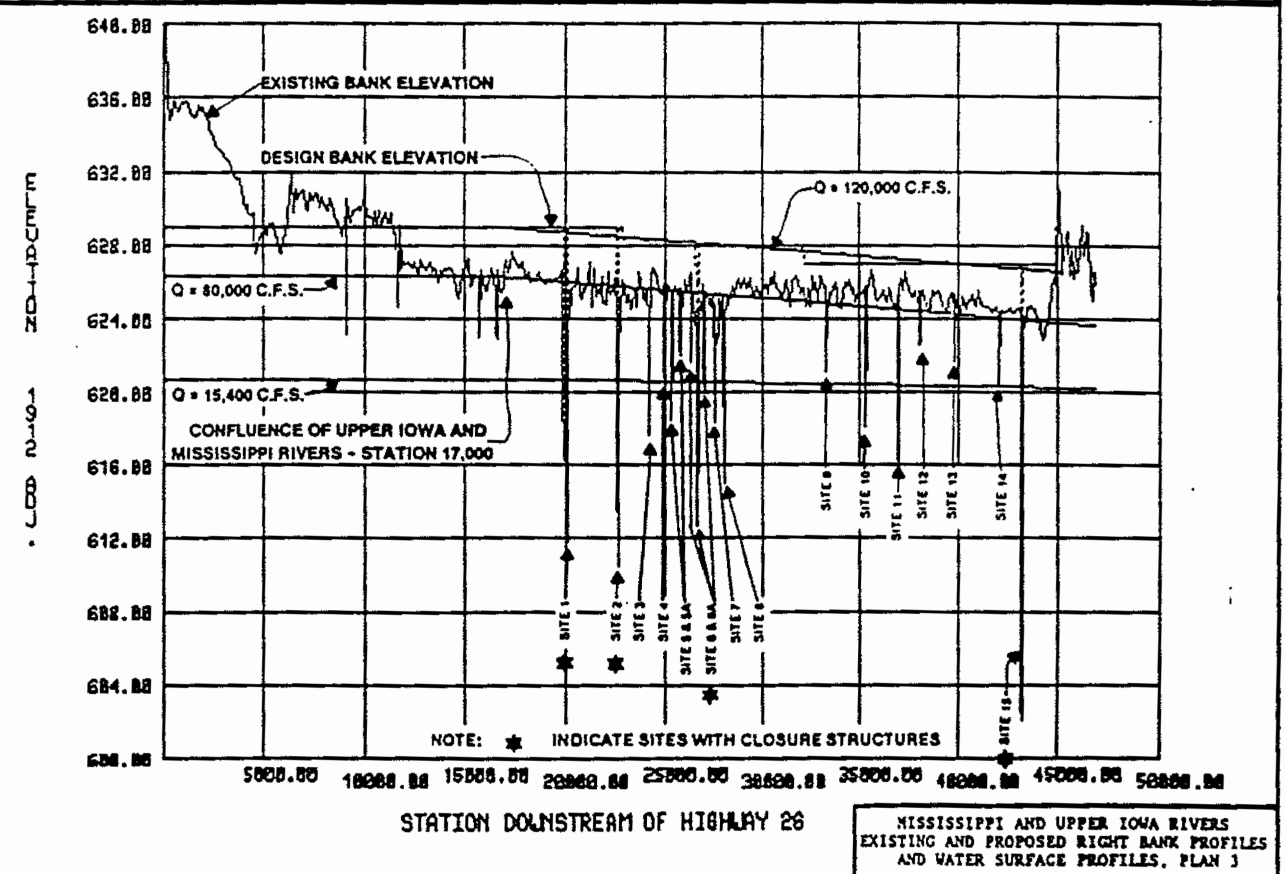
MISSISSIPPI AND UPPER IOWA RIVERS
EXISTING AND PROPOSED RIGHT BANK PROFILES
AND WATER SURFACE PROFILES, PLAN 2

PLAN 2

PLAN AND SECTION VIEW

PLATE 6





PLAN 3 & 4

PLAN AND SECTION VIEW

PLATE 7

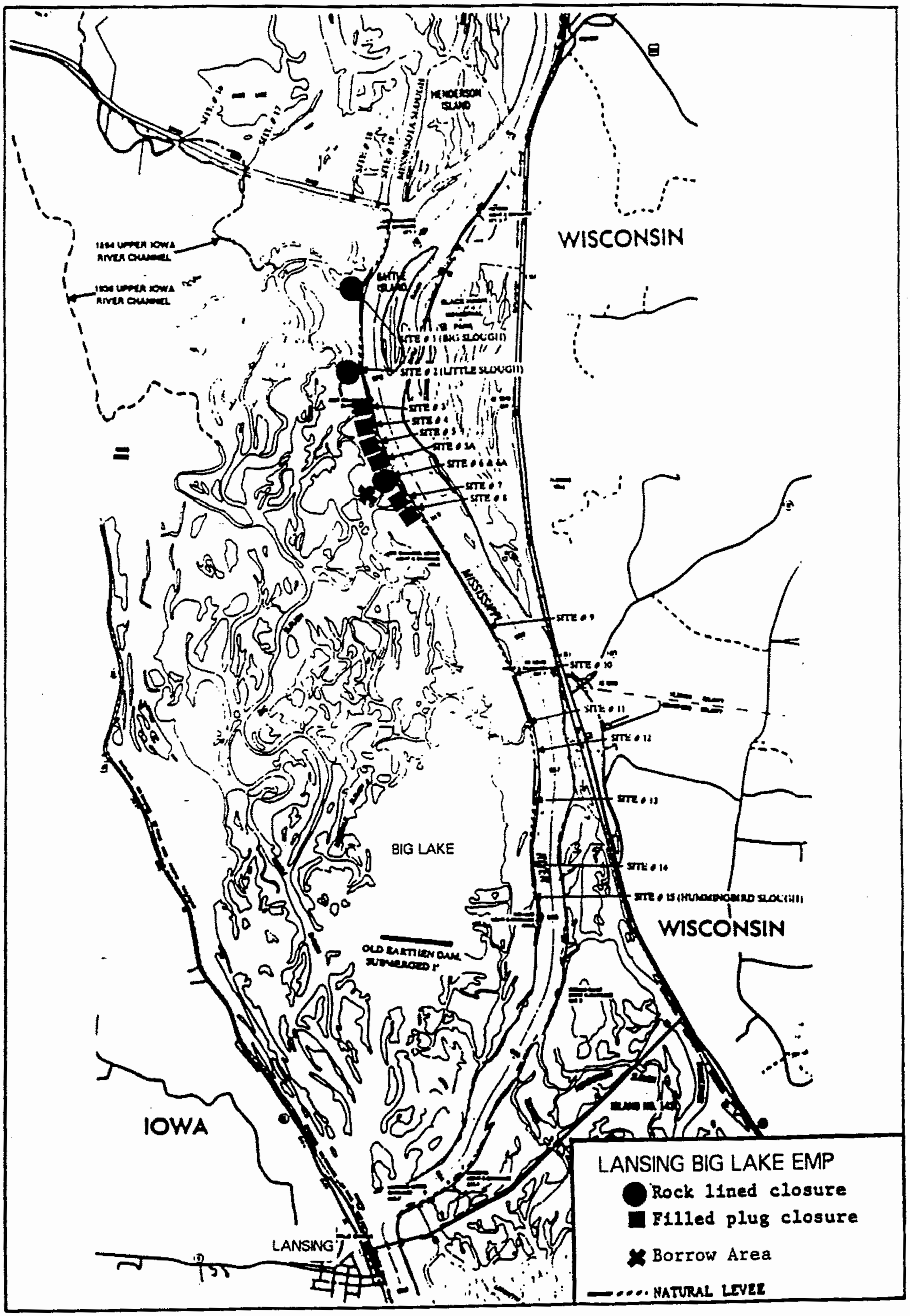
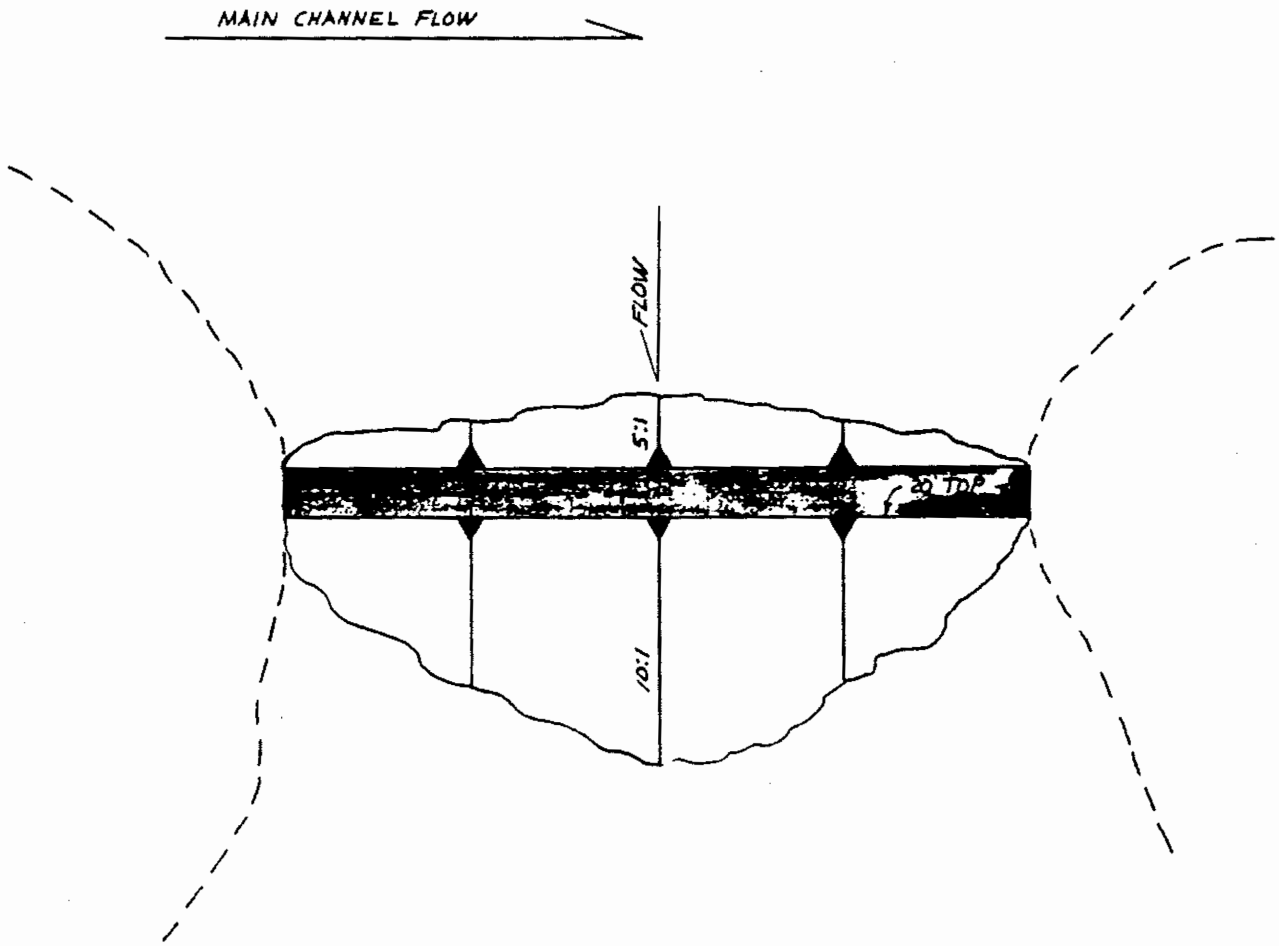
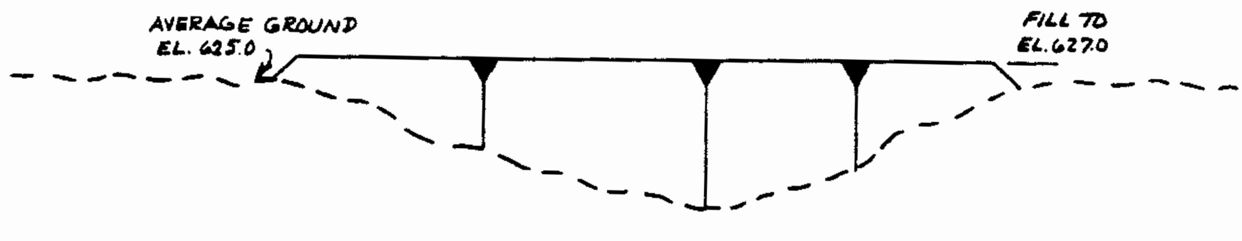

WISCONSIN
WISCONSIN
IOWA
BIG LAKE
LANSING
HENDERSON ISLAND
SITE # 9
SITE # 10
SITE # 11
SITE # 12
SITE # 13
SITE # 14
OLD EARTHEN DAM, SUBMERGED 1'
LANSING BIG LAKE EMP
Rock lined closure
Filled plug closure
Borrow Area
NATURAL LEVEE

PLATE 8



TYPICAL
CHANNEL CLOSURE STRUCTURE
PLAN
NTS



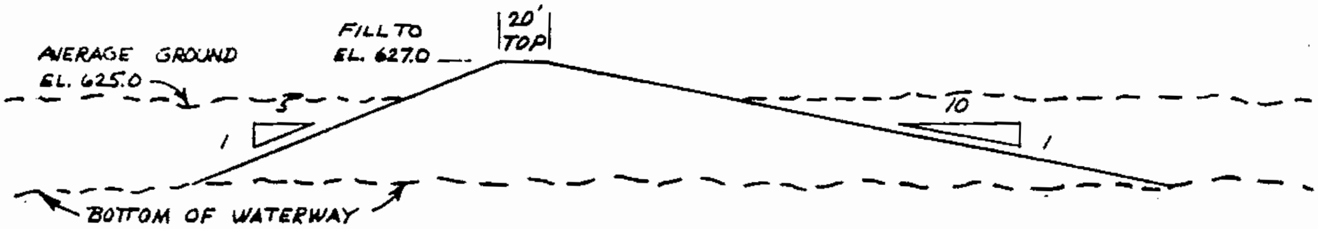
TYPICAL
CHANNEL CLOSURE STRUCTURE
SECTION
NTS

LANSING BIG LAKE

CHANNEL CLOSURE STRUCTURES

SITES #3, 4, 5, 5A, 6A, 7 & 8

Plate 9



TYPICAL
CHANNEL CLOSURE STRUCTURE
CROSS SECTION
NTS

DIMENSION AND QUANTITIES
FOR
CHANNEL CLOSURE STRUCTURES

SITES 3, 4, 5, 5A, 6A, 7 & 8

	SITES						
	3	4	5	5A	6A(1)	7	8
*DEPTH-Ave	3.9	2.7	4.2	2.4	2.1/2.9	3.2	3.9
-Max	8	5	8	4	4/6	8	11
WIDTH	124	85	124	72	72/98	124	163
**LENGTH	80	60	100	75	60/130	410	330
FILL	1,370	527	1,324	850	1,395	2,000	2,650

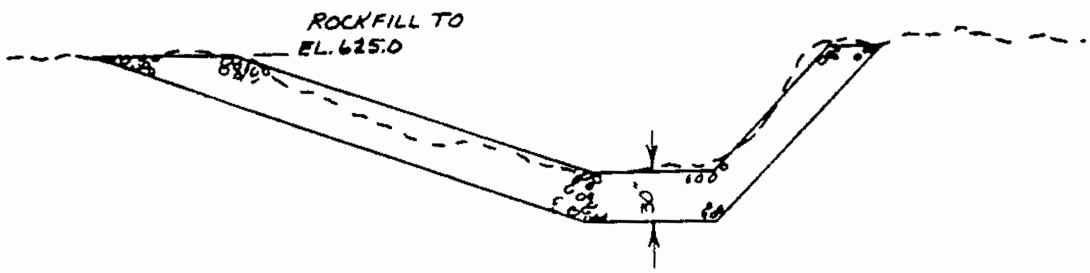
***TOTAL FILL 10,116cy

* Average depth determined below El. 627.0.
Maximum depth determined below El. 627.0.
** Horizontal centerline distance of top of channel closure structure.
*** Fill will be obtained from the excavations at Sites 1 & 2.
Any additional fill or borrow will be obtained from the following:
1. Preformed scour hole (Site 6).
2. An alternative to material from the scour hole will be the main channel.
(1) Includes two 6A's.

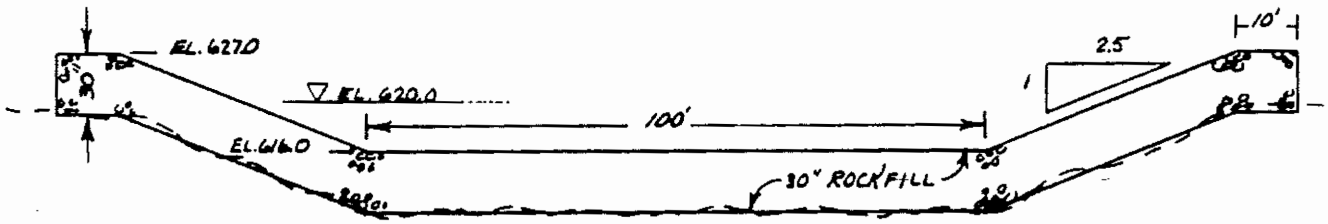
LANSING BIG LAKE

CHANNEL CLOSURE STRUCTURES

SITES #3, 4, 5, 5A, 6A, 7 & 8



TYPICAL
ROCK LINED SIDE CHANNEL
SECTION
NTS



TYPICAL
PARTIAL CLOSURE STRUCTURE
SECTION
NTS

DIMENSION AND QUANTITIES
FOR
ROCK LINED SIDE CHANNELS(#1 & 2)
AND
PARTIAL CLOSURE STRUCTURE(#6)

SITES # 1, 2 & 6

SITES

	1	2	6(1)
DEPTH	30"	30"	30"
WIDTH	30'	100'	200'
*LENGTH	360'	200'	230'
**EXCAVATION	1,000cy	1,950cy	0
ROCKFILL	***1,000cy	***1,950cy	3,670
FILL	NA	NA	0

**TOTAL EXCAVATION 2,950CY
***SITES 1 & 2 ROCKFILL 2,950CY
SITE 6 ROCKFILL 3,670CY
SITES 1, 2 & 6 TOTAL ROCKFILL 6,620CY

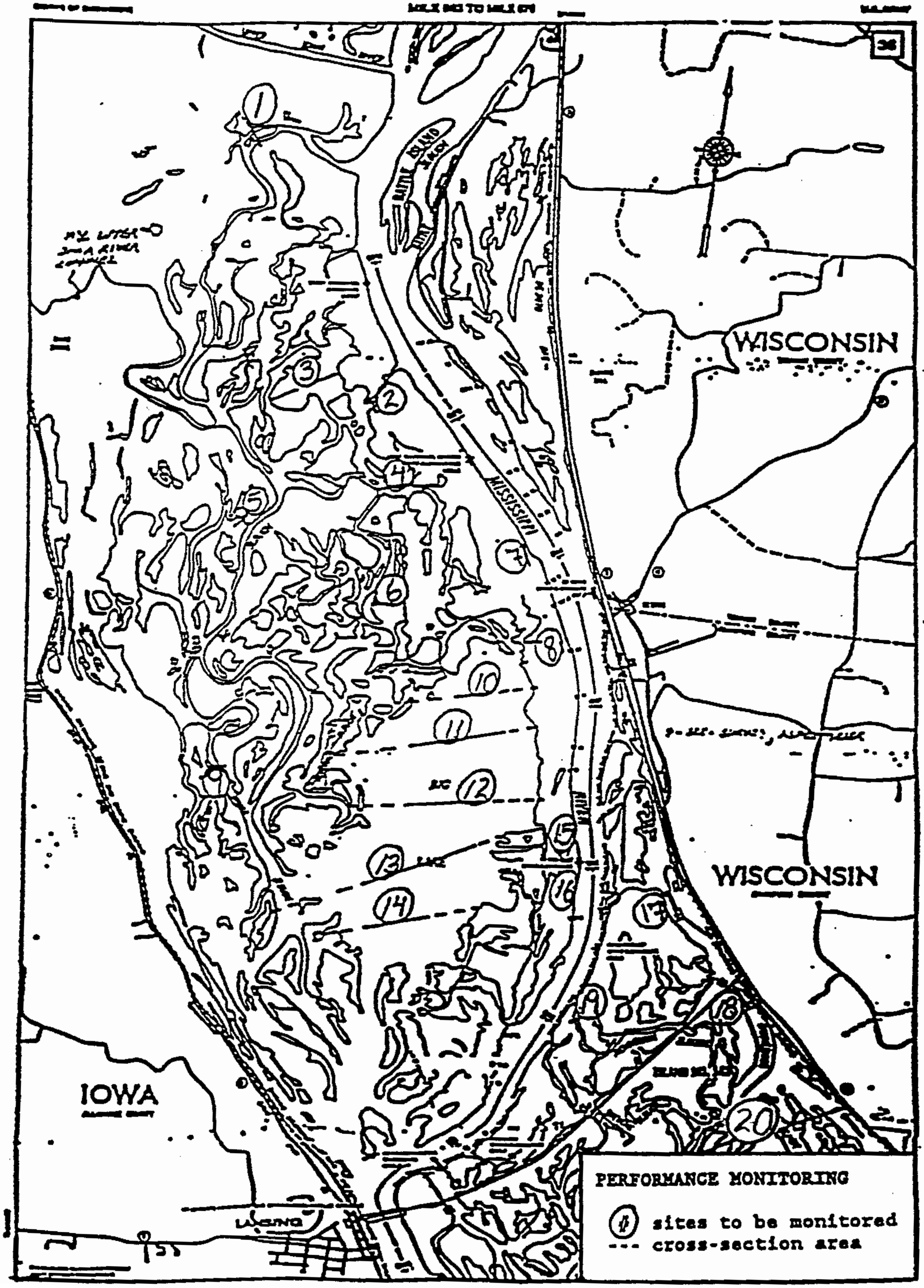
* Horizontal distance across rock lined side channels.
** Material as excavated will be placed in Sites 3, 4, 5, 5A, 6A, 7 and 8 to construct channel closures.
*** Rockfill will replace excavated materials.

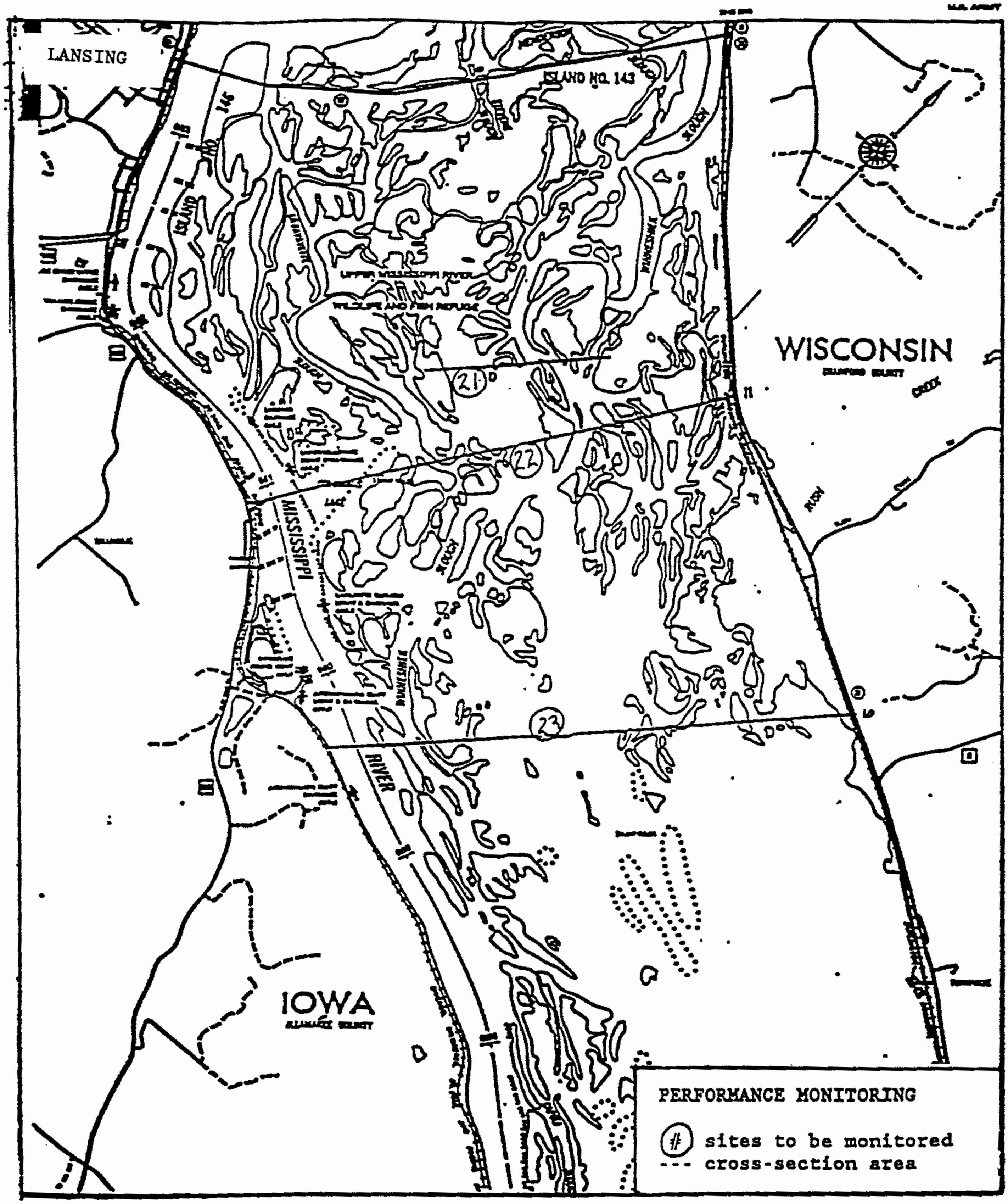
LANSING BIG LAKE

ROCK LINED SIDE CHANNELS
and
PARTIAL CLOSURE STRUCTURE

SITES #1, 2, & 6

Plate 11

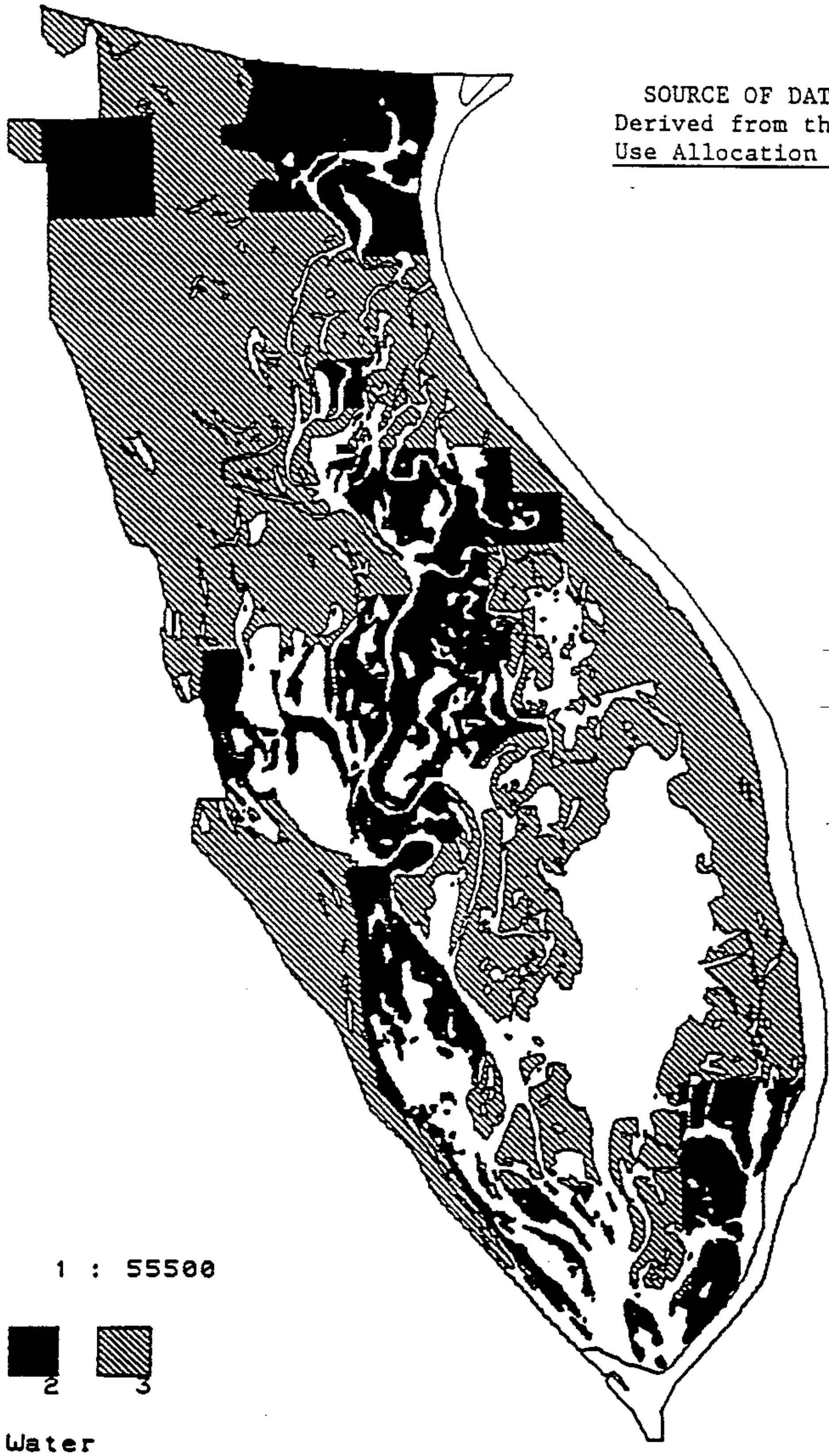

WISCONSIN
WISCONSIN
IOWA
LANSING
MISSISSIPPI
PERFORMANCE MONITORING
sites to be monitored
--- cross-section area



LANSING
ISLAND NO. 143
UPPER MISSISSIPPI RIVER
WILDLIFE AND FISH REFUGE
WISCONSIN
MISSISSIPPI
RIVER
IOWA
21
22
23
PERFORMANCE MONITORING
sites to be monitored
--- cross-section area

PLATE 13

SOURCE OF DATA:
Derived from the Land Use Allocation Plan, '83



SCALE: 1 : 55500

1 Water
2 U.S. Fish and Wildlife Service Land
3 Corps of Engineers Land

TITLE: Land Ownership - Lansing Big Lake EMP Study Area
LOCATION: Pool 9 - Mississippi River

PLATE 14

Attachment 1

Appendix A - Hydraulics and Sedimentation Analysis

APPENDIX A

HYDRAULICS AND SEDIMENTATION ANALYSIS

LANSING BIG LAKE
DEFINITE PROJECT REPORT

TABLE OF CONTENTS

PLATES

TABLES

Lansing Big Lake
Definite Project Report

Appendix A
Hydraulics and Sedimentation Analysis

PHYSICAL PROCESSES

The Big Lake backwater area is located in upper Pool 9 between river miles 663.7 and 670.6 (Plate 1). Prior to construction of Lock and Dam 9, this area was typical of the irregularly braided Mississippi River floodplain. During normal low flows three major secondary channels; Big Slough, Little Slough, and Hummingbird Slough had continuous flow through them. Other secondary channels carried flow only during high water events. Both erosion and deposition of sediments occurred during various phases of annual hydrographs.

Construction of the lock and dams in the 1930's created a series of pools where braided riverine environments previously existed. This released a great amount of aquatic habitat from the fluvial matrix of sloughs, lakes, ponds, and flood plain forest. However, the decrease in hydraulic energy slope in each pool created an imbalance between sediment supply and transport capacity of the fluvial system, the result being sediment deposition in backwaters.

For existing conditions, Mississippi River discharges up to approximately 80,000 cfs result in the majority of sediment laden water entering the Big Lake area through secondary channels and low spots through the right bank of the Mississippi and Upper Iowa River main channels. These are labeled as "Sites" on Plate 1. During Mississippi River discharges in excess of 80,000 cfs portions of the right bank of the Mississippi River and the Upper Iowa River channels are overtopped and flow enters the Big Lake area over a much larger reach. Four major secondary channels provide the majority of the discharge into the area. They are Site 1 located at river mile 670.6, Site 2 at river mile 670.1, Site 6 at river mile 669.5, and Site 15 at river mile 666.1. Sites 1, 2, and 15 correspond to Big Slough, Little Slough, and Hummingbird Slough and have existed in some form since prior to 1937. Twelve smaller (tertiary) channels have also been identified. For total river flows of 15,000 cfs to 80,000 cfs, secondary channel discharge ranges from 17 to 32 percent of the total river discharge for existing conditions. Historically, Site 1 was the major secondary channel into the Big Lake area. In recent years, however, Site 6, has eroded and enlarged to the point where it now carries the greatest amount of the flow.

The Big Lake backwater area receives sediment from both the Mississippi and Upper Iowa Rivers. Most of this sediment enters through the secondary channels. The Mississippi River is the main source of sediment, however the Upper Iowa River, due to its relatively high sediment concentrations and proximity to the Big Lake area contributes a significant portion of the total sediment load. Both coarse sediments ($d50 > .0625$ mm) and fine sediments ($d50 < .0625$ mm) contribute to the degradation of aquatic habitat as follows:

a. Coarse sediments generally are transported through secondary channels as bed load and deposit in areas adjacent secondary channels or where these channels enter the open areas of Big Lake. This process gradually changes marsh habitat to terrestrial habitat.

b. Fine sediments from the Mississippi and Upper Iowa Rivers are usually transported as suspended load. These sediments enter the Big Lake area and cause wide spread deposition, limit light penetration and growth of aquatic plants, and generally degrade aquatic habitat. Fine sediment deposition is the major sediment related problem in the Big Lake area for existing conditions.

Prior to 1959 the Upper Iowa River flowed directly through the Big Lake area. Because of the decreased hydraulic energy gradient due to backwater effects of Lock and Dam 9, a significant amount of the Upper Iowa River sediment load deposited in the Big Lake area between 1937 and 1959. A flood control project completed in 1959 relocated the Upper Iowa channel so that it entered the Mississippi River at river mile 671.3, 0.7 miles upstream of Site 1. This didn't eliminate inputs from the Upper Iowa River to the Big Lake area however. Sediment laden Upper Iowa River discharges enter the Mississippi River in Minnesota Slough, follow the right bank of Minnesota Slough and the Mississippi River, and are drawn in by the secondary channels leading into the Big Lake area. Flood events on the Mississippi River may cause overtopping of the right bank of the Upper Iowa River and also result in sediment entering the area.

HYDRAULIC DATA

Discharge-Duration and Discharge-Frequency Relationships

Discharge duration curves for Lock and Dam 8 and for flow to the Big Lake area are shown on Plates 2 and 3. The discharges that correspond to the 2, 5, 10, 50, 100, and 500 year floods are given in the following table.

Table 1

Discharge - Frequency

Time of Return (Years)	Discharge (cfs)
2	96,000
5	137,000
10	164,000
50	226,000
100	255,000
500	321,000

Average Discharges

The average river discharge in the Big Lake area is 34,940 cfs. The Upper Iowa River and Bad Axe River enter the Mississippi River upstream of the study area. While these tributaries have a local impact on sediment transport and water quality they don't appreciably increase average discharges in the Mississippi River. The average discharge in the Upper Iowa River at Dorchestor, Iowa is approximately 460 cfs.

Stage-Discharge Relationship

The plan of operation of Lock and Dam 9 is detailed in the Lock and Dam 9 operation manual and is briefly described here.

Elevation 620 (all elevations given in this appendix are in feet above mean sea level, 1912 adjustment) is maintained at Lansing, Iowa, the primary control point for Pool 9 until the total river discharge exceeds 32,000 cfs. At this discharge, the maximum drawdown of the pool at the dam, one foot to elevation 619.0, is reached, and control of the pool is shifted to secondary control at the dam. As total river discharge exceeds 32,000 cfs, the pool level at the dam is held at elevation 619.0, and the stage at all other points in the pool is allowed to rise. At a total river discharge of 64,000 cfs all the gates at Lock and Dam 9 are raised out of the water. As discharges increase above 64,000 cfs open river conditions exist 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 619.0, which occurs at a discharge of approximately 64,000 cfs. Elevation 619.0 is maintained at the dam until the water level at Lansing drops to project pool, elevation 620.0, which occurs at a discharge of approximately 32,000 cfs. Plate 4 shows the operation curves for Lock and Dam 9. Table 2 shows stage discharge information at various locations throughout the study area.

Table 2

Stage - Discharge in Project Area

Lock and Dam 8 Discharge	Description	Lansing Gage	D/S end Big L.	D/S end Surveys	Humm & Winn Slough Site 15	Site 6	Little Slough Site 2	Big Slough Site 1	Upper Iowa River
	River Mile >>>>	663	663.7	665.64	666.1	669.5	670.1	670.6	671.3
15360	Ave. Q for USGS Discharge Meas.	620.00	620.06	620.22	620.26	620.54	620.60	620.64	620.70
34940	Ave. Q at Project Area	620.02	620.18	620.61	620.72	621.50	621.63	621.73	621.89
80000	66 percent frequency discharge	622.48	622.74	623.45	623.62	624.88	625.10	625.28	625.54
90000		623.20		624.18					626.27
100000	46 percent frequency discharge	623.92	624.18	624.88	625.05	626.30	626.52	626.70	626.96
110000		624.61		625.56					627.59
120000		625.29		626.23					628.23
137000	20 percent frequency discharge	627.00	627.20	627.44	627.50	628.00	628.20	628.30	628.50
164000	10 percent frequency discharge	628.65	628.83	629.10	629.50	629.80	629.90	630.00	630.15
255000	1 percent frequency discharge	633.65	633.80	634.15	634.20	634.70	634.80	634.90	635.00

Note:

1. Lock and Dam 9 operation curves were used for discharges of 15,360, 34,940, 80,000, and 100,000 cfs. Linear interpolation using water surface elevation at Lansing and L/D 8 was used to obtain water surface elevations.

2. Upper Mississippi River Water Surface Profiles was used for discharges of 137,000, 164,000, and 255,000 cfs.

Water Surface Profiles

Water surface profiles for existing conditions throughout the study reach are shown on Plate 5.

SECONDARY CHANNEL DISCHARGES INTO BACKWATER AREAS

Physical Parameters

The discharge entering the Big Lake area is a function of secondary channel geometry, hydraulic roughness, and energy slope. Channel geometry affects cross sectional area and wetted parameter. Plate 6 shows the relationship between total secondary channel area and Lock and Dam 8 discharge for discharges up to 100,000 cfs. As can be seen, at a total river discharge in excess of 80,00 cfs, when the right bank of the Mississippi and Upper Iowa Rivers is overtopped, side channel area increases substantially. This is offset somewhat by the increased hydraulic roughness due to the effects of vegetation and the shallower depth of flow over the right bank, and by the decrease in hydraulic energy slope at discharges greater than 80,000 cfs.

The relationship between energy slope is a function of river discharge. As described by Rada, et al., 1980.

" An important hydrological feature observed and documented in Navigation Pool No. 9 is the linear relationship between total discharge and head. In other words, as discharge increased, the slope of Pool 9 between Lock and Dam No. 8 and the control point (Lansing, Ia.) increased. This phenomenon is important because changes in head significantly affected the amount of water discharged from the main channel into secondary channels within the study area."

In the Big Lake area this means that increases in total river discharge cause an increase in the percentage of the total discharge that enters the area. This phenomenon is graphically illustrated by the operation curve for Lock and Dam 9, Plate 4. As previously described and as shown on Plate 4, elevation 620 is maintained at Lansing, Iowa until the total river discharge is 32,000 cfs. At this discharge the tailwater elevation at Lock and Dam 8 has risen to 623.3, resulting in a head differential of 3.23 feet between Lock and Dam 8 and Lansing. As total river discharges exceed 32,000 cfs the water surface elevation at Lansing is allowed to increase. However, the increase at Lansing is not as rapid as that at Lock and Dam 8 and the head differential continues to increase. For example at a total river discharge of 80,000 cfs the water surface elevation at Lansing is 622.50 and at Lock and Dam 8 it is 628.45 for a head differential of 5.95 feet. As discharges increase above 80,000 cfs, however, the head differential between Lock and Dam 8 and Lansing decreases. Thus Rada's statements are true up to a discharge of 80,000 cfs. Rada also pointed out that as the total river discharge increases, the percentage of total river flow into secondary channels in the upper reaches of the study area increases. However, in the lower reaches of the study area, closer to the control point at Lansing, the percentage of secondary channel discharge decreases for increasing total river flows.

Field Data

A summary of secondary channel discharge measurements taken by the U.S. Geologic Survey, Iowa Branch (USGS), the Iowa Department of Natural Resources (IDNR), the Corps of Engineers, and as part of Rada's study is presented in Table 3.

Table 3

Summary of Discharges Through Secondary Channels into the Big Lake Area

Lock and Dam 8 Discharge	Big Slough Site 1	Little Slough Site 2	Site 3	Site 6	Site 7	Site 8	Humming bird Sl. Site 15	Winne shiek Sl.	Source and Date
River >>> Mile	670.6	670.1	669.85	669.5	669.2	669.2	666.1	666.1	
45700	1606 (3.50)								COE 6/7/89
44800		1346 (3.00)							COE 6/7/89
37225			57 (0.15)						COE 6/8/89
42860				2487 (5.80)					COE 6/7/89
43920					80 (0.18)				COE 6/7/89
43570						311 (0.71)			COE 6/7/89
37675							2240 (5.94)		COE 6/8/89
37525								8086 (21.6)	COE 6/8/89
9600	231 (2.40)	148 (1.54)		415 (4.32)					COE 8/6/89
15800	318 (2.01)	306 (1.93)							USGS 10/25/88
14930				935 (6.26)	2 (0.00)	26 (0.17)	627 (4.20)	2390 (16.01)	USGS 10/26/88
60800	1900 (3.12)	2900 (4.77)							IDNR 07/23/86
12249	243 (1.98)	185 (1.51)				163 (1.33)	686 (5.60)	2288 (18.7)	Rada 7/17/80
21300	596 (2.80)	201 (0.94)				272 (1.28)	803 (3.77)	3132 (14.7)	Rada 7/1/80
45000	722 (1.60)	608 (1.35)				837 (1.86)	1562 (3.47)	7156 (15.90)	Rada 6/19/80
78000	6365 (8.16)	3777 (4.84)				2388 (3.06)	5161 (6.62)	13251 (17.0)	Rada 6/11/80

Note: 1. Numbers in parenthesis are percentage of total river discharge at lock and dam 8.

2. Discharges down Winneshiek Slough for 1980 data were assumed to equal the sum of discharges at cross sections S-7 and S-11 in the study by Rada.

As might be expected, there is some scatter in the data. Some of this scatter is due to errors in taking discharge measurements, however fluvial changes in the area over the time period of the measurements (ie. 1980 to 1989) also account for some of the scatter. Examination of aerial photos and other data indicate that Site 6 has been the major inflow point to the Big Lake area for only the last 5 to 10 years. Aerial photographs taken in 1975 indicate that the top width of Site 6 was approximately 30 feet. A channel cross section at Site 6 obtained in 1980 for a study done by Eckblad (1981) shows a larger channel with an average bottom elevation of approximately 616.5 and a top width at elevation 620 of approximately 70 feet. Based on discharge measurements done in 1989, it appears that this cross section has continued to erode and now has a top width of approximately 130 feet. Field Reconnaissance of this site shows actively eroding channel banks.

By comparing the 1980 discharge measurements to those done in 1988 and 1989, some information on the magnitude of the fluvial changes in the area can be gained. Table 4 below is a supplement to Table 3 and lists the percentage of the total river discharge entering the Big Lake area based on the individual secondary channel discharge measurements given in Table 3.

Table 4

Total Side Channel Discharge

Date	Lock and Dam 8 (cfs)	Percent to Big Lake Area
	1980 Discharge Measurements	
11 June 80	78000	22.7
19 June 80	45000	8.3
01 July 80	21300	8.8
17 July 80	12249	10.4
	1988 and 1989 Discharge Measurements	
25 Oct 88	15360	14.6
07 June 89	41000	19.2

Only major secondary channels were monitored in 1980. Based on aerial photos from the time period there potentially could have been flow through several smaller sites. Sites included in the 1988 and 1989 surveys that weren't in the 1980 discharge surveys include Sites 3, 6, and 7. Flow through sites 3 and 7 account for less than 1 percent of the total discharge to the Big Lake area for existing conditions and based on aerial photographs it appears that the top width of these channels hasn't changed significantly. Site 6 is the major secondary channel for existing conditions but in 1980 it was quite small. Therefore, for the purpose of analysis, it will be assumed that the 1980 measurements represent the total discharge to the Big Lake area at that time.

Based on this it appears there has been a 5 to 10 percent increase in secondary channel discharges for river discharges of 15,000 cfs to 41,000 cfs respectively. Most of this can be accounted for by the increased discharge at Site 6. Based on the individual measurements in Table 3, Site 6 discharges equal approximately 6 percent of the total discharge.

At lower discharges the data taken by the Rada and the USGS correspond quite well for Site 1, but for Site 2 the USGS measurement seems to indicate that there is more flow entering for a given river discharge. Field reconnaissance of this area indicate that erosion is occurring at Site 2. At Sites 7 and 8 it appears that the discharge capacity has decreased with time. Rada measured discharges of 300 and 837 cfs for total river discharges of 21,300 and 45,000 cfs respectively, while COE personnel measured a discharge of only 380 cfs for a total river discharge of 43800 cfs.

Based on the above information it appears that the secondary channel discharge into Big Lake increased 5 to 10 percent between 1980 and 1989. The discharge in Site 1 is same while the discharge in Site 2 and Site 6 has gone up.

Some of the characteristics of secondary channel discharge discussed previously are apparent in the data. First of all, the percentage of total discharge to the Big Lake area increases with increasing discharge. Secondly, for increasing river discharges, the percentage of secondary channel discharge increases at a faster rate for upstream channels than for downstream channels. For example, the 1980 discharge measurements show that the percentage of the total discharge flowing through Site 1 and through Site 2 is approximately 4.1 times and 3.2 times greater respectively at a total discharge of 78,000 cfs than it is for a discharge of 12249 cfs. However, the percentage of total flow through Site 15 only increased 1.2 times and that in Winneshiek Slough decreased for this same range of discharge measurements. A comparison of the discharge measurements taken in 1989 by Corps personnel with those taken in 1988 by USGS personnel gives similar results although the percentage increase in discharge through each of the secondary channels is not as great.

An examination of Upper Iowa River discharges was done for the dates when discharge measurements were taken to see what influence these may have had. Typically the discharges in the Upper Iowa were 1 percent of the Mississippi River discharge or less, and thus didn't have a significant impact on secondary channel discharges.

Algebraic Equations for Secondary Channel Discharge

The measured discharge data was used to develop algebraic equations for discharge to the Big Lake area as a function of Lock and Dam 8 discharge up to 80,000 cfs. The 1980 measurements don't include the secondary channel discharge through Site 6, however, they can still be used for guidance if the measured discharges are increased 5 to 10 percent. Cubic Polynomials resulted in the best fit of discharge data between 0 and 78,000 cfs. The following equations were obtained for each secondary channel

(1)	Site 1	Qsl = -321.0 + .061416*Qr - .14099E-5*Qr**2 + .22088E-10*Qr**3
(2)	Site 2	Qsl = 145.9 - .003113*Qr + .72751E-6*Qr**2 - .11562E-11*Qr**3
(3)	Site 6	Qsl = 50.9 + .074538*Qr - .11364E-5*Qr**2 + .16965E-10*Qr**3
(4)	Site 15	Qsl = 91.4 + .027834*Qr + .10556E-5*Qr**2 - .74254E-11*Qr**3
(5)	Site 7&8	Qsl = -221.2 + .026845*Qr - .79154E-6*Qr**2 + .11234E-10*Qr**3
(6)	Winne shiek Slough	Qsl = 2121.0 - .040686*Qr + .48082E-5*Qr**2 - .31503E-10*Qr**3

where Qsl = slough discharge and Qr = Lock and Dam 8 discharge. Plate 7 shows the relationships in the above equations in graphical form along with field data.

The following 3rd order polynomial was developed to calculate the total flow into the Big Lake area versus Lock and Dam 8 discharge

(7) Qslt = 2.8+.15148*Qr-.28038E-6*Qr**2+.31357E-10*Qr**3, Qtotal < 78,000 cfs

where Qslt = the total slough discharge into the Big Lake area.

Extrapolation of Secondary Channel Discharge Relationship

For total discharges greater than 80,000 cfs the total conveyance area to the Big Lake area increases considerably. This is somewhat balanced by the increased hydraulic roughness of flow over the right bank and a slight decrease in hydraulic energy slope over the right bank. For example, the conveyance area over the right bank of the Mississippi and Upper Iowa Rivers increases from 12300 to 30850 square feet for discharges of 78,000 cfs to 100,000 cfs. However, the hydraulic energy slope in the river for discharges of 78,000 cfs and 100,000 cfs is approximately the same and the energy slope across the right bank decreases somewhat because of backwater effects. As additional guidance for extrapolating the measured data, the river discharge at river mile 666.1 should continue to increase since the hydraulic energy slope remains approximately the same but the conveyance area of the river increases with increasing stages. Results from an HEC-2 model were used at high flood events. At the 100 year flood discharge of 255,000 cfs, HEC-2 simulations show that approximately 50 percent of the total river discharge flows through the Big Lake area.

Plate 8 shows the relationship of total secondary channel discharge to the Big Lake area versus river discharge up to a discharge of 255,000 cfs. The above third order polynomial was used for total river discharges up to 80,000 cfs. For discharges greater than 150,000 cfs it was assumed that 50 percent of the total river discharge enters the Big Lake area. Between discharges of 80,000 cfs and 150,000 cfs refer to Plate 8. At 100,000 cfs the secondary channel discharge should be 42,000 cfs.

SEDIMENT

Sediment Deposition

In a study done by Eckblad et. al. (1977), sediment deposition rates were determined by comparing 1973 bathymetric data in Big Lake to the 1896 River Commission Maps and by using Cesium-137 dating techniques. Comparison of bathymetric data resulted in an average sedimentation rate of 0.39 inches/year if it were assumed that sediment accumulated uniformly over the 77 year period from 1896 to 1973. A rate of 0.83 inches per year was obtained if the assumption were made that the majority of sediment deposition occurred during the 36-year period since construction of Lock and Dam 9 in 1937. The time period since construction of Lock and Dam 9 in 1937 would normally be used for determining sediment deposition rates. However, an earthen dam constructed in the 1920's near the downstream end of Big Lake may have increased deposition in Big Lake. The analysis using Cesium-137 resulted in a sedimentation rate of 0.66 inches/year. This is representative of the 10 year period 1964 to 1974.

In a separate study done by the IDNR (Aspelmeier, 1989) an average sediment deposition rate of .66 inches per year was found for the 4 year time period from 1984 to 1988. In this study, range lines were set up in the Big Lake area and bottom elevations measured over the time period. Measurements taken in 1989, however, showed an increase in water depth (ie. the bottom had settled) at some stations. The explanation for this isn't clear, however, consolidation may have occurred during the extreme low flow period prevalent at this time. The average deposition rate based on the 5 year period from 1984 to 1989 was .43 inches per year.

Studies on sediment deposition rates were done by the Science and Education Administration (SEA) Sedimentation Laboratory, Oxford, Mississippi in lower Pool 9 (McHenry and Ritchie, 1977). Methods used to quantify deposition rates include fathometer surveys, spud surveys, and Cesium-137 dating. The deposition rates obtained by the fathometer and spud surveys which theoretically represents the years 1937 to 1976, were .20 and .39 inches per year respectively. The deposition rate obtained from the Cesium-137 analysis was .90 inches per year.

Based on the results of Eckblad and Aspelmeier, a reasonable value to use for deposition rates in the Big Lake area is 0.6 inches/year. This value represents more recent sedimentation trends in the Big Lake area. Most important, however is that it is representative of time period since the Upper Iowa River was rechannelized.

Sediment Types

Generally suspended sediment includes silts and clays. Measurements of suspended sediment particle sizes done for a study on the effects of commercial and recreational navigation on sediment transport to backwaters (Claflin, 1981) indicate that average diameters range from 10 to 40 microns. This is a function of hydrographic conditions at the sampling site, and seasonal hydrologic and hydraulic conditions.

Field reconnaissance of the area revealed sediment deposition in the upper reaches of Big slough. Coarse to fine sand was found mixed in with the clay and organics in the deposition areas. Fine sand and silt was found along the thalweg of Big Slough for a distance of approximately 5 miles downstream from the Mississippi River. A mixture of sand, silts, and clays was found in several other secondary channels also.

Rada et al., 1980 collected sediment data in Pool 9 for a study being done on the impacts of commercial and recreational navigation on water quality. Sand size material (63 micrometers or larger) was found in the navigation channel adjacent the Big Lake area. Within defined secondary channels, sand, silts (particle diameter from 4 to 63 microns), and clays (particle diameter less than 4 microns) were found. In Big Lake sediment samples consisted of 80 to 90 percent silt and clay, with 40 to 50 percent in the clay size range. Samples collected on the right side of Minnesota Slough and the navigation channel between the Upper Iowa River and Site 1 had vary similar gradations with over 90 percent of the material being in the silt and clay size range. Nearby samples in Minnesota Slough and the navigation channel show very little silt or clay. This indicates some influence from the Upper Iowa River, however samples collected in the Upper Iowa River are much coarser, and Site 1 which is the closest downstream secondary channel to the Upper Iowa River, also has a higher percentage of coarse material. The bed material in Winneshiek Slough was mostly sand.

In the study done by Eckblad (1981), coarse to medium sand was found in and near secondary channels, however most of the lake sediments consisted of material in the clay to fine sand size range.

Sediment Loads in the Mississippi and Upper Iowa Rivers

The following suspended sediment discharge relationship was developed for the GREAT I study, and is based on measured data from sediment gages at Winona, Minnesota and McGregor, Iowa

(8) $Qs = 2.597E\text{-}07*Qr**2.235$

where Qs = the suspended sediment discharge in the river. Winona is in Pool 6 at river mile 726, and McGregor is in Pool 10 at river mile 633.5, 34 miles downstream of the project area. The long-term suspended sediment load at Lock and Dam 8 was determined by integrating this sediment discharge relationship with the discharge duration curve for Lock and Dam 8. This resulted in an annual suspended sediment discharge of 2.36 million tons. This is based on the measured sediment loads at the Winona and McGregor gage which is the sediment maintained in suspension in the water column between the water surface and a point approximately 0.3 feet above the bed. Most of the sediment in this zone is fine sediment in suspension. The zone between the bed and a point 0.3 feet above the bed carries both coarse and fine sediments. A general rule of thumb for estimating the sediment load in the unmeasured zone is that it is usually 5 to 15 percent of the total load. For this study a value of 10 percent will be used. This results in an annual sediment load in the unmeasured zone of 236,000 tons. This closely matches the bed material load at Lock and Dam 8 of 214,000 tons/year computed for the GREAT I study using a 1-dimensional sediment transport model (Simons, et al., 1979b). The bed material load isn't exactly equal to the sediment load in the unmeasured zone, however, it appears that 10 percent is a reasonable amount to increase the measured load by. This gives an annual total load at Lock and Dam 8 of 2.60 million tons.

The following table summarizes annual measured sediment loads transported past the gaging stations at Dorchestor,Iowa on the Upper Iowa River, and at McGregor, Iowa on the Mississippi River. Sediment records were kept at Dorchestor for only the 6 year time period shown.

Table 5

Annual Measured Sediment Load at Dorchester, IA,
Upper Iowa River and at McGregor, IA, Mississippi River

Water Year	Sediment Load Dorchester Upper I. Riv. (tons)	McGregor Miss. Riv. (tons)	Dorch SS / Mcgreg SS (percent)
1976	198887	1461937	.136
1977	37863	627561	.600
1978	760418	2204863	.345
1979	499024	3068867	.163
1980	379127	3098650	.122
1981	232592	1912995	.122
Average	351318	2062479	.158

The ratio of the Upper Iowa load at Dorchestor to the Mississippi River load is shown in the third column. As can be seen the average annual sediment load in the Upper Iowa River at Dorchestor is approximately 16 percent of that in the Mississippi River at McGregor. On a monthly basis, the sediment load in the Upper Iowa River can actually exceed that in the Mississippi River. For example, in February of 1977, the total measured load at Dorchestor was 13,104 tons while the load at McGregor was 13490 tons. This is significant, and indicates that the Upper Iowa River could supply a high percentage of the sediment load to the Big Lake area.

Based on the 6 year period of record , the average annual measured sediment yield at Dorchestor is 351,318 tons. Since Dorchestor is approximately 18.1 miles upstream of the confluence with the Mississippi River, and the drainage area at Dorchestor is 770 square miles while at the confluence it is 1060 square miles, the sediment yield at Dorchestor must be transferred to the mouth. Annual sediment yield data calculated at a specific site can usually be transferred to the study site using a drainage area relationship provided topography, soils, and land use are similar (EM 1110-2-4000). The following equation is used to do this when the study watersheds drainage area is greater than 0.5 or less than 2.0 times the surveyed watersheds area.

(9) $$Ye = Ym * (Ae / Am)$$

Ye = the annual sediment yield for the area under study, tons/year
Ym = the annual sediment yield measured at the gaged site, tons/year
Ae = the contributing drainage area for the area under study
Am = the contributing drainage area at the gaged site

Applying this equation results in a sediment load at the mouth of 483,600 tons per year. Accounting for the unmeasured load by multiplying by a factor 1.1 gives a total annual sediment load of 532,000 tons/year. The bed material load in the Upper Iowa River isn't known, however in the GREAT I study the bed material load in the Root River watershed which has similar geographic, topographic, soil, and land-use characteristics was determined to be 7.3 percent of the washload. Thus using the factor of 1.1 to account for the unmeasured load again seems reasonable. The total annual load of 532,000 tons/year is 18.7 percent of the estimated total load in the Mississippi River at Lock and Dam 8.

Historic Sedimentation

Between the years 1937, when Lock and Dam 9 was constructed, and 1959, when the Upper Iowa River was rechannelized the Upper Iowa River flowed directly through the Big Lake area. Because of the reduced hydraulic slope of the Upper Iowa once it entered the Big Lake area, significant amounts of sediment deposition occurred. A siltation study done by the St. Paul District Corps of Engineers in 1945, shows an average of 3.33 inches of deposition annually in the area covered by the study. The cross sections used in this study were obtained in 1936 and 1945 and are shown on Plates 9 through 11. The total volume of deposition in the survey area was 3.5 to 4 million cubic yards during this 10 year period. Assuming that this material is mainly silt with a specific weight of 70 pounds per cubic foot, this corresponds to 370,000 to 420,000 tons per year over the nine year period. The average annual sediment load of the Upper Iowa River based on data from the time period 1975 to 1981 is 532,000 tons. While the sediment load from this time period doesn't necessarily represent the sediment load from 1937 to 1959, it appears that a significant amount of the Upper Iowa River sediment load deposited in the Big Lake area. Unfortunately, the siltation study didn't define the downstream extent of this deposition, since, the downstream cross sections had just as much deposition as upstream sections. The siltation study does show that in in 1945, 3 to 4 feet of sediment had accumulated at least as far down as the confluence of the Old Upper Iowa River channel and Big Slough. This point is over 13,000 feet downstream of the point where the Upper Iowa enters the Big Lake area. If deposition continued to expand downstream at this rate between the years 1945 and 1959 when the channel was rerouted, the downstream extent of major sediment deposition would have reached the western side of Big Lake. Based on this, it is probable that the Upper Iowa River caused major deposition in the Big Lake area as far down as Big Lake. The lateral extent of major deposition was generally limited to with 3,000 to 4,000 feet of the Upper Iowa River based on the 1945 siltation study. This indicates that the majority of the deposition was limited to the western side of the Big Lake area. This is further verified by the fact that if deposition was more widespread, the bathymetric surveys by Eckblad should have yielded higher deposition rates.

Existing Conditions Sedimentation From the Mississippi River

Based on the studies done by Eckblad (1977) and the IDNR (Aspelmeier, 1989) an existing conditions deposition rate of 0.6 inches per year is most representative of the Big Lake area.

The long-term suspended sediment load to the Big Lake area from the Mississippi River was determined by integrating the sediment discharge relationship in equation 8 with the discharge duration curve for flow into the Big Lake area. For existing conditions the long-term annual sediment load to the Big Lake area was 763,500 tons. Increasing this by a factor of 1.1 to account for the unmeasured portion of the fluvial sediment supply gives an annual total load into the Big Lake area of 840,000 tons.

Plate 12 is a plot representing the percent of the total annual sediment load transported in the Mississippi River and to the Big Lake area for all discharges up to a given discharge. The significance of this is that the majority of the sediment transport into the Big Lake area occurs for a higher range of river discharges than the corresponding percentage of sediment transport in the river. For instance, 50 percent of the sediment transport in the Mississippi River occurs for discharges less than 50,000 cfs, while at this same total river discharge, only 17 percent of the total sediment load transported into the Big Lake area has occurred.

Existing Conditions Sedimentation From the Upper Iowa River

Under certain conditions, Upper Iowa River discharges entering Minnesota Slough form of a high concentration plume extending downstream along the right bank of Minnesota Slough and the Mississippi River. Sediment from the Upper Iowa River enters the Big Lake area when sediment laden water from this plume enter the Big Lake area through secondary channels. The following passage from Nakato and Kennedy (1977), in a study on pool 20 of the Mississippi River, describes a similar occurrence for the Des Moines River.

"Examination of the measured lateral distribution of unit water and sediment discharges in the study reaches revealed that the mean suspended sediment concentrations are generally higher near the right bank of the Mississippi River during high Mississippi River stages, because of the abrupt downstream deflection of the Des Moines River discharge and the slow rate of lateral mixing of the water and sediment influxes from the Des Moines River. During low Mississippi River stages, the Des Moines River flow penetrates farther across the Mississippi River channel and becomes mixed with the Mississippi River flow more rapidly."

The study reaches referred to in the above passage are 6 miles and 12 miles downstream of the confluence of the Des Moines River.

An examination of aerial photographs shows that the plume is often visible. The following table summarizes these findings.

Table 6

Downstream Extent of Upper Iowa River Plume

Date	Downstream Extent of Plume (feet)	Source of Info.
4/23/69	No Plume	Aerial
4/28/73	No Plume	Aerial
10/29/75	720	Aerial
11/16/75	950	Aerial
9/5/76	750	Black and White Neg.
10/13/77	300	Color IR

The visible plume never extended beyond Site 1. Research done by personnel from Luther College (Eckblad, pers. com.) indicates that while heavy rains in the Upper Iowa basin are responsible for major sediment plumes, a plume can be detected with a conductivity meter on just about any day. Also, they found that the plume extends down to Site 1 but not much beyond. This seems to indicate that the plume is drawn into Site 1. In fact, the average discharge in the Upper Iowa River at Dorchestor is only 25 percent of the average flow through Site 1, and is only 5.6 percent of the average combined discharge in Site 1, Site 2, and Site 6. This indicates that there is great potential for Upper Iowa River flows to be drawn into the Big Lake area.

A dye study was done in August 1989 to try to better quantify the amount of the Upper Iowa discharge that enters the Big Lake area. Dye was injected into the Upper Iowa River and tracked out into the Mississippi River. When the dye reached the river, however, it could no longer be tracked. This was caused by water temperatures on the Upper Iowa River being 3 to 4 degrees celsius cooler and thus more dense than those on the Mississippi River. This caused a negatively buoyant plunging flow situation as the Upper Iowa flow entered the Mississippi River. Instead of a plume forming and following the right bank of the Mississippi down to Site 1, the flow apparently went farther out to the deeper part of Minnesota Slough. This was informative in that it indicates that the Upper Iowa River flows don't always enter the Big Lake area, however extremely low flow conditions existed on both rivers during the study and thus the results aren't representative of those conditions when the majority of sediment transport is occurring. To better understand whether conditions such as this are typical, water temperature data obtained at the USGS gages at Dorchestor, Iowa on the Upper Iowa River and at McGregor, Iowa on the Mississippi River downstream of the Big Lake area for the years 1974 to 1981 were compared to determine if there was any consistent trends in temperature differential between the two gage sites. From this comparison it was determined that throughout most of the year, the water temperature in the Mississippi River at McGregor is 1 to 4 degrees Celsius warmer than that in the Upper Iowa River at Dorchestor. However, during the months of April and May when the majority of the annual sediment load in the Upper Iowa River is transported, this temperature difference is not as great and often the temperature in the Mississippi is less than the Upper Iowa River temperatures. This means that a plunging flow situation due to negative buoyancy of Upper Iowa River water is less likely to occur in April and May. In fact, anytime discharges on the Upper Iowa River are high, the inertial forces associated with these high discharges dominate over gravitational forces set up by temperature driven density differences.

Obviously, characteristics of Upper Iowa River discharges that enter the Mississippi River are complicated. Inertial and gravitational forces affect the behavior of the plume greatly. For purposes of this analysis, it will be assumed that 50 percent of the Upper Iowa sediment load that enters the Mississippi River also enters the Big Lake area. Previously we had looked at the period of record at Dorchestor and determined that the average annual sed load from this 5 year period was 351,318 tons per year. This corresponds to a sediment discharge of 532,000 tons per year at the confluence. If we also assume that flow over the right bank of the Upper Iowa results in all of the Upper Iowa sediment load being transported at that time entering the Big Lake area, then this leaves 457,700 tons per year. If 50 percent of this enters the Big Lake area, this equals 228,800 tons per year from the plume.

High water on Mississippi can result in Upper Iowa River water directly entering the Big Lake area over the right bank of the Upper Iowa. Major overtopping of the UI right bank levee occurs when the water surface elevation exceeds 626. This elevation occurs at a Mississippi River discharge of approximately 86,000 cfs.

High discharges on the Upper Iowa River may also cause overtopping of the right bank. The General Design Memorandum for the 1959 Upper Iowa River flood control project gives the following design statistics for the Upper Iowa channel.

Bottom width = 150'
Side slope = 3
Bottom Slope = .00004545
Bottom elevation at mouth = 616

Assuming a roughness coefficient of 0.035 a normal depth analysis gives the following rating curve

Q (Upper Iowa)	Yn	Water Surface Elevation at Mouth
500	4.29	620.29
1000	6.44	622.44
2000	9.61	625.61
3000	12.11	628.11
4000	14.24	630.24
5000	16.12	632.12
6000	17.83	633.83
7000	19.40	635.40

This indicates that an Upper Iowa River discharge slightly greater than 2,000 cfs results in flow over the right bank. However, a normal depth assumption requires that the tailwater on the Mississippi River matches normal depth on the Upper Iowa and that flow is contained within the Upper Iowa channel down to the area where it can flow over the right overbank. If these requirements are not met then the water surface elevation on the Upper Iowa River will be lower than that predicted by a normal depth routine. In fact, either of these conditions will result in lower stages at the mouth of the Upper Iowa River and an M-2 backwater profile will exist on the Upper Iowa River. Normal depth on the Upper Iowa may not be reached for a substantial distance upstream. For example, if the discharge in the Upper Iowa River is 3,000 cfs, the normal depth is 12.11 feet. However, if the average discharge of 34,940 cfs is occurring on the Mississippi River, normal depth will not be reached within the reach of the Upper Iowa that is in the Mississippi flood plain.

The first requirement is a function of hydrological conditions and may or may not be met. The period of record for the Dorchestor gage was analyzed to determine at what Mississippi River discharges, the majority of the sediment in the Upper Iowa River is transported. This indicates that most of the sediment on the Upper Iowa River is transported at lower discharges on the Mississippi. For example, 86 percent of the sediment load is transported for Mississippi River discharges less than 86,000 cfs. If it is assumed that this discharge is needed to establish an overtopping normal depth on the Upper Iowa River, then it is apparent that most of the Upper Iowa River sediment enters Minnesota Slough.

The second requirement may not be met for higher discharges on the Upper Iowa River. The GDM for the Upper Iowa River flood control project states that the right bank levee will extend 2500 feet further downstream than the left bank levee. It also says that from the end of the levee to Minnesota Slough, spoil material should be spread out on the right bank so as not to create an obstruction to the flow. The end of the right bank levee corresponds to the point approximately 8100 feet upstream of the confluence. This indicates that from the mouth to a point 10,600 feet upstream, the right bank levee is higher than the left bank levee and flood waters on the Upper Iowa River will tend to flow over the left bank.

The above discussion indicates that the discharge on the Mississippi River is the main factor in determining whether flow occurs over the right bank of the Upper Iowa River and that a discharge of 86,000 cfs is required for overtopping to occur. The total Upper Iowa River sediment load transported when Mississippi River discharges exceeded 86,000 cfs amounts to 74,320 tons/year. Probably not all of this load enters the Big Lake area since there will continue to be flow to Minnesota Slough. However, the head in the Big Lake area will be less than that in Minnesota Slough and this will probably result in a significant amount of discharge to the Big Lake area. For the purposes of this analysis it will be assumed that all of this load enters the Big Lake area.

Total Sediment Load

The total sediment load to the Big Lake area can be broken down into the load from the Upper Iowa River and the load from the Mississippi River. As discussed previously, the sediment load to the Big Lake area if only the Mississippi River is considered is 840,000 tons per year. Inputs from the Upper Iowa River will increase this sediment load. For purposes of this analysis, it will be assumed that 50 percent of the Upper Iowa River plume discharge enters the Big Lake area. Previously, it was determined that of the total Upper Iowa River sediment load of 532,000 tons per year, 74,320 tons per year directly entered the Big Lake area over the right bank of the Upper Iowa River . This leaves 457,700 tons per year that enter Minnesota Slough. If 50 percent of this enters the Big Lake area, the total load from the Upper Iowa River is 303,160 tons per year. Upper Iowa River discharges that enter the Big Lake area will displace Mississippi River water and thus the Mississippi River sediment load of 840,000 tons per year reported above would have to be reduced. However, as mentioned previously, the average discharge in the Upper Iowa River is only 5.6 percent of the average discharge in Big Slough, Little Slough, and Site 6, thus it can be assumed that the sediment loads are additive without introducing a great deal of error into the analysis. Making this assumption, the sediment load into the Big Lake area is as follows.

Source	Tons/Year
Mississippi River	840,000
Upper Iowa	
Overbank	74,320
Plume	228,800
Total	1,143,000

The volumetric load that corresponds to this depends on the specific weight of sediment. The following equation along with the sediment size gradations obtained in Big Lake by Rada (1980) will be used to calculate the specific weight of sediment.

(10) $$Wc = 1 / [(Ps/Ws) + (Psl/Wsl) + (Pcl/Wcl)]$$

Wc = composite specific weight (lbs/ft3)
Ws = specific weight of sand (lbs/ft3)
Wsl = specific weight of silt (lbs/ft3)
Wcl = specific weight of clay (lbs/ft3)
Ps = percent sand in mixture expressed as a decimal
Psl = percent silt in mixture expressed as a decimal
Pcl = percent clay in mixture expressed as a decimal

Typical gradations of the samples in Big Lake are given in the following table.

Table 7

Typical Gradation of Big Lake Sediments

Material	Size (mm)	% Finer	Fraction	Specific Weight (lbs/ft3)
	0.0	0		
Clay			.45	26
	.004	45		
Silt			.50	70
	.0625	95		
Sand			.05	97
		100		

The resulting composite specific weight is 40.0 pounds per cubic foot. Using this specific weight the annual volumetric sediment load would be 1,312 acre-feet. If it were assumed that all of this material settled out in the Big Lake area and were uniformly spread out over the 7,000 acre backwater area, the annual deposition rate would be 2.25 inches per year. As expected, this is higher than the deposition rate obtained by Eckblad (1977) and Aspelmeier (1989). This is because the trap efficiency of the Big Lake area hasn't been accounted for. A trap efficiency of 26 percent, that is, 26 percent of the sediment settles out in the Big Lake area, would match the deposition rates obtained by Eckblad and Aspelmeier. This is much greater than the trap efficiency obtained from the capacity inflow method of Brune. This is because Brune's method assumes that the entire volume of the water body (the capacity) is used to transport flow and river sediment. Typically what exists in backwater areas are two zones. The first of course are the secondary channels which have a low trap efficiency, and the second is the off-channel areas that have a high trap efficiency. Thus as is the case in all backwater areas, the calculated trap efficiency from Brune's equation doesn't always reflect the ability of backwaters to trap sediment. The significance of this is that, the trap efficiency isn't directly correlated to inflow rates. Thus a reduction in inflows will not necessarily increase the trap efficiency of the area. The backwater area will continue to be divided up into channelized areas and marsh areas.

Effects of Navigation

Studies (Claflin, et al., 1981) done on the effects of commercial and recreational boat traffic on sediment transport indicate that local hydrographic and hydrologic conditions are the main factor affecting whether additional sediment is resuspended and transported. For example, a tow passage may increase suspended sediment concentrations and mass transport to secondary channels during summer low flows when ambient sediment concentrations are low, however little change may be seen during higher flow events when the ambient sediment concentrations are already high. Generally, recreational traffic in the navigation channel doesn't increase sediment transport to secondary channels however recreational traffic in the secondary channels themselves may resuspend bottom sediments. Again this is a function of hydrologic conditions.
The average particle size in suspension may increase during boat passage depending on local conditions also.

Future "Without Project" Conditions

As discussed previously, the total secondary channel discharge to the Big Lake area has increased 5 to 10 percent in the last ten years. This increase is due to erosion of secondary channels, mainly at site 6. This is similar to erosion observed at other backwater areas on the Upper Mississippi River. Since both sites 2 and 6 are actively eroding, the total inflow and sediment load to the Big Lake area will probably continue to increase. Assuming that the sediment load increased 8 percent and that the increase in sediment deposition was proportional to the increase in sediment load, the future deposition rate would be .65 inches per year as compared to the rate of .60 inches per year that exists now. This may be offset somewhat by improved land use practices which would reduce sediment loads in the Mississippi and Upper Iowa Rivers, however these practices typically take a long time to implement and take effect. Also, the trap efficiency of the area may be reduced with time as sediment deposits reduce the volume of the backwater areas. Of course, this is exactly the process this project is trying to prevent.

Sediment Conclusion

1. The average deposition rate in the Big Lake area is .6 inches per year.
2. Sediment distribution in the project area by mineralogy is typical of the Mississippi River Valley in that coarse sediments including sands and gravels are found in the navigation channel, and fine sediments such as silts and clays are found in backwater areas.
3. The Upper Iowa River was responsible for much of the sediment deposition in the Big Lake area between 1937 and 1959. Most of this sedimentation occurred in the western half of the Big Lake area.

4. The Mississippi River sediment load at Lock and Dam 8 is 2.6 million tons/year. The Upper Iowa River sediment load is 532,000 tons/year, 18.7 percent of that at Lock and Dam 8.

5. The Mississippi River sediment load to Big Lake area is approximately 840,000 tons/year. The Upper Iowa River sediment load to the Big Lake area is more difficult to quantify but it is probably at least 300,000 tons/year. This means that the proximity of the Upper Iowa River to the Big Lake area and the higher sediment load associated with it increases the sediment load to the Big Lake area by a factor of 1.36 over the sediment load that would result from the Mississippi River only.

6. The trap efficiency of the Big Lake area is approximately 26 percent.
7. Erosion of secondary channels has increased sediment loads to the Big Lake area 5 to 10 percent in the last 10 years and since 2 of the major sites are actively eroding this will probably continue into the near future.

ANALYTICAL METHOD TO SIMULATE PROJECT EFFECTS

Rational for Analytical Method

A one-dimensional HEC-2 model has previously been developed for Pool 9 and will be used to quantify flood plain impacts. The use of a 2-dimensional hydrodynamic model was considered for analyzing project impacts on flow distribution and water surface elevation, however, due to time and funding constraints, was not used. As an alternative to a numerical model, an analytical method was developed to simulate project impacts. This was based on existing field data in the area and on HEC-2 simulations.

Equation for Secondary Channel Discharges

The project will have effects on water surface elevations, conveyance area, hydraulic energy slope, and hydraulic roughness. An analytical method based on Mannings Equation was developed to determine the impacts of various project plans on these parameters. The discharge measurements presented previously were used to calibrate the analytical method. The following modified Manning's equation resulted from this calibration.

(11) $$Q = 1.49 \cdot A \cdot Ye^{.84} \, Se^{.5}/n$$

Where

A = conveyance area of the right bank of the Mississippi and Upper Iowa Rivers.
Ye = effective depth, which was set equal to the difference between the water surface elevation at river mile 670.6 and a reference elevation of 617
Se = energy slope
n = hydraulic roughness

The conveyance area can accurately be determined from surveys of the right banks of the Mississippi and Upper Iowa Rivers. Ye replaces the hydraulic radius in the standard Mannings equation and the exponentiation factor of 0.84 was based on calibration to available data. The energy slope is based on the following rational.

1. For conditions when the majority of the flow to the Big Lake area is through existing secondary channels the energy slope should be based on the water surface slope between river miles 670.6 and 663.0.

2. For conditions when the right bank of the Mississippi and Upper Iowa Rivers is overtopped the energy slope will be reduced to account for decreases in energy slope and increases in hydraulic roughness values. The amount that the energy slope is reduced will be calibrated based on the secondary channel discharge relationship determined previously.

This rational was necessary because at discharges greater than 80,000 cfs most of the right bank of the Mississippi River is overtopped along with parts of the right bank of the Upper Iowa River. The effect of this is that the hydraulic roughness increases, and the energy slope from the river to the backwater area decreases. The hydraulic roughness was set at 0.035. The following table shows total secondary channel discharge for existing conditions calculated using the analytical method described above.

Table 8

Analytical Results Using Equation for Side Channel Discharge

TOTAL DISCHARGE (cfs)	WATER SURFACE ELEVATION RM 670.6	666.1	ENERGY SLOPE	TOTAL CONVEYANCE AREA (ft2)	EXISTING COND. SIDE CHANNEL DISCHARGE FROM FIELD DATA (cfs)	BY EQUATION (cfs)
15360	620.64	620.26	.00001590	5124	2575	2377
34940	621.73	620.72	.00004300	6180	6364	6290
80000	625.28	623.62	.00007000	12546	26383	26381
90000	626.01	624.34	.00004673	18641	34384	34385
100000	626.70	625.05	.00001868	33918	42000	42000
110000	627.34	625.72	.00000899	54519	49507	49507
120000	627.98	626.39	.00000535	76446	56338	56338

For river discharges up to 80,000 cfs no adjustment of the energy slope was necessary. This indicates that when flow is contained within defined secondary channels, the above analytical method can be used without having to adjust parameters. At discharges above 80,000 cfs the energy slope had to be decreased to previously established secondary channel discharges. For example, at 90,000 cfs, the water slope between river miles 670.6 and 663.0 is approximately .00007, however this had to be reduced to .00004673.

This method can now be used to estimate the effects of the proposed project on inflows to Big Lake area. The effects of the project will be to decrease secondary channel discharge and thus increase main channel discharge. This will result in an increase in water surface elevation in the main channel and a decrease in water surface elevation the backwater areas. The conveyance area, hydraulic radius, and energy slope are all a function of water surface elevation and must be adjusted accordingly. It is first assumed that the water surface elevations at river mile 663 which is downstream of the project doesn't change from existing conditions to proposed conditions. The water surface elevation at river mile 670.6 was assumed to be a function of the average of navigation channel discharge at river mile 666.1 and total discharge. This accounts for the increase in water surface elevation due to the project while at the same accounting for the fact that there is no change in tailwater elevation downstream of the project. This relationship is shown in Plate 13. The conveyance area is then based on a linear water surface profile between river miles 670.6 and 663.

The energy slope is likewise a function of water surface slope between river miles 670.6 and 663.0. However, the decrease in water surface elevation in backwater areas also must be accounted for. Since this is a function of the decrease in discharge to the backwater, and this isn't known yet, an iterative procedure must be used. For initial calculations the conveyance area relationship will be based on existing conditions water surface profiles. For final designs, water surface profiles for proposed conditions will be generated and conveyance areas determined.

DESIGN ALTERNATIVES

Five design alternatives have been investigated. These are labeled plans 1, 2, 3, 4, and 5 and are shown on Plates 14 through 18.

Plan 1 involves constructing 8 complete closures across Sites 1 through 8 to completely eliminate secondary channel discharge through these sites for discharges up to 80,000 cfs. At discharges greater than 80,000 cfs the right bank of the Mississippi and Upper Iowa Rivers is overtopped.

Plan 2 consists of a combination of partial and complete closures at Sites 1 through 15. Rock lined partial closure structures that will reduce secondary channel discharge but not completely eliminate it will be constructed across Sites 1, 2, 6, and 15. Complete closure structures that will completely eliminate flow will be constructed across all other sites. The right bank along the Upper Iowa and Mississippi River will be raised to elevation 629 from a point approximately 5,000 feet upstream of the Upper Iowa River and Mississippi River confluence down to Site 2. At this point the right bank raise will drop down to elevation 628.5 and this elevation will be maintained to a point 2,000 feet downstream of Site 8.

Plan 3 consists of a combination of partial and complete closures at Sites 1 through 15. Rock lined partial closure structures that will reduce secondary channel discharge but not completely eliminate it will be constructed across Sites 1, 2, 6, and 15. Complete closure structures that will completely eliminate flow will be constructed across all other sites. The right bank along the Upper Iowa and Mississippi River will be raised to elevation 629 from a point approximately 5,000 feet upstream of the Upper Iowa River and Mississippi River confluence down to Site 2. At this point the right bank raise will drop down to elevation 628.0 and this elevation will be maintained down to a point 4,000 feet downstream of Site 8. At this point the right bank elevation will again drop, to elevation 627, and will remain at this elevation until it ties into high ground at the dredge material disposal site downstream of Site 15.

Plan 4 is similar to Plan 3 except that the rock lined partial closure structures are designed to maintain existing conditions low flow discharges at Sites 1, 2, 6, and 15. Essentially this means that channel conveyance area below elevation 620.0 remains the same as that for existing conditions.

Plan 5 consists of a combination of partial and complete closures at sites 1 through 8. Rock partial closure structures would be constructed at sites 1, 2, and 6. And sand plugs would be constructed at sites 3, 4, 5, 5A, 6A, 7, and 8. The sand plugs at sites 6A, 7, and 8, and the rock partial closure at site 6 would form a continuous structure. Essentially, this plan would prevent further increases in side channel discharge to the Big Lake area through the upper 8 sites, and would decrease existing conditions secondary channel discharges 8 percent.

PROJECT EFFECTS

Effects on Discharge

Plate 19 and Table 9 below show the relationship of side channel discharge to the Big Lake area versus total river discharge for existing conditions and for the 5 plans. Plan 3 results in the greatest decrease in side channel discharge. As can be seen the greatest effects of the 5 plans occurs in the total river discharge range of 80,000 cfs to 120,000 cfs. Once the right bank of the Mississippi and Upper Iowa main channel is overtopped, the project has less effect.

Table 9

Side Channel Discharges for Plans 1 through 5

TOTAL DISCHARGE (cfs)	DISCHARGE TO BIG L. EXIST (cfs)	Plan 1 (cfs)	Plan 2 (cfs)	Plan 3 (cfs)	Plan 4 (cfs)	Plan 5 (cfs)
15360	2575	1161	1500	1500	2280	2250
34940	6364	2794	3760	3760	5640	6000
80000	25989	17000	17000	15080	20500	22770
90000	34302	26000	23500	18370	24900	30500
100000	42000	35000	30300	21720	29700	37900
110000	49531	44000	36000	25180	34100	46050
120000	56493	53000	43000	32000	41000	53680
137000	66670	64530	57000	48000	56000	65172
150000	75000	73890	68000	61000	67000	74500
164000	82000	82000	78000	74000	77000	82000
200000	100000	100000	99000	97000	98000	100000
255000	127500	127500	126500	125500	126500	127500

Table 10 below shows the discharge at river mile 666.1 for existing conditions and for the 5 plans.

Table 10

Discharge at River Mile 666.1 for Plans 1 Through 5

TOTAL DISCHARGE (cfs)	DISCHARGE AT RIVER MILE 666.1 EXIST (cfs)	Plan 1 (cfs)	Plan 2 (cfs)	Plan 3 (cfs)	Plan 4 (cfs)	Plan 5 (cfs)
15360	12785	14199	13860	13860	13080	13110
34940	28576	32146	31180	31180	29300	28940
80000	54011	63000	63000	64920	59500	57230
90000	55698	64000	66500	71630	65100	59500
100000	58000	65000	69700	78280	70300	62100
110000	60469	66000	74000	84820	75900	63950
120000	63507	67000	77000	88000	79000	66320
137000	70330	72470	80000	89000	81000	71828
150000	75000	76110	82000	89000	83000	75500
164000	82000	82000	86000	90000	87000	82000
200000	100000	100000	101000	103000	102000	100000
255000	127500	127500	128500	129500	128500	127500

An interesting characteristic of this area is that once the right bank is overtopped, main channel flow at river mile 666.1 doesn't increase as fast. This means that increases in river discharge above the overtopping discharge result in that much more flow to the Big Lake area. For example, the main channel discharge at river mile 666.1 for existing conditions only increases from 54,000 to 60,000 cfs for total discharges of 80,000 to 110,000 cfs. In other words, the total discharge increase of 30,000 cfs resulted in only an increase of 6,000 cfs in the main channel with the other 24,000 cfs entering the Big Lake area.

Effects on Water Surface Elevations

Table 11 shows the effects of the five plans on water surface elevations at river mile 670.6 which is at the upstream end of the project and corresponds to the locations of Big Slough and Blackhawk Park. This is also plotted in Plate 20. Plan 3 results in the greatest increase in water surface elevation. The maximum increase, of slightly more than one foot, occurs for discharges of 100,000 to 110,000 cfs. The upstream extent of increased water surface elevations for a discharge of 110,000 cfs was determined for Plan 3 using the numerical model HEC-2 (Water Surface Profiles). This is presented in Table 12.

Table 11

Effects on Water Surface Elevation at River Mile 670.6 for Plans 1 Through 5

WATER SURFACE ELEVATION AT RIVER MILE 670.6 (BIG SLOUGH)

TOTAL DISCHARGE (cfs)	EXIST	Plan 1	Plan 2 1912 ADJ.	Plan 3	Plan 4	Plan 5
15360	620.64	620.69	620.68	620.68	620.65	620.65
34940	621.73	621.95	621.86	621.86	621.80	621.77
80000	625.28	626.02	625.96	626.00	625.58	625.50
90000	626.01	626.50	626.80	626.88	626.63	626.30
100000	626.70	627.09	627.58	627.72	627.42	626.97
110000	627.34	627.67	628.10	628.35	628.14	627.52
120000	627.98	628.15	628.56	628.70	628.49	628.07
255000	634.90	634.90	634.92	634.92	634.92	634.90

Table 12

Effects on Water Surface Profile for Plan 3

River Mile	Water Surface Elevation Discharge of 110,000 cfs Existing Conditions	Proposed Conditions Plan 3	Increase in WSEL	
663.00	624.61	624.61	0.00	Lansing, Iowa
666.00	625.69	626.09	0.40	
667.95	626.23	626.96	0.73	
668.55	626.41	627.21	0.80	
669.07	626.57	627.43	0.86	
669.80	626.65	627.56	0.91	
669.81	626.65	627.56	0.91	
669.90	626.77	627.69	0.92	
669.91	626.77	627.69	0.92	
670.00	626.99	627.93	0.94	
670.40	627.12	628.08	0.96	
670.41	627.12	628.08	0.96	
670.60	627.34	628.32	0.98	Blackhawk Park
670.70	627.46	628.47	1.01	
670.90	627.58	628.62	1.04	
671.41	627.70	628.72	1.02	
672.00	627.99	628.96	0.97	
672.90	628.66	629.51	0.85	
674.71	629.31	630.06	0.75	
676.06	629.76	630.43	0.67	
677.56	630.15	630.76	0.61	
679.08	630.43	631.01	0.58	
679.24	630.46	631.05	0.59	Lock and Dam 8

Effects on Water Surface Elevations in Backwaters

A step backwater analysis was performed for Big Slough to approximate these impacts. For lower discharges this is a faily good approximation since Big Slough is a well defined channel. For higher flows this type of analysis at best is approximate, however it should be beneficial in determining project impacts. Decreases in water surface elevation at the upstream end of Big Slough of .3 feet for a discharge of 15,400 cfs, 0.8 feet for a discharge of 34,940 cfs, and 1.5 feet for a discharge of 80,000 to 120,000 cfs were obtained for plan 3. At river discharges when the proposed conditions right bank is overtopped, the project effects on backwater surface elevations aren't as great. Table 13 summarizes the change in backwater elevation at the upstream end of Big Slough for plan 3. This represents the maximum decrease in backwater elevations.

Table 13

Maximum Decrease in Water Surface Elevation in Backwaters (Big Slough)

TOTAL DISCHARGE (cfs)	WATER SURFACE ELEVATION BIG SLOUGH EXIST	PROP PLAN 3	RIVER MILE 663.0 1912 ADJ.
15360	620.64	620.34	620.00
34940	621.73	620.93	620.02
80000	625.28	623.78	622.48
90000	626.01	624.51	623.20
100000	626.70	625.20	623.92
110000	627.34	625.84	624.61
120000	627.98	626.48	625.29
137000	628.30	627.20	626.40
164000	630.00	629.50	628.15

For discharges of 80,000 cfs or above, the most critical parameter is the head differential across the right bank during overtopping. If the head differential is too large, then the final design must account for this, either through special overflow structures or through a stepped levee design.

Effects on Sediment Loads to the Big Lake Area

The sediment load from the Mississippi River to the Big Lake area not including the Upper Iowa River for existing conditions and for the 5 plans is summarized in the Table 14.

Table 14
Effects on Sediment Load to the Big Lake Area for Plans 1 Through 5

	Sediment Load Tons/Year
Existing Conditions	840,000
Plan 1	667,950
Plan 2	642,765
Plan 3	558,450
Plan 4	713,210
Plan 5	768,060

Previously, the sediment load to the Big Lake area from the Upper Iowa River was summarized as follows.

Source	Tons
Upper Iowa	
Overbank	74,300
Plume	228,800

By raising the levee along the Upper Iowa right bank, most of the sediment load from overbank flow is eliminated. However, some of this load will enter the Big Lake area through secondary channels. It will be assumed that the reduction in Upper Iowa River sediment load that enters the Big Lake area through secondary channels corresponds to the reduction in Mississippi River sediment load. Table 15 shows the total reduction in sediment load to the Big Lake area for the five plans. Also shown is the assumed reduction in sediment deposition based on the percent reduction in sediment load.

Table 15

Effects on Sediment Load to the Big Lake Area for Plans 1 Through 5

	Sediment Load Tons/Year	Percent Reduction	Sediment Deposition (in/yr)
Existing Conditions	1,143,000		.60
Plan 1	924,240	19	.49
Plan 2	846,310	26	.44
Plan 3	735,294	36	.38
Plan 4	939,062	18	.49
Plan 5	1,051,560	8	.55

The percent reductions given in the above table are based on a comparison with the existing conditions sediment load. This is an acceptable method to compare plans, however the reduction in sediment loading should also be compared to future "without project" conditions. As discussed in the "Future Without Project" part of the sedimentation section, the side channel discharge and sediment load to the Big Lake area has increased 5 to 10 percent since 1980, and this increase will probably continue into the future. If it is assumed that an increase in sediment load of 8 percent occurs, then the future sedimentation rate would increase to .65 inches per year. This sedimentation rate should be used to assess project impacts. Comparing Plan 5 to future "without project" conditions would result in a 16 percent reduction in sediment load over future conditions.

Effects on Adjacent Backwaters

The major project impact at Blackhawk Park will be the increase in water surface elevations. As presented in Table 11 the greatest increase in water surface elevations is approximately 1 foot for Plan 3 when the river discharge is 100,000 to 110,000 cfs. Besides flooding numerous park facilities on a more frequent basis, this could potentially increase discharges into the backwaters east of Blackhawk Park. However, this is offset by the fact that control structures exist across the secondary channels leading into Blackhawk Park. Also, unlike the Big Lake area which will experience a decrease in water surface elevations, the water surface elevations in the Blackhawk Park backwaters will rise since the entire area will be affected by increased stage.

Increases in stage at River Mile 666.1, would cause additional discharge down Winneshiek Slough due the increased energy slope, and slight increases in wetted area and hydraulic radius. Mannings Equation was used to quantify the increased discharge for Plan 3 proposed conditions. This is summarized in Table 16 and is shown on Plate 21. The maximum increase in discharge down Winneshiek Slough of 22 percent occurs at total river discharges of 100,000 to 110,000 cfs. For discharges less than the average discharge, the increase is approximately 4 percent.

Table 16

Winneshiek Slough Discharge
Versus Lock and Dam 8 Discharge,
Existing and Proposed Plan 3 Conditions

TOTAL DIS-CHARGE (cfs)	WINN. DIS-CHARGE EXIST.	WINN. DIS-CHARGE PROPOSED	PERCENTAGE INCREASE
15360.0	2522.0	2621.1	3.93
34940.0	5293.4	5508.7	4.07
80000.0	13673.9	15850.8	15.92
90000.0	15356.0	18141.8	18.14
100000.0	17386.8	21184.0	21.84
110000.0	19057.2	23214.7	21.82
120000.0	20919.1	24094.6	15.18

The percentage increases given in Table 16 don't take into account geomorphic changes in the navigation channel. Monitoring done for the Weaver Bottoms Backwater Rehabilitation project, which greatly reduced secondary channel discharges to Weaver Bottoms, indicate that discharges to adjacent backwaters haven't increased over preproject conditions until a total river discharge of 60,000 cfs is reached. In fact, for discharges less than 60,000 cfs the secondary channel discharge to adjacent backwaters has decreased. Therefore, the percentage increases given above are probably conservative. However, the sediment load downstream of the Big Lake area will increase and eventually this sediment will enter other backwater areas. There should not be any adverse impacts to the navigation channel.

STRUCTURE DESIGN

Partial Closure Structures

To maintain discharge into the Big Lake area, partial closure structures (ie. not a complete closure structure) will be constructed at the major secondary channels into the backwater area. The closure structures will be constructed of an earth core with a 30 inch layer of rock fill to protect against erosion. Rock fill shall be reasonably well graded between the following limits. Maximum stone size shall be 24 inches. No more than 5 percent by weight shall be smaller than 2 inches and the 50 percent size shall be individual stones weighing between 40 pounds (approximately 8 inch size) and 120 pounds (approximately 12 inch size). The inclusion of objectionable quantities of dirt, clay and other deleterious material will not be permitted. Rock protection should be taken to the top of bank after the bank is shaped to a 2.5H:1V side slope. At site 6, a scour hole presently exists at a location just downstream of the proposed structure location. Detailed data will be obtained for plans and specs to determine whether this scour hole should be reshaped to fit the structure design better.

Complete Closure Structures

Complete closure structures will be constructed at sites where it is desired to completely eliminate secondary channel flow. These closures will be constructed of sand and be will have a 6 inch layer of topsoil placed on them. Woody vegetation such as willows and indigenous species of grasses will be planted to reduce the potential for erosion during overtopping. The crest elevation of all complete closure structures will be 627 which is 1 to 2 feet over natural levee elevations. This will result in the closure structures being overtopped only after the entire right bank natural levee is overtopped and head differentials between the navigation channel and the backwater area have been reduced.

MONITORING PLAN

Side channel discharges to the Big Lake area and in the Winneshiek Slough area will be monitored after project construction. Discharge measurements will be done immediately after construction, with subsequent discharge measurements done so that an adequate range of flow conditions is monitored. With the excellent data base that exists for preproject side channel discharges, the impacts of the Big Lake project should be easily determined.

Sediment deposition will be monitored by measuring water depths along transects in the Lansing Big Lake and Winneshiek Slough backwater area. The transects used by the IDNR to monitor sedimentation rates should continue to be monitored in the future. Additionally, four transects should be located in Big Lake and 2 or 3 transects should be located in the Winneshiek Slough area.

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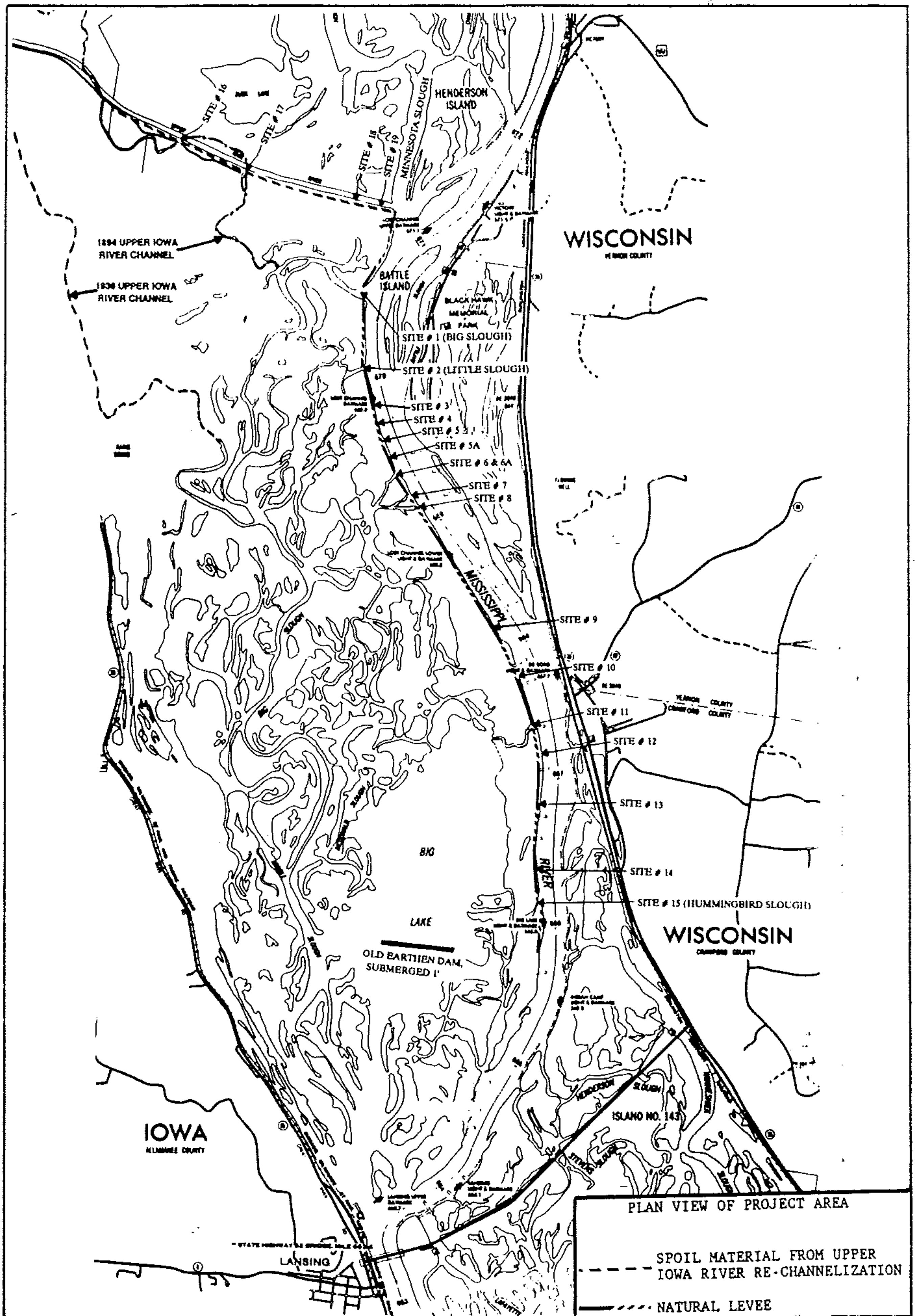
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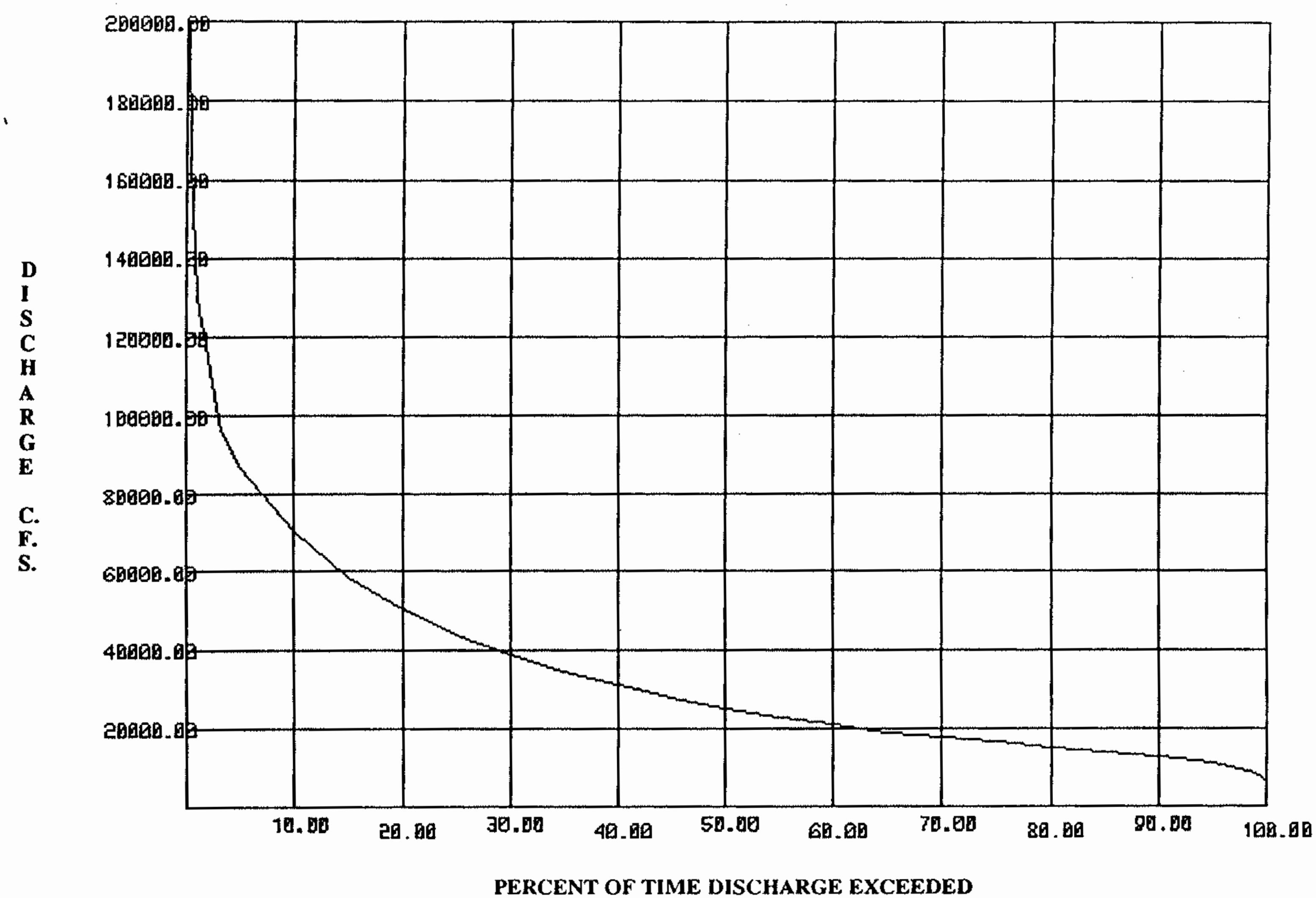
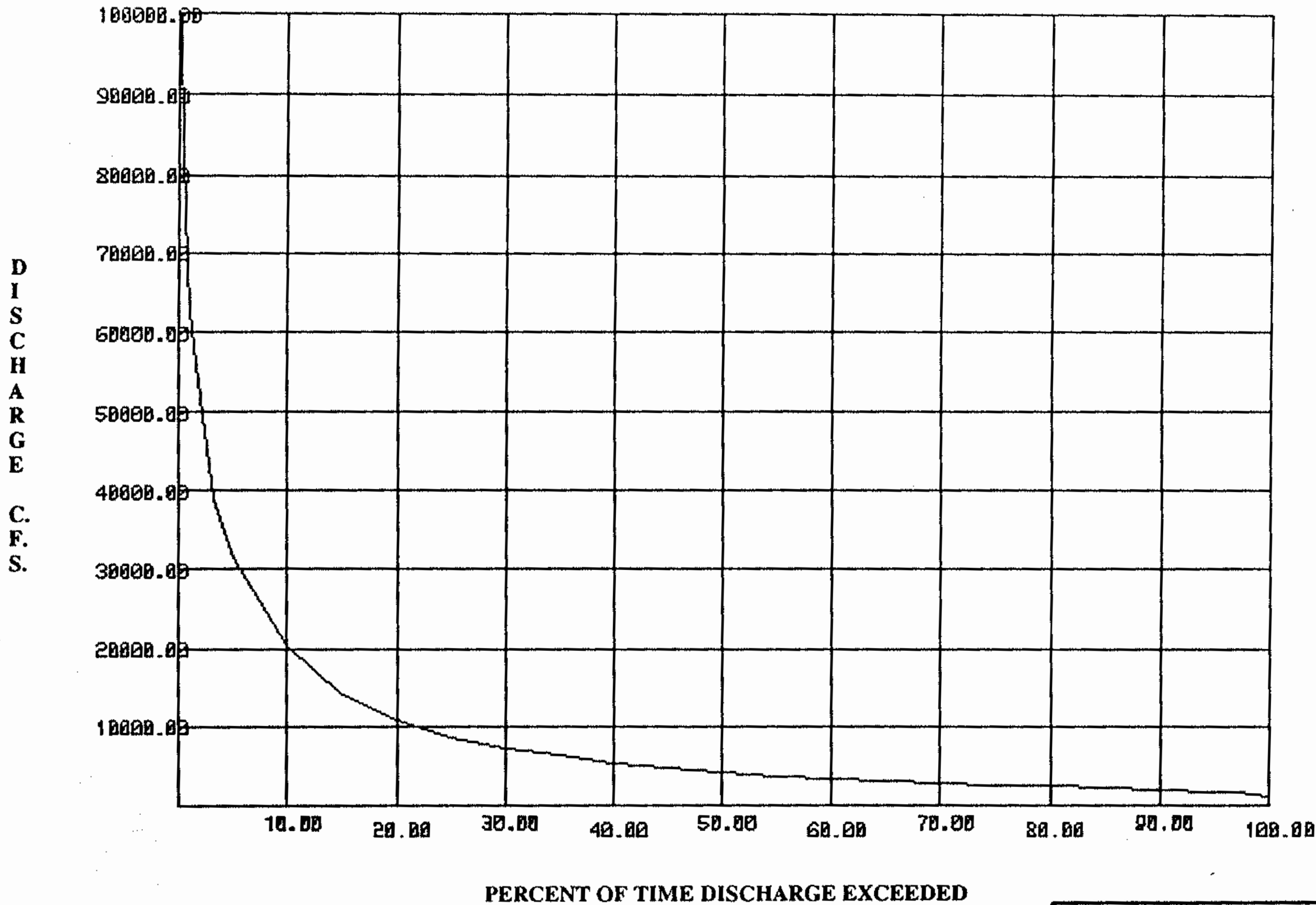
MINNESOTA SLOUGH
SITE # 16
SITE # 17
SITE # 18
SITE # 19
1894 UPPER IOWA RIVER CHANNEL
1936 UPPER IOWA RIVER CHANNEL
WISCONSIN
BATTLE ISLAND
BLACK HAWK MEMORIAL PARK
SITE # 1 (BIG SLOUGH)
SITE # 2 (LITTLE SLOUGH)
SITE # 3
SITE # 4
SITE # 5
SITE # 5A
SITE # 6 & 6A
SITE # 7
SITE # 8
MISSISSIPPI
SITE # 9
SITE # 10
SITE # 11
SITE # 12
SITE # 13
SITE # 14
SITE # 15 (HUMMINGBIRD SLOUGH)
BIG
LAKE
RIVER
OLD EARTHEN DAM, SUBMERGED 1'
WISCONSIN
HENDERSON SLOUGH
ISLAND NO. 143
IOWA
LANSING
PLAN VIEW OF PROJECT AREA
SPOIL MATERIAL FROM UPPER IOWA RIVER RE-CHANNELIZATION
NATURAL LEVEE



DISCHARGE - DURATION

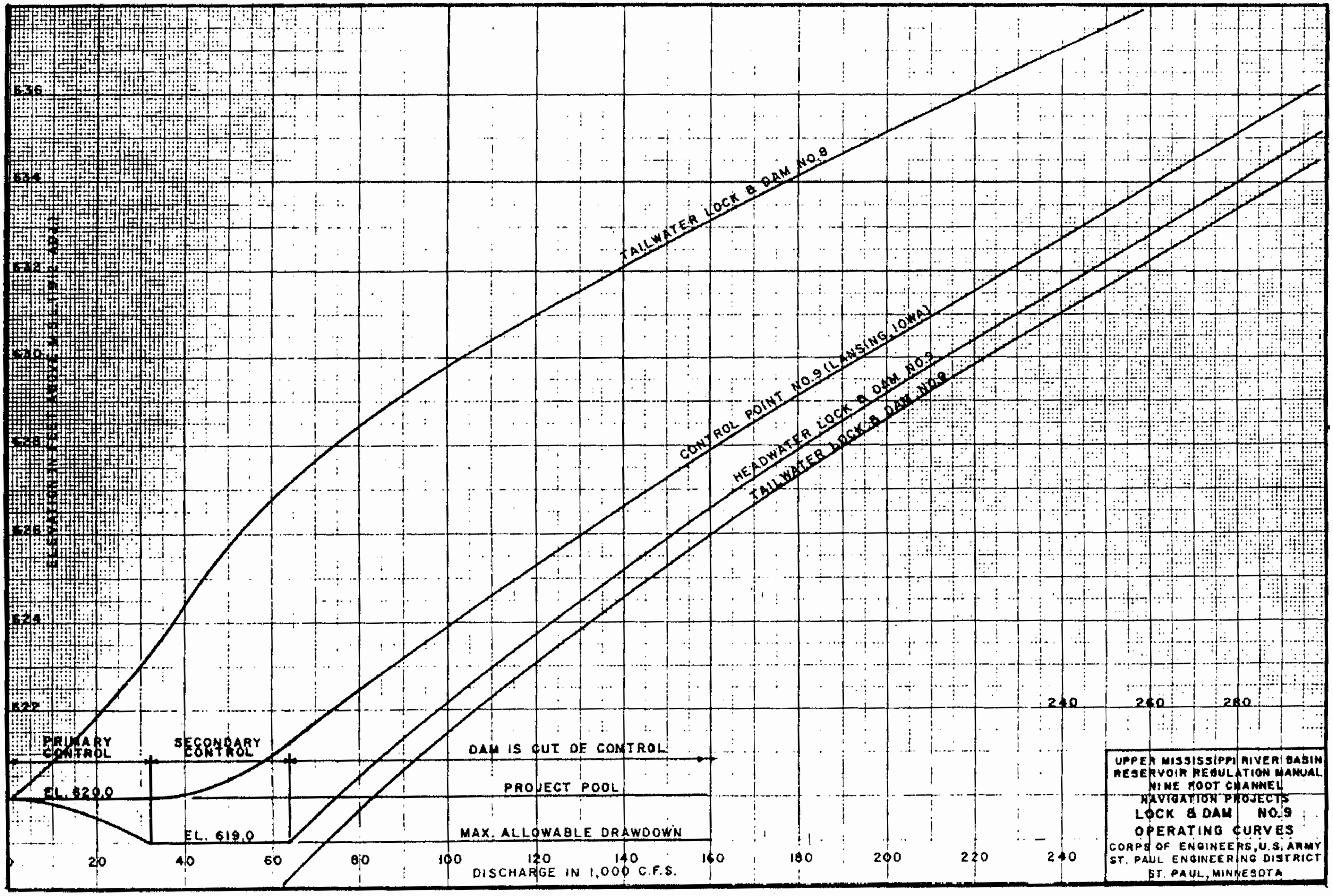
LOCK AND DAM 8 GENOA, WISCONSIN

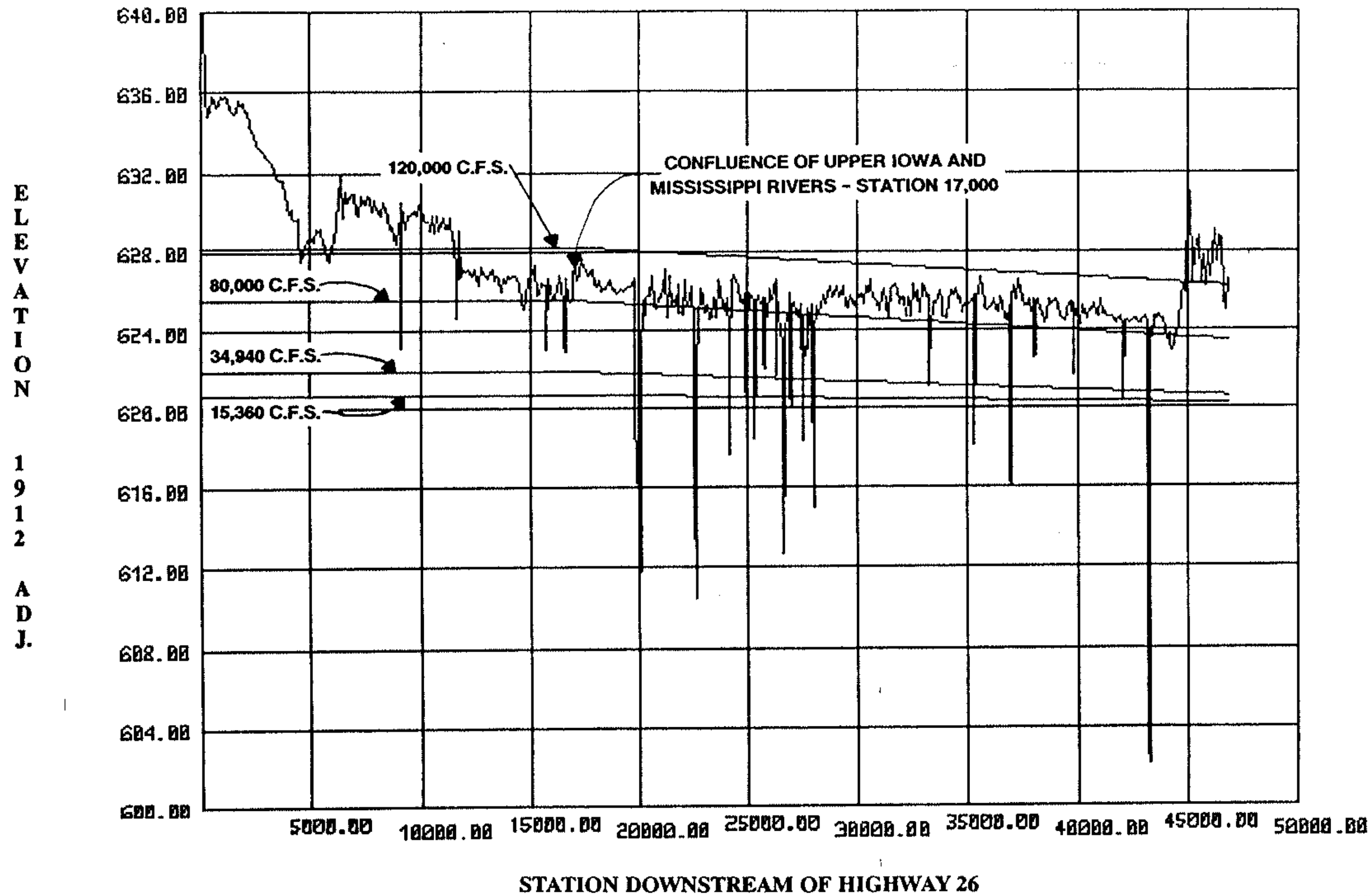
RIVER MILE 679.2



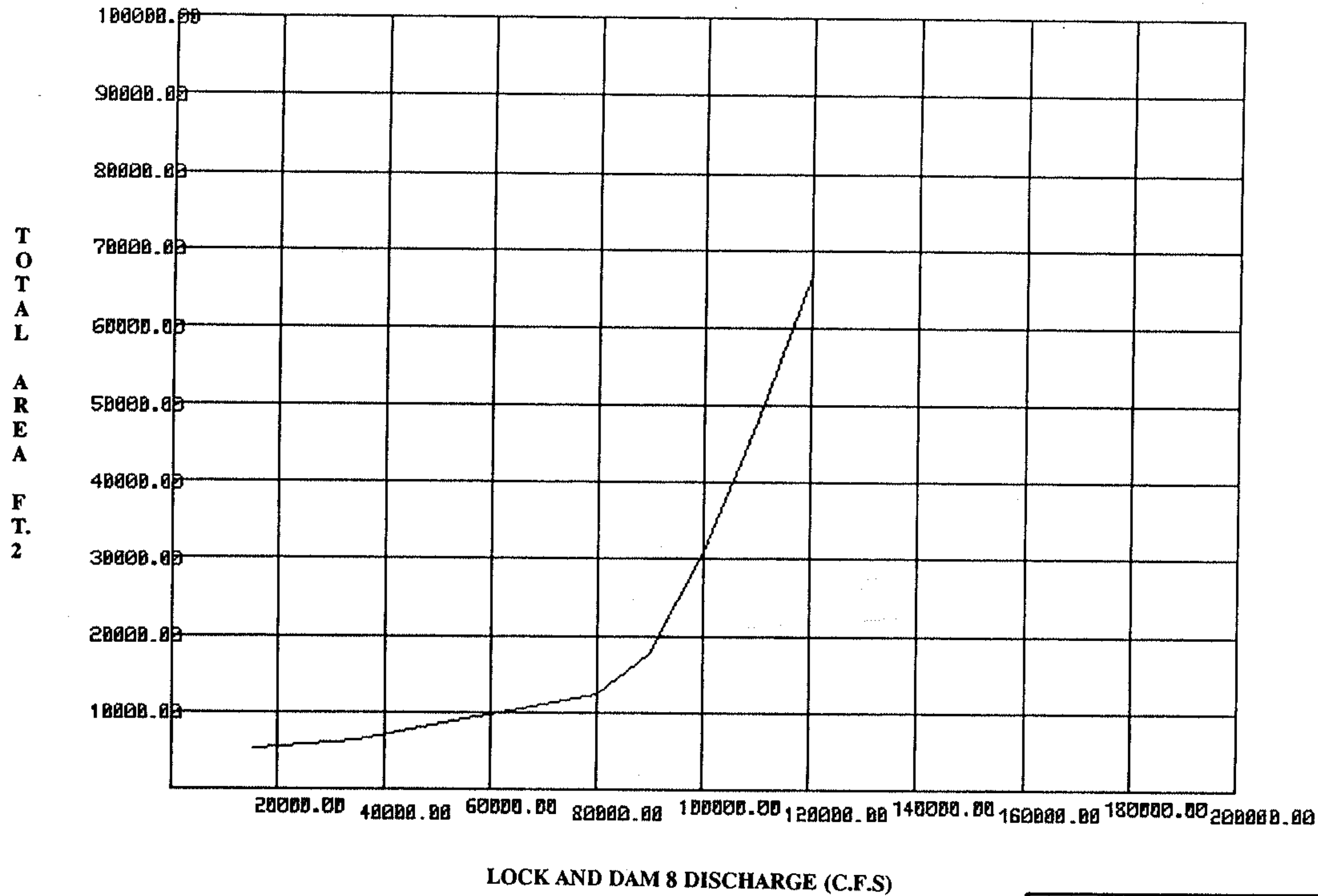
DISCHARGE - DURATION

SECONDARY CHANNEL DISCHARGE TO BIG LAKE AREA, RIVER MILES 663 TO 670.6

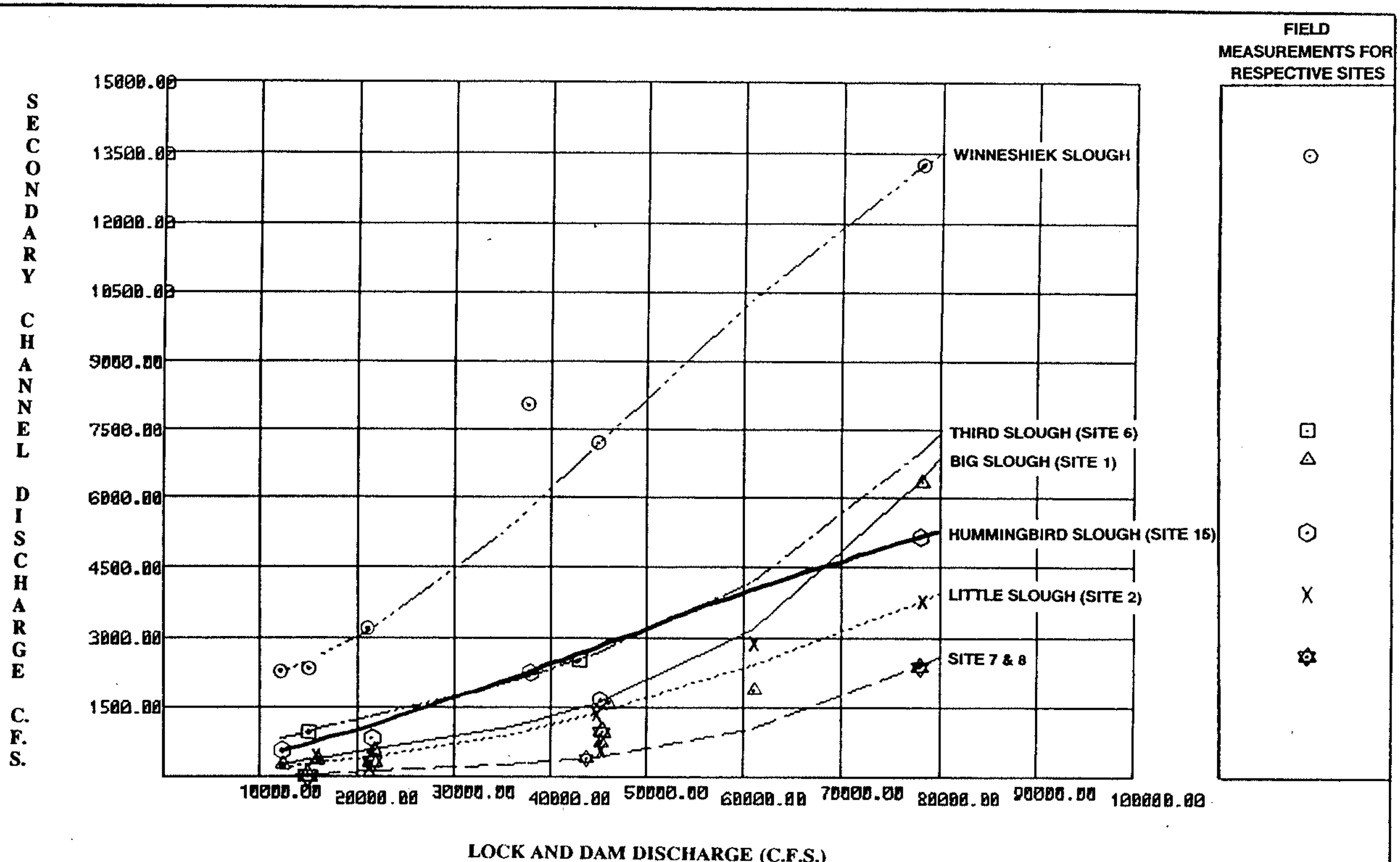

ELEVATION IN FEET ABOVE M.S.L. (1912 ADJ)
636
634
632
630
628
626
624
622
TAILWATER LOCK & DAM NO.8
CONTROL POINT NO.9 (LANSING, IOWA)
HEADWATER LOCK & DAM NO.9
TAILWATER LOCK & DAM NO.9
PRIMARY CONTROL
SECONDARY CONTROL
DAM IS OUT OF CONTROL
EL. 620.0
PROJECT POOL
EL. 619.0
MAX. ALLOWABLE DRAWDOWN
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
DISCHARGE IN 1,000 C.F.S.
UPPER MISSISSIPPI RIVER BASIN
RESERVOIR REGULATION MANUAL
NINE FOOT CHANNEL
NAVIGATION PROJECTS
LOCK & DAM NO.9
OPERATING CURVES
CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA



WATER SURFACE PROFILES

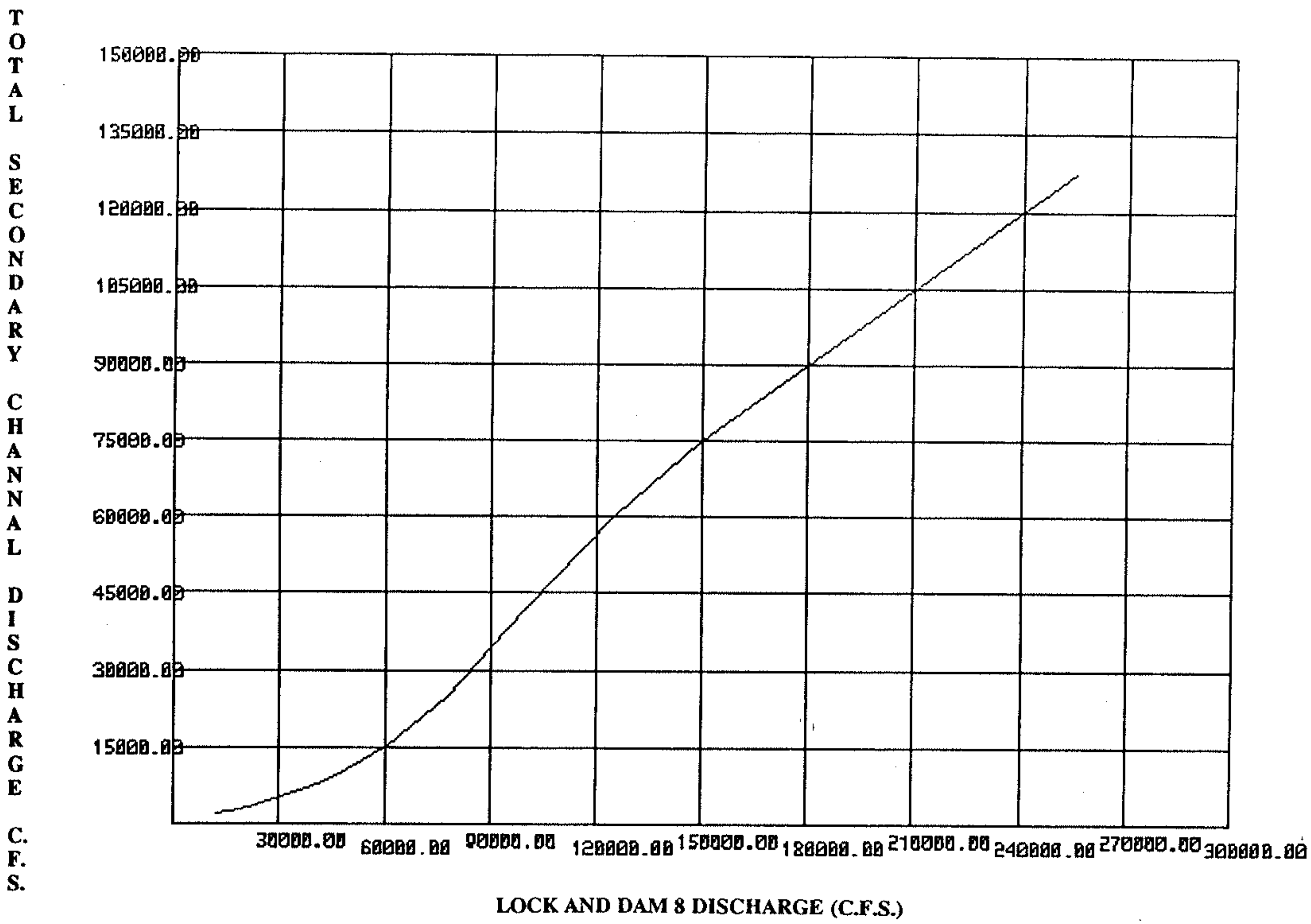


TOTAL SECONDARY CHANNEL AREA VERSUS
LOCK AND DAM 8 DISCHARGE



SECONDARY CHANNEL DISCHARGE VERSUS

LOCK AND DAM 8 DISCHARGE



TOTAL SECONDARY CHANNEL DISCHARGE
VERSUS LOCK AND DAM 8 DISCHARGE

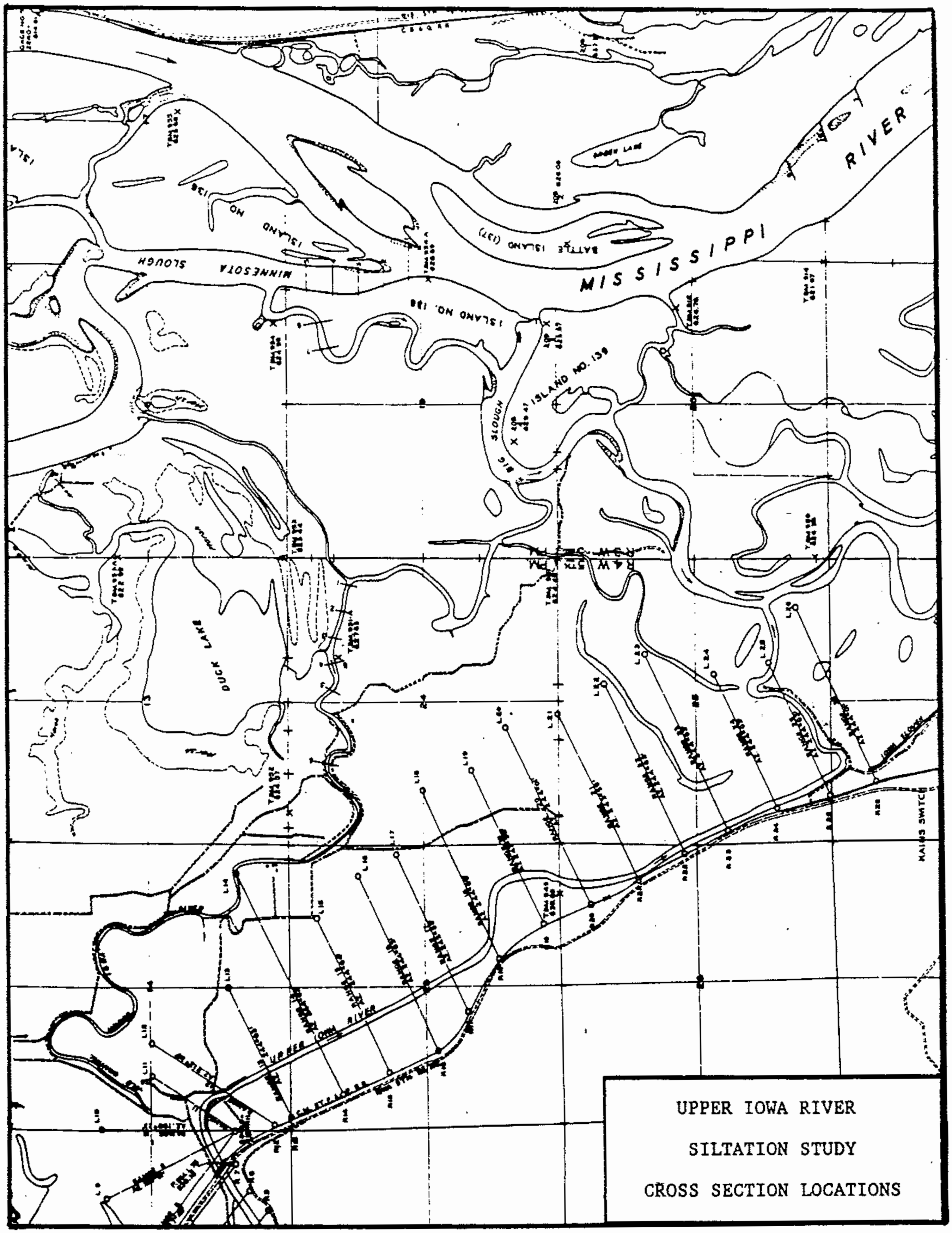
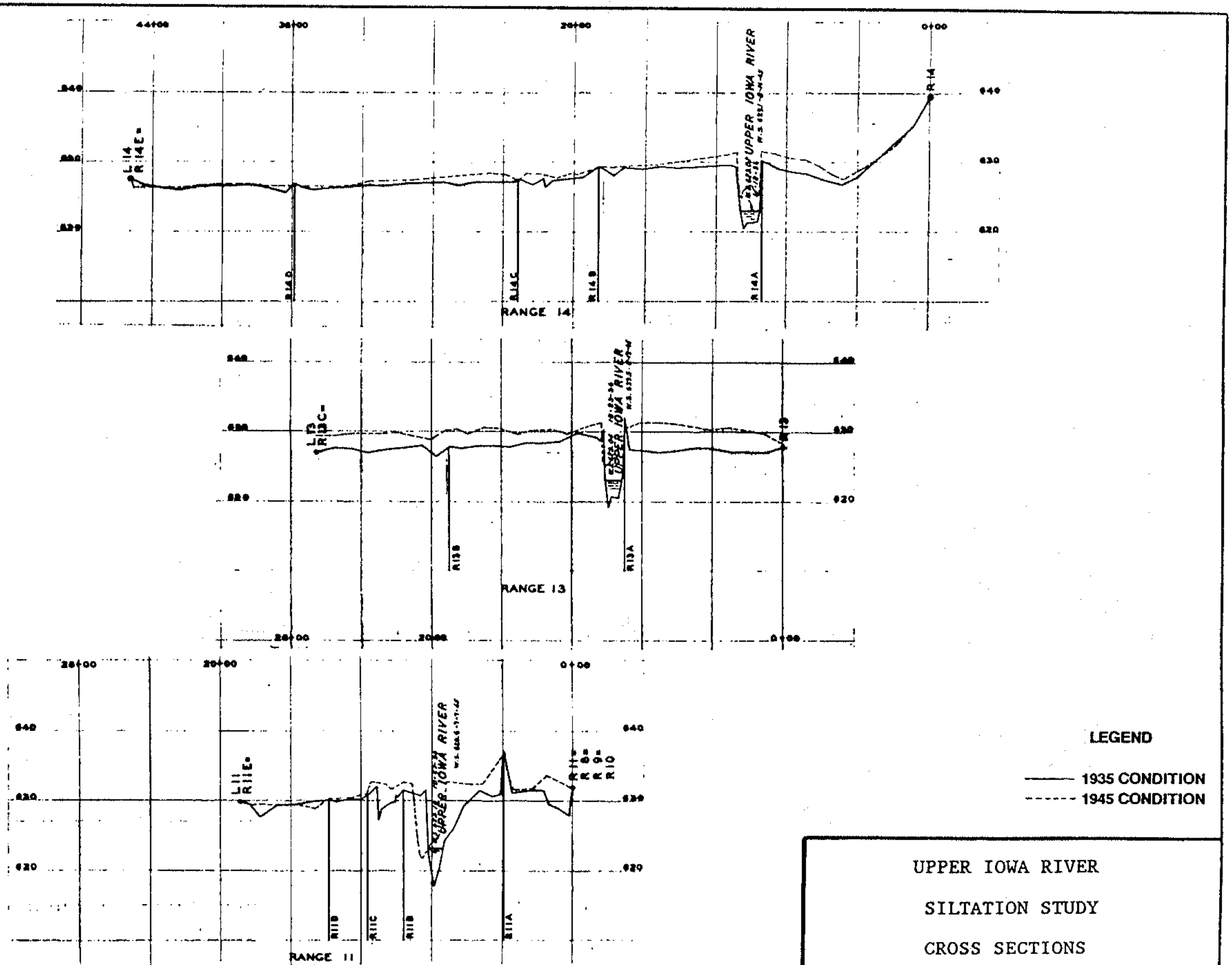

MISSISSIPPI
RIVER
MINNESOTA SLOUGH
ISLAND NO. 138
ISLAND NO. 139
BATTLE ISLAND (137)
BIG SLOUGH
DUCK LAKE
UPPER IOWA RIVER
MAINS SWITCH
R4W
UPPER IOWA RIVER
SILTATION STUDY
CROSS SECTION LOCATIONS

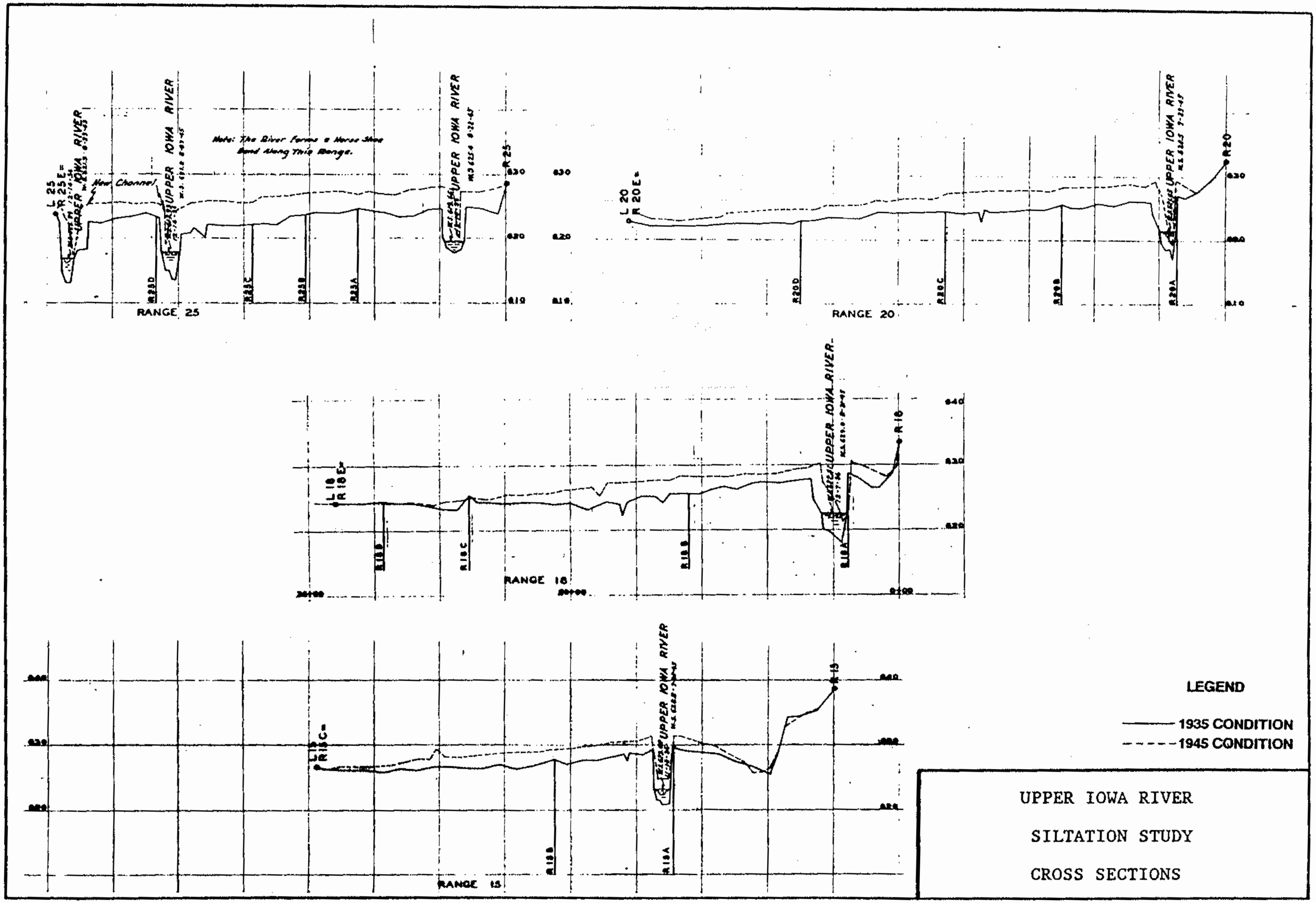
PLATE 9

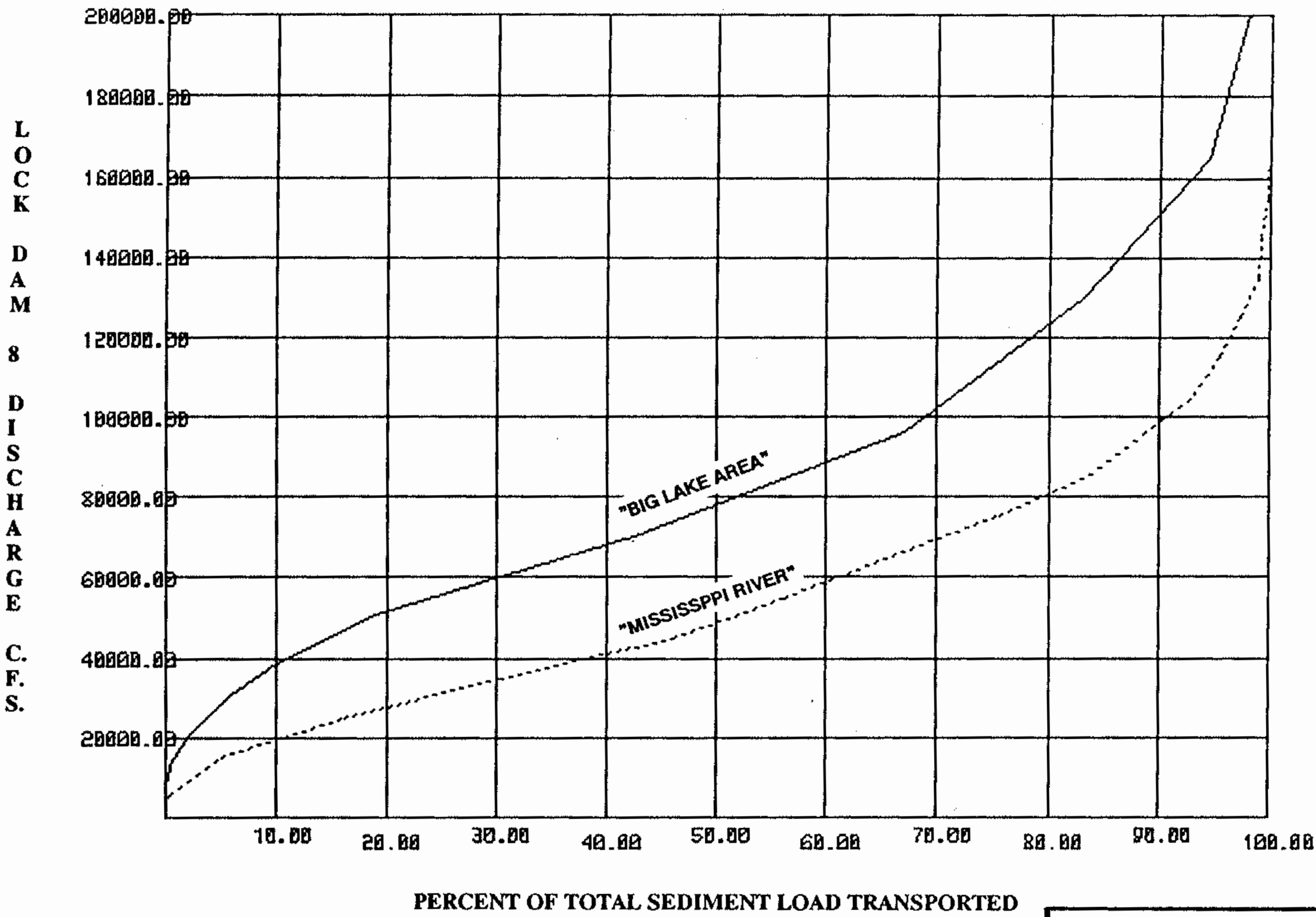


UPPER IOWA RIVER

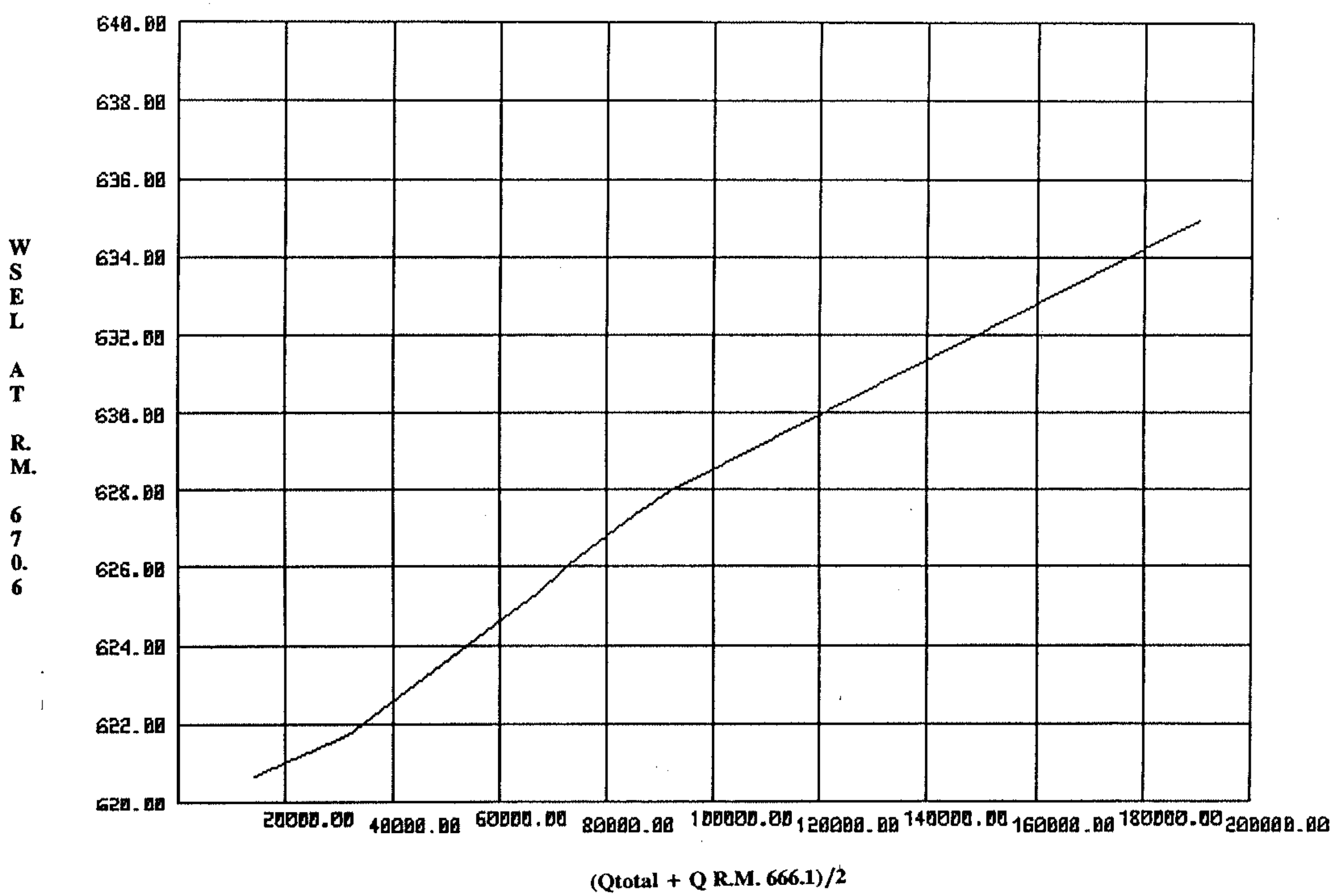
SILTATION STUDY

CROSS SECTIONS

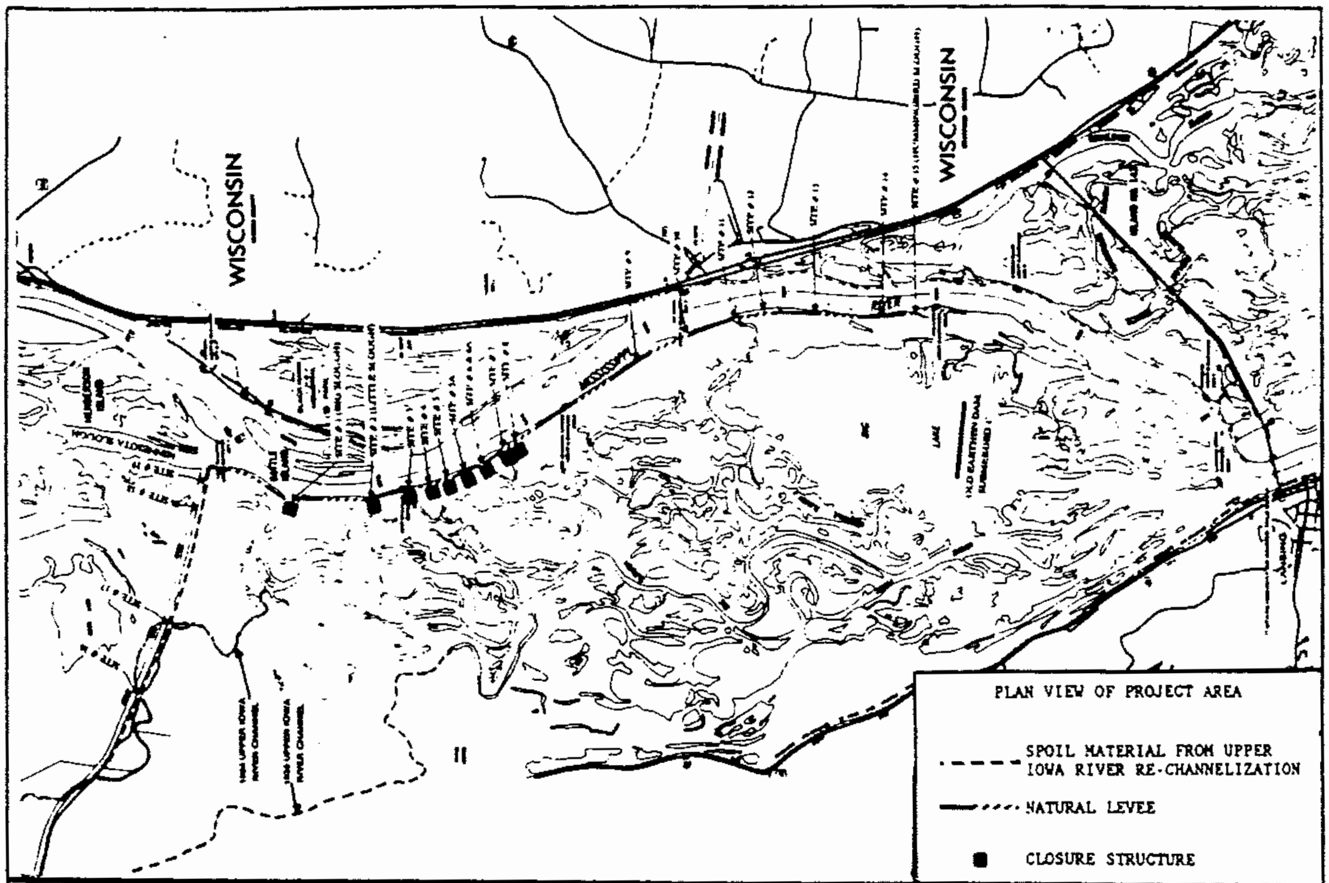

Note: The River Forms a Horse Shoe Bend Along This Range.
New Channel
UPPER IOWA RIVER
L 25
R 25 E
R 25
R25D
R25C
R25B
R25A
RANGE 25
630
620
610
L 20
R 20 E
R 20
R20D
R20C
R20B
R20A
RANGE 20
L 18
R 18 E
R 18
R18D
R18C
R18B
R18A
RANGE 18
640
L 15
R 15 C
R 15
R15B
R15A
RANGE 15
LEGEND
1935 CONDITION
1945 CONDITION
UPPER IOWA RIVER
SILTATION STUDY
CROSS SECTIONS

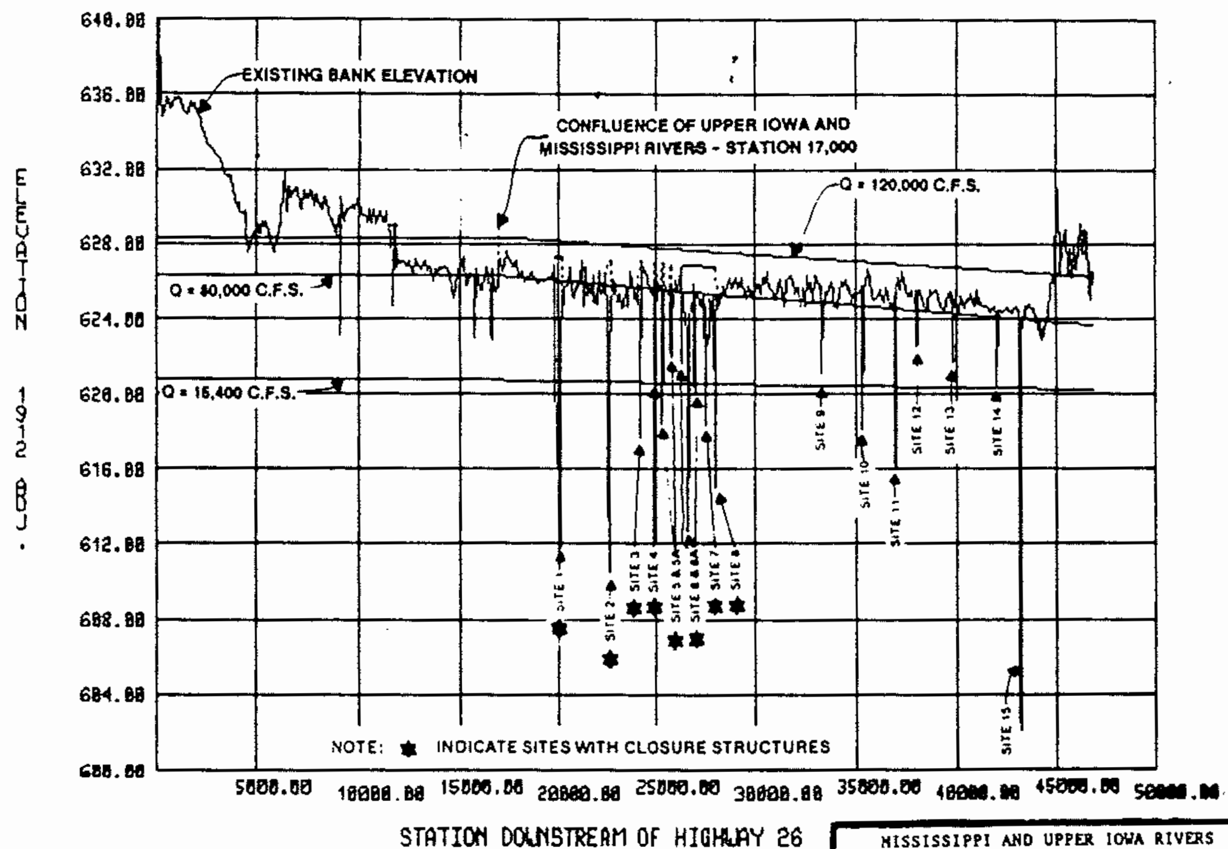


PERCENTAGE OF TOTAL SEDIMENT LOAD TRANSPORTED FOR ALL LOCK AND DAM 8 DISCHARGES UP TO SPECIFIED DISCHARGE



WATER SURFACE ELEVATION AT RIVER MILE 670.6 VERSUS AVERAGE OF TOTAL DISCHARGE AND DISCHARGE AT RIVER MILE 666.1

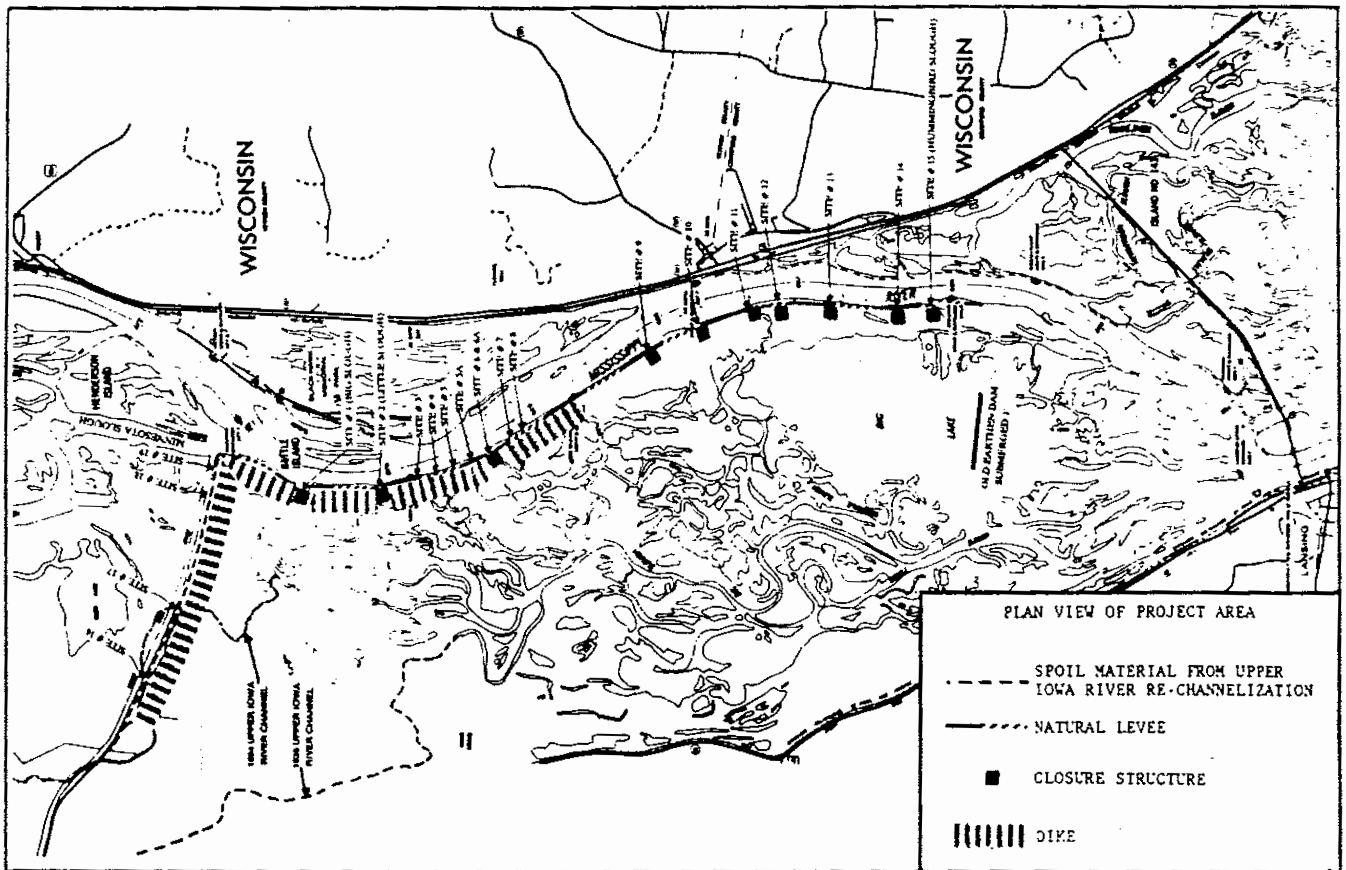


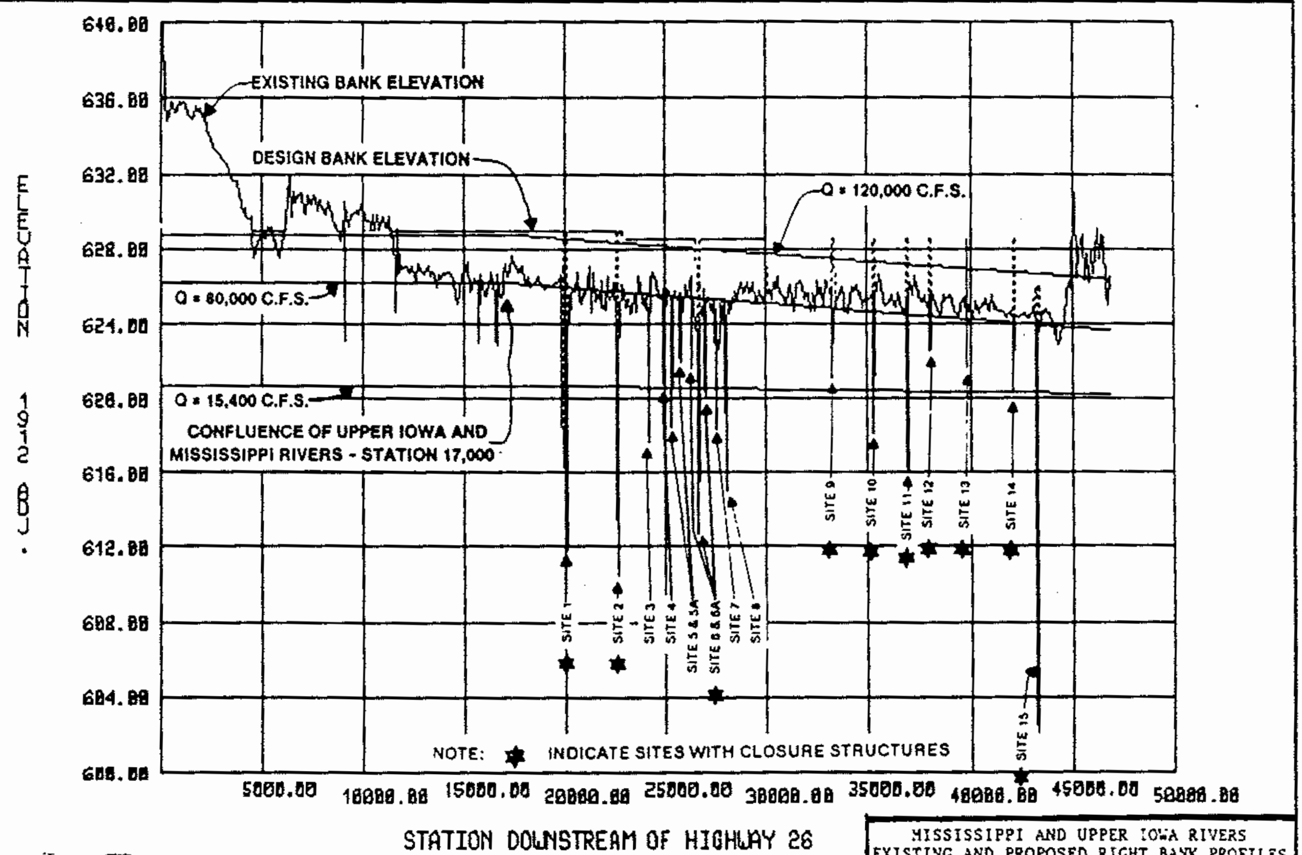


MISSISSIPPI AND UPPER IOWA RIVERS
EXISTING AND PROPOSED RIGHT BANK PROFILES
AND WATER SURFACE PROFILES, PLAN 1

PLAN 1

PLAN AND SECTION VIEW



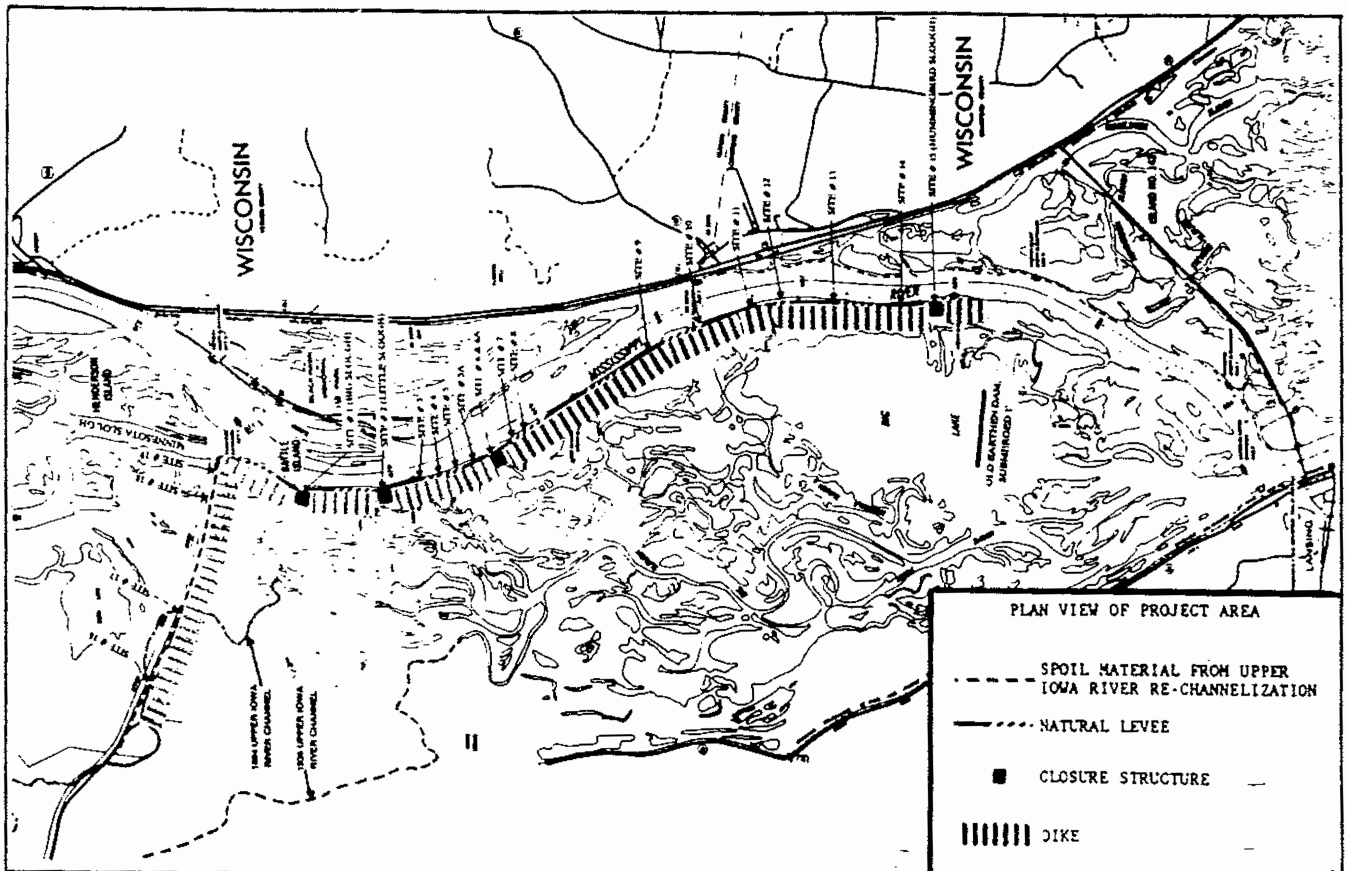


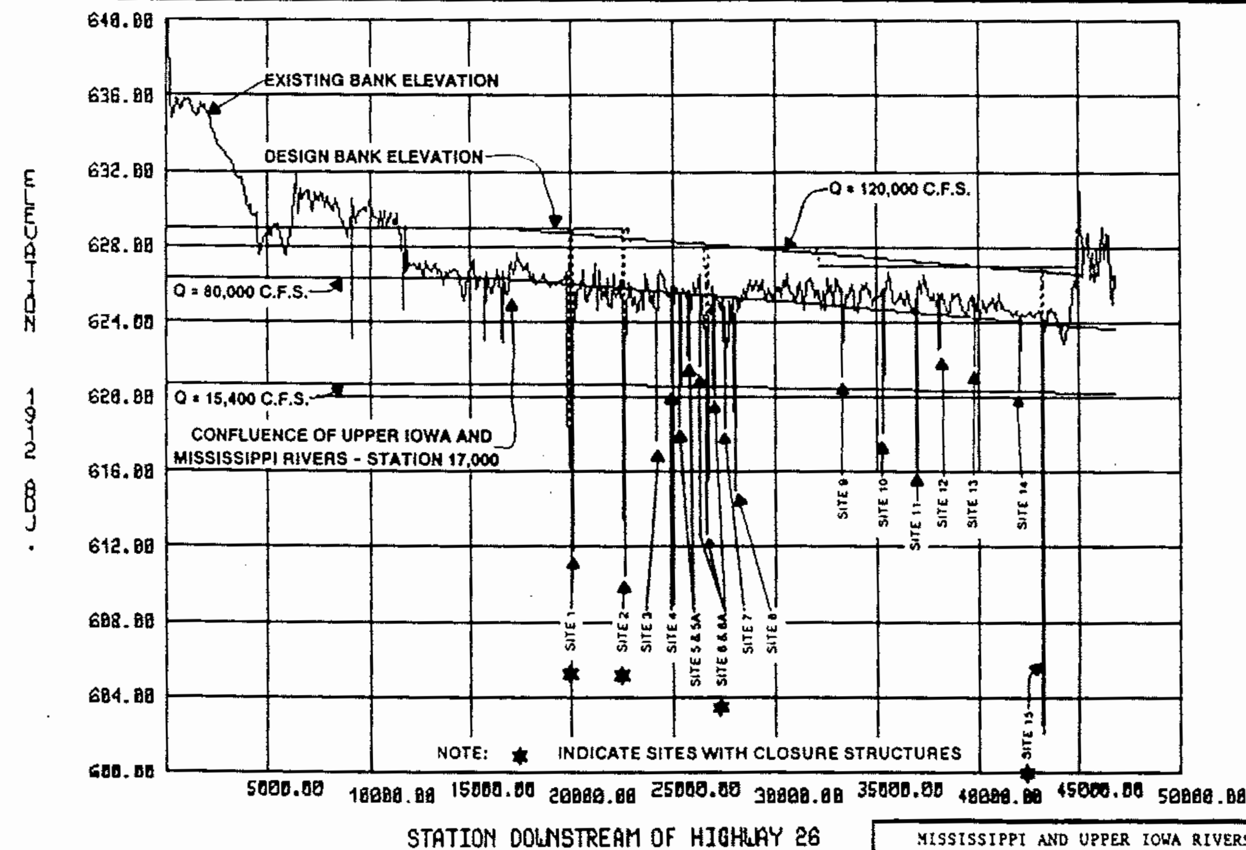
MISSISSIPPI AND UPPER IOWA RIVERS
EXISTING AND PROPOSED RIGHT BANK PROFILES
AND WATER SURFACE PROFILES, PLAN 2

PLAN 2

PLAN AND SECTION VIEW

PLATE 15

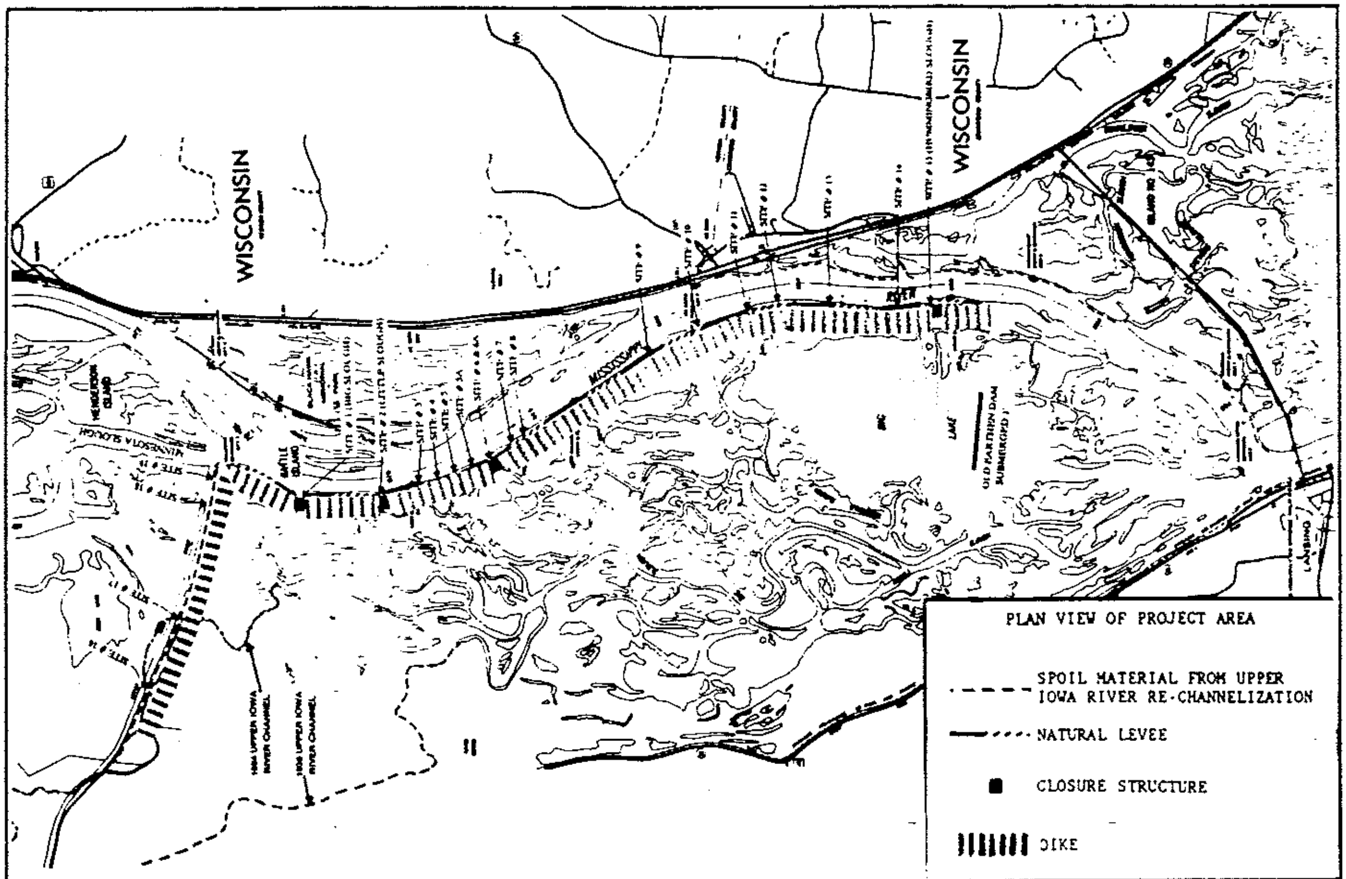


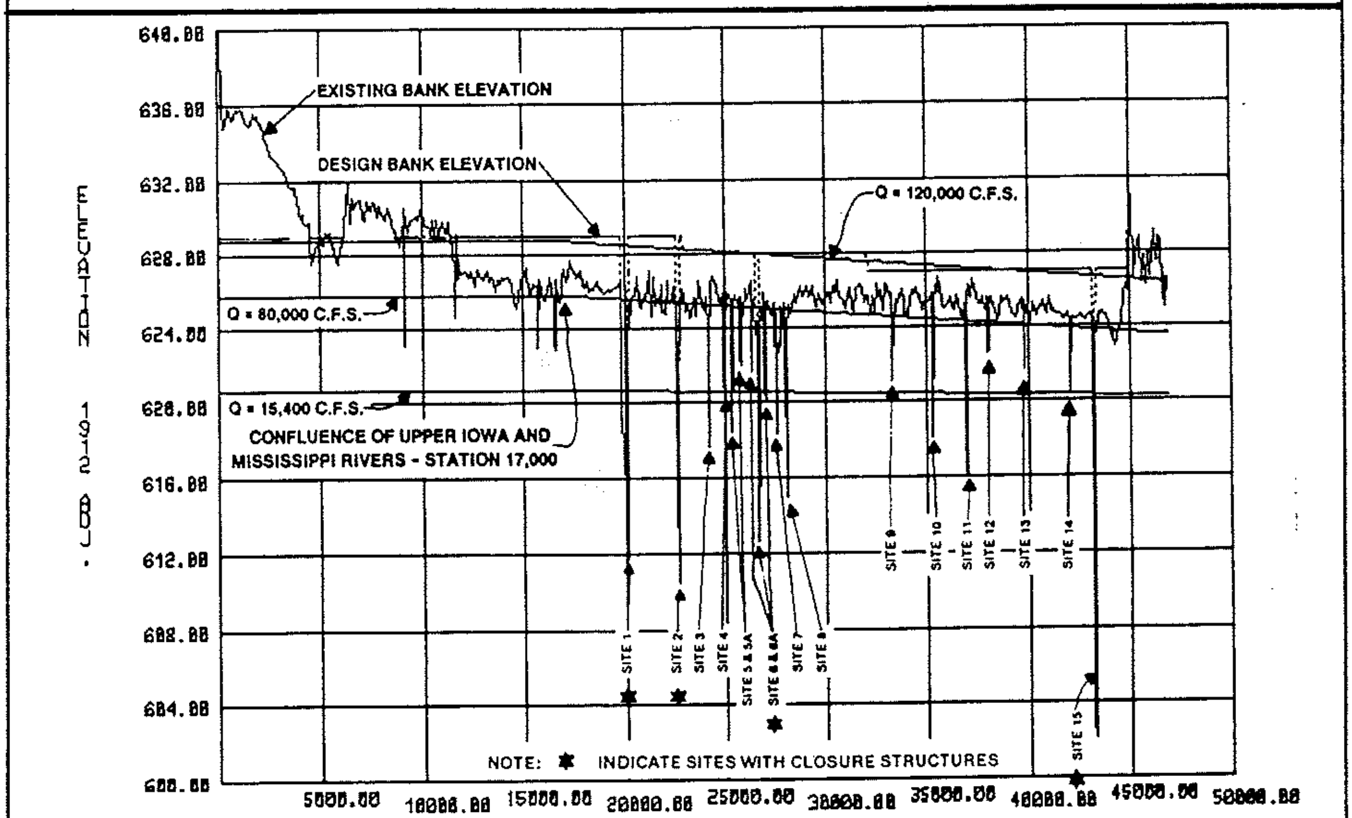


MISSISSIPPI AND UPPER IOWA RIVERS
EXISTING AND PROPOSED RIGHT BANK PROFILES
AND WATER SURFACE PROFILES, PLAN 3

PLAN 3

PLAN AND SECTION VIEW

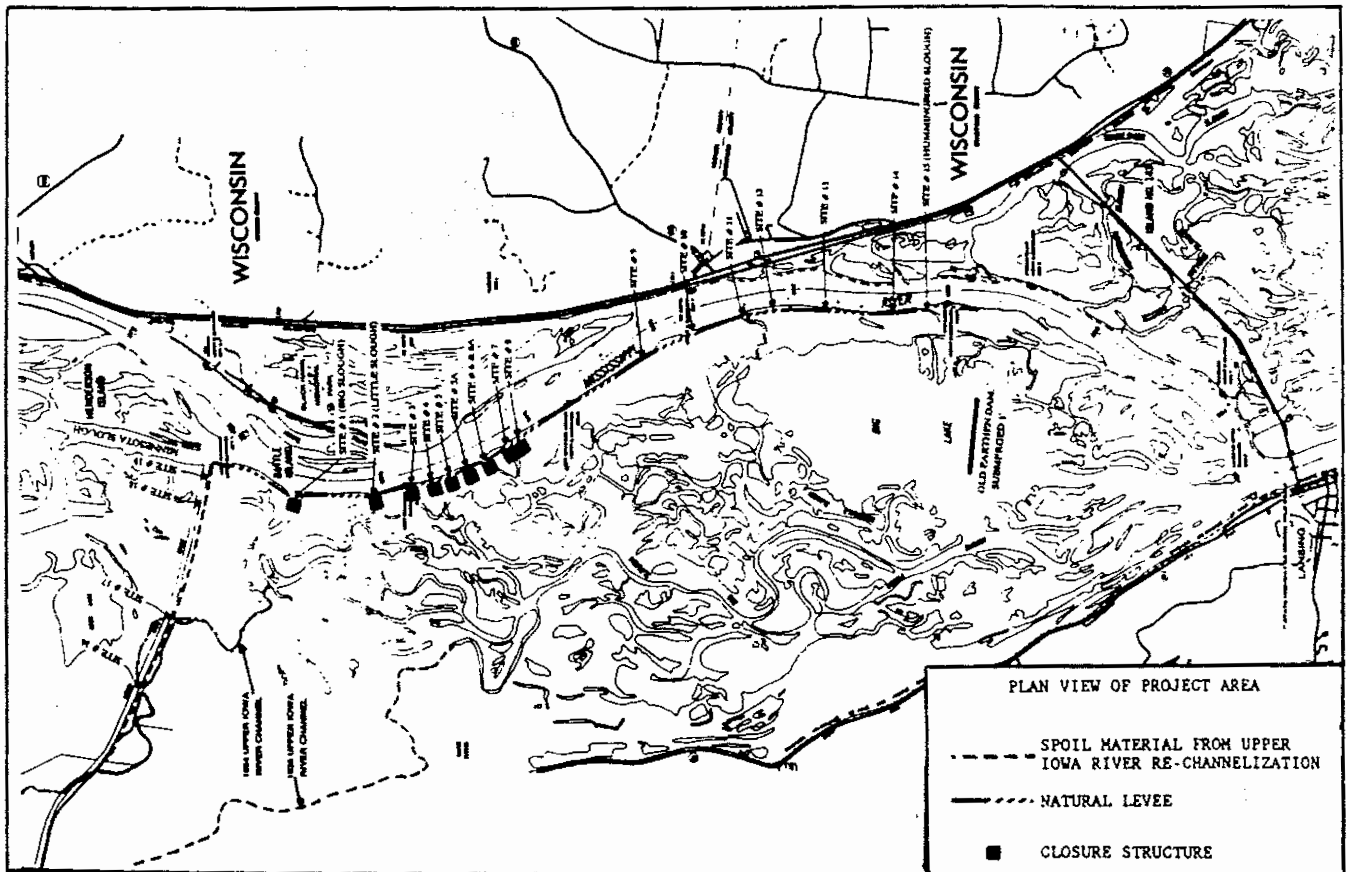


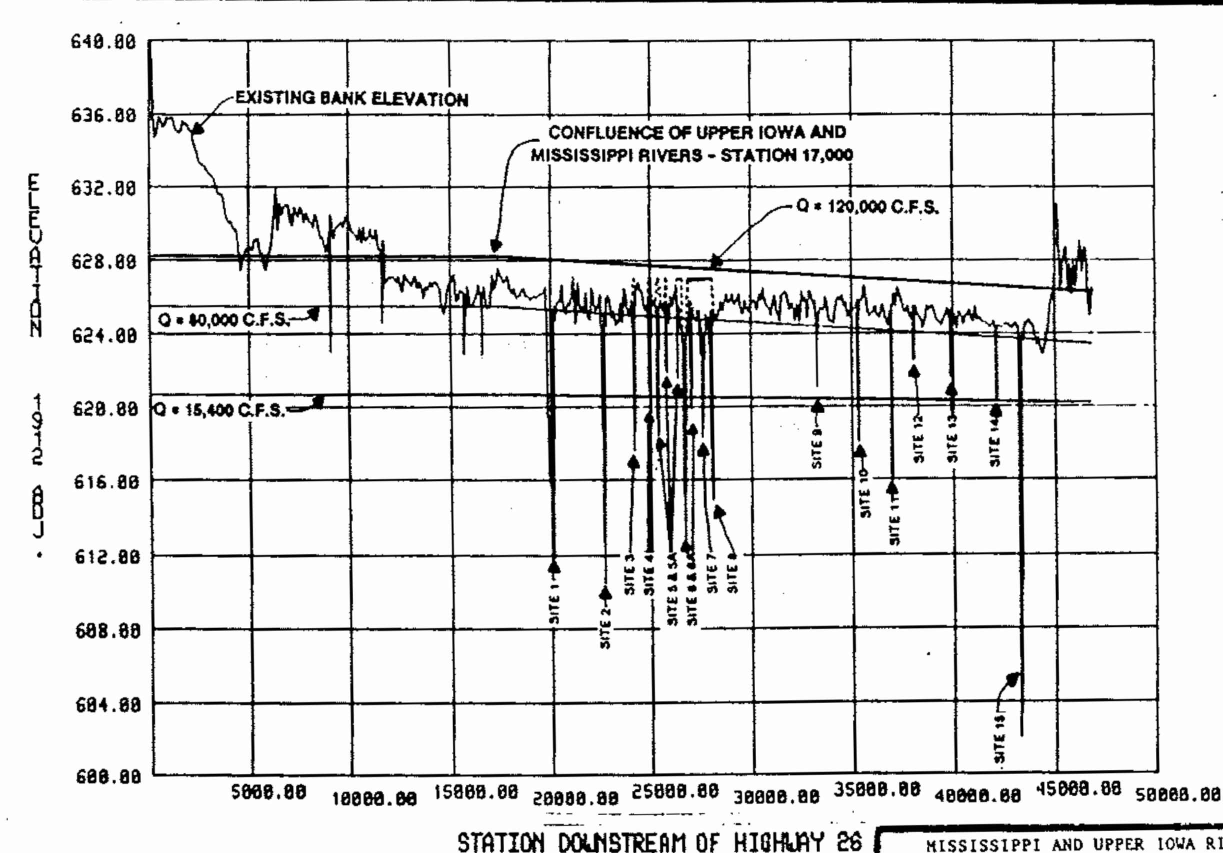


MISSISSIPPI AND UPPER IOWA RIVERS
EXISTING AND PROPOSED RIGHT BANK PROFILES
AND WATER SURFACE PROFILES, PLAN 4

PLAN 4

PLAN AND SECTION VIEW

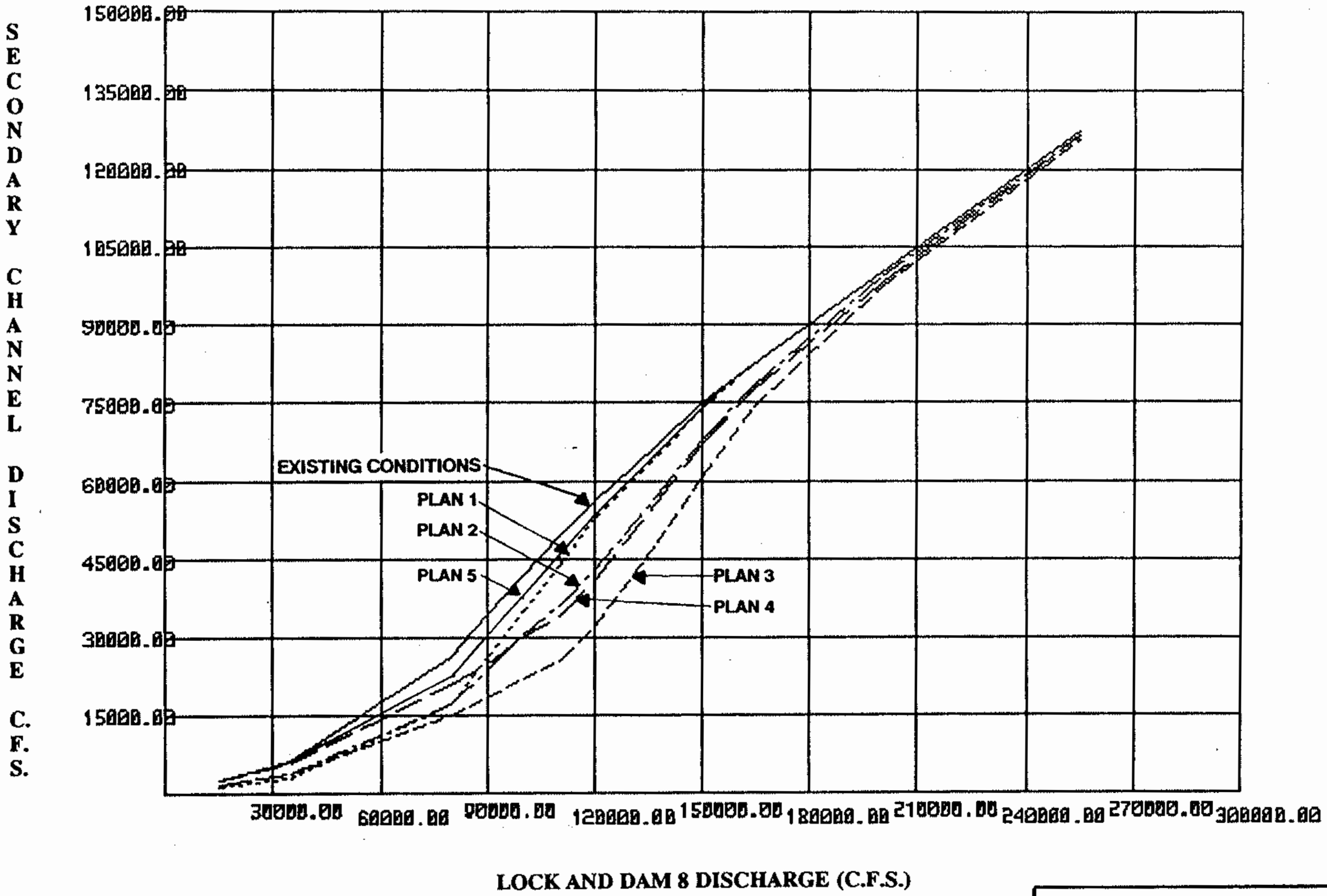




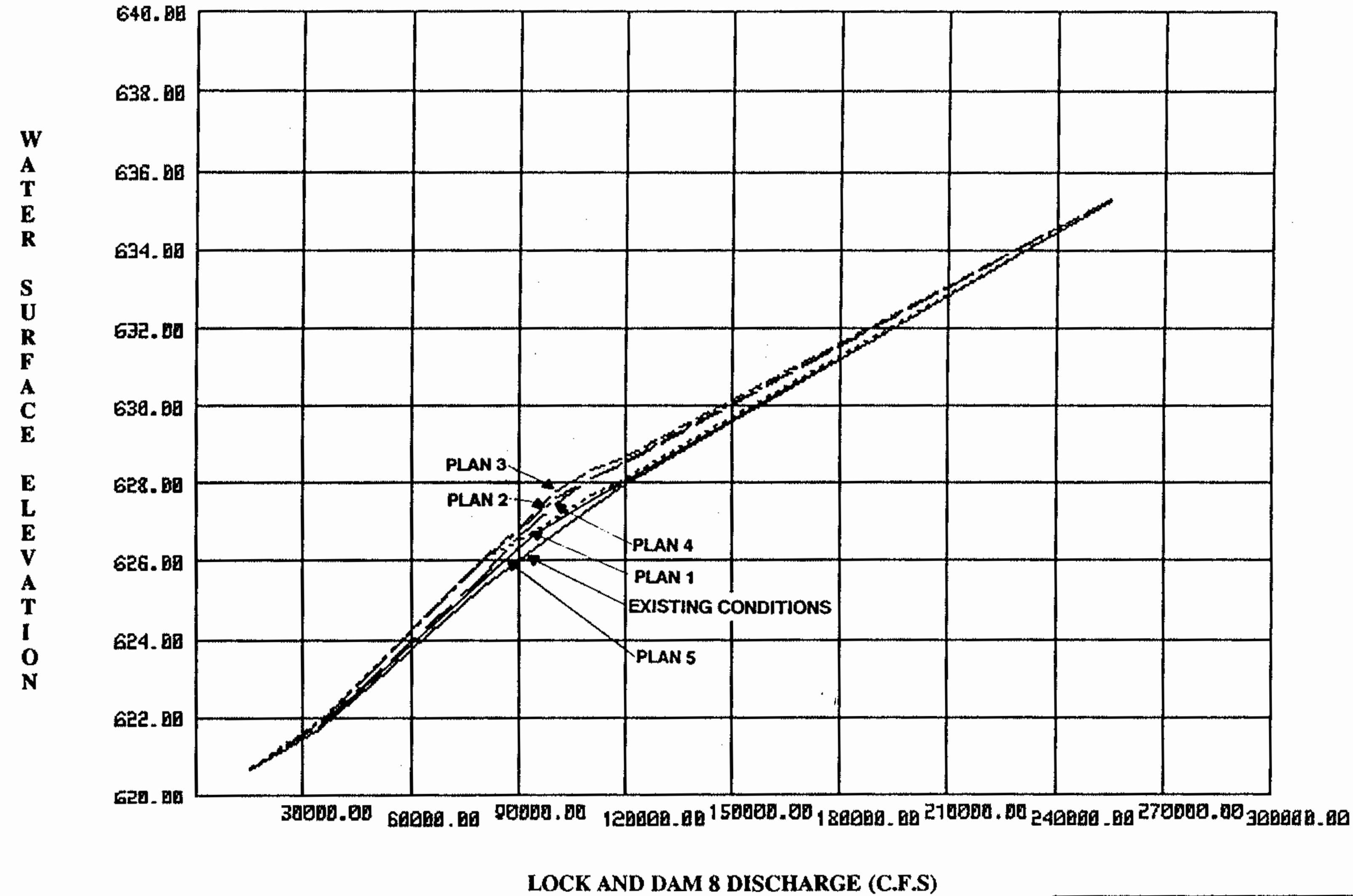
MISSISSIPPI AND UPPER IOWA RIVERS
EXISTING AND PROPOSED RIGHT BANK PROFILES
AND WATER SURFACE PROFILES, PLAN 5

PLAN 5

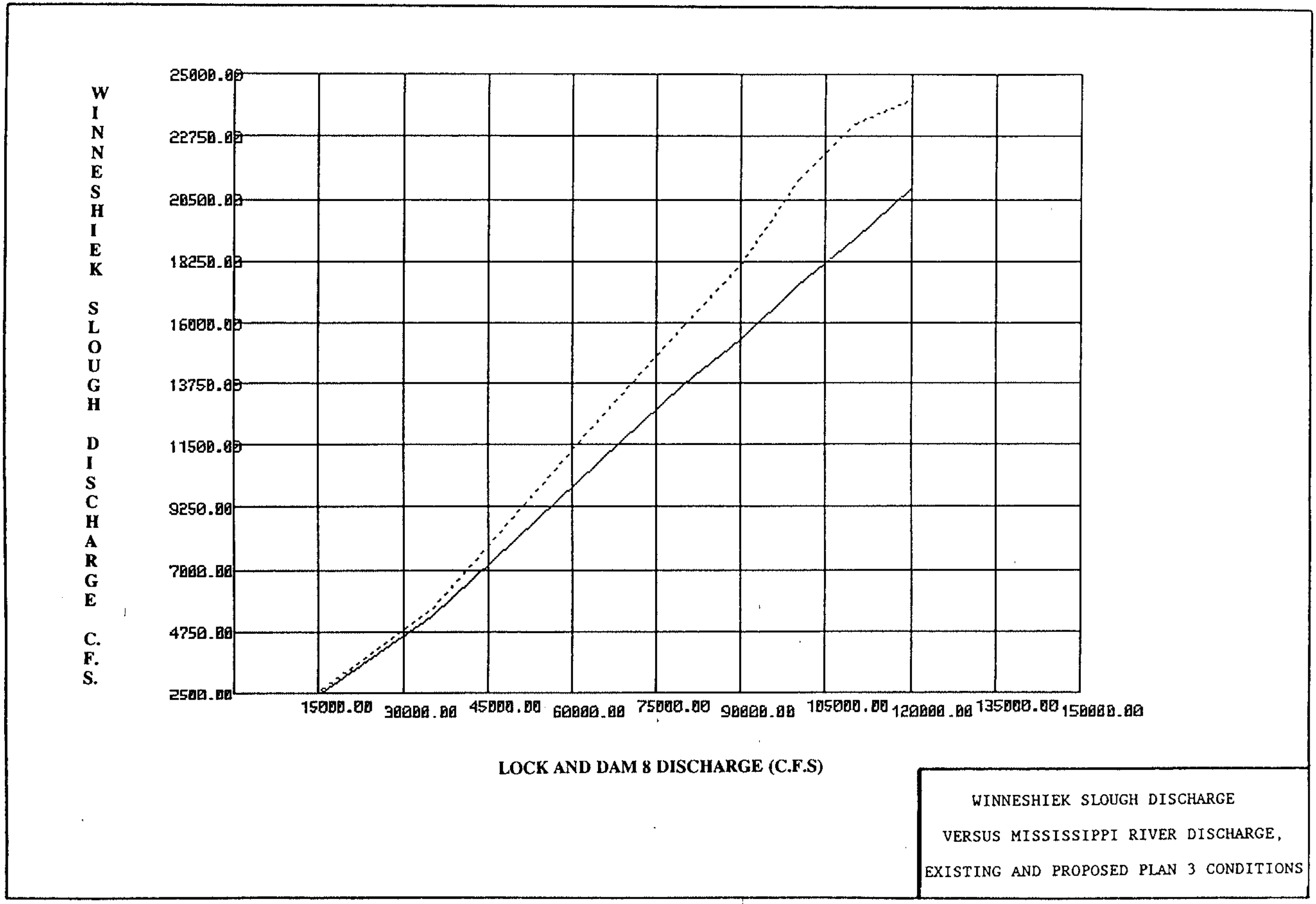
PLAN AND SECTION VIEW



SECONDARY CHANNEL DISCHARGE VERSE LOCK AND DAM 8 DISCHARGE FOR EXISTING CONDITIONS, AND PLANS 1,2,3,4,& 5



WATER SURFACE ELEVATION AT RIVER MILE 670.6 VERSE LOCK & DAM 8 DISCHARGE FOR EXISTING CONDITIONS, AND PLANS 1,2,3,4,& 5


WINNESHIEK SLOUGH DISCHARGE C.F.S.
25000.00
22750.00
20500.00
18250.00
16000.00
13750.00
11500.00
9250.00
7000.00
4750.00
2500.00
15000.00
30000.00
45000.00
60000.00
75000.00
90000.00
105000.00
120000.00
135000.00
150000.00
LOCK AND DAM 8 DISCHARGE (C.F.S)
WINNESHIEK SLOUGH DISCHARGE
VERSUS MISSISSIPPI RIVER DISCHARGE,
EXISTING AND PROPOSED PLAN 3 CONDITIONS

Attachment 2

Finding of No Significant Impact

Environmental Resources Branch
Planning Division

FINDING OF NO SIGNIFICANT IMPACT

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

LANSING/BIG LAKE HABITAT REHABILITATION AND ENHANCEMENT PROJECT POOL 9, UPPER MISSISSIPPI RIVER ALLAMAKEE COUNTY, IOWA

The purpose of the project is to slow the ongoing process of sedimentation which is occurring in the Lansing/Big lake backwater area. This area is an important component of the Upper Mississippi River Wildlife and Fish Refuge. Since the inundation of Pool 9, over half of the open water area originally present in the Lansing/Big Lake backwater complex has been converted to floodplain forest through the process of sedimentation. The source of this sediment material is primarily the waters entering from the main channel through side channel sloughs. The intent of the project is to reduce the quantity of sediment laden water that is entering the backwater. This would be accomplished by closing seven of the smaller sloughs and armoring the three larger sloughs. The proposed action would reduce the total annual flow into the backwater by about 15 percent. Over the 50-year life of the project, this would preserve approximately 150 acres of deepwater habitat. Alternatives to the proposed action that were considered and evaluated are also described in the Plan Formulation Section.

This finding is based on the following determinations:

1) The proposed action would result in the preservation of valuable deepwater habitat in the Upper Mississippi River Wildlife and Fish Refuge.

2) The proposed actions would have only minor impacts on sedimentation rates and patterns in adjacent areas.

3) The placement of large amounts of rock riprap would increase the area's benthic habitat diversity.

4) The proposed action would have only minor impacts on the area's cultural, social, and recreational resources.

A complete explanation of these determinations is presented in the Environmental Effects section of the Environmental Assessment.

Our environmental review indicates that the proposed actions do not constitute a major Federal action significantly affecting the quality of the human environment. Therefore, an environmental impact statement will not be prepared.

____
Date

Roger L. Baldwin
Colonel, Corps of Engineers
District Engineer

Attachment 3

Section 404(b)(1) Evaluation

SECTION 404(b)(1) EVALUATION
LANSING/BIG LAKE HABITAT REHABILITATION
AND ENHANCEMENT PROJECT
POOL 9, UPPER MISSISSIPPI RIVER
ALLAMAKEE COUNTY, IOWA

I. Project Description

A. Location - The proposed project area is located between River Miles (RM) 668 and 671 of the Upper Mississippi River Navigation Channel (Figure 1). The proposed fill sites are 10 sloughs which enter off of the main channel into the Lansing/Big Lake backwater area.

B. General Description - The proposed action is part of the Habitat Rehabilitation Program being implemented on the Upper Mississippi River. The proposal calls for the placement of either sand or rock fill in 10 sloughs entering into the Lansing/Big Lake backwater complex (Figure 2). Seven of the locations would be completely closed by sand plugs and the remaining three would be lined with rock to stabilize the size of the existing opening. These actions would reduce the amount of sediment laden waters which enter the backwater area during high frequency flood events. The fill action would result in an overall decrease of 16 percent in the total flow of water into the backwater area. The greatest reduction would occur at the 2-year event. At this point, the natural levees would be overtopped and the effectiveness of the structures would begin to decrease. Beyond the 7-year event, the proposed structures would have minimal impact on the amount of water entering the backwater. This reduction in flow into the backwater would result in greater flows in the main channel of the river immediately below the proposed structures.

C. Authority and Purpose - The authority for this report is provided in Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662). The Lansing/Big Lake complex is one of the most important backwater areas in this portion of the Upper Mississippi River Fish and Wildlife Refuge. Since inundation, a significant portion of the open water area within the complex has been converted to other habitat types through the process of sedimentation. The source of the sediment material is the waters entering from the main channel. The proposed action would close or stabilize the size of the sloughs entering the upper half of the backwater complex. This would reduce the amount of suspended solids material which is entering and settling out in the area, thus reducing the rate of sedimentation. Over the 50-year life of the project, the proposed action would preserve 200 acres of deepwater habitat.

D. General Description of Fill Material

1. Physical Characteristics - Sand and stone fill material would be used in this action. The sand would be a medium to coarse grained material. The stone material would be a 10- to 30-inch diameter rock.

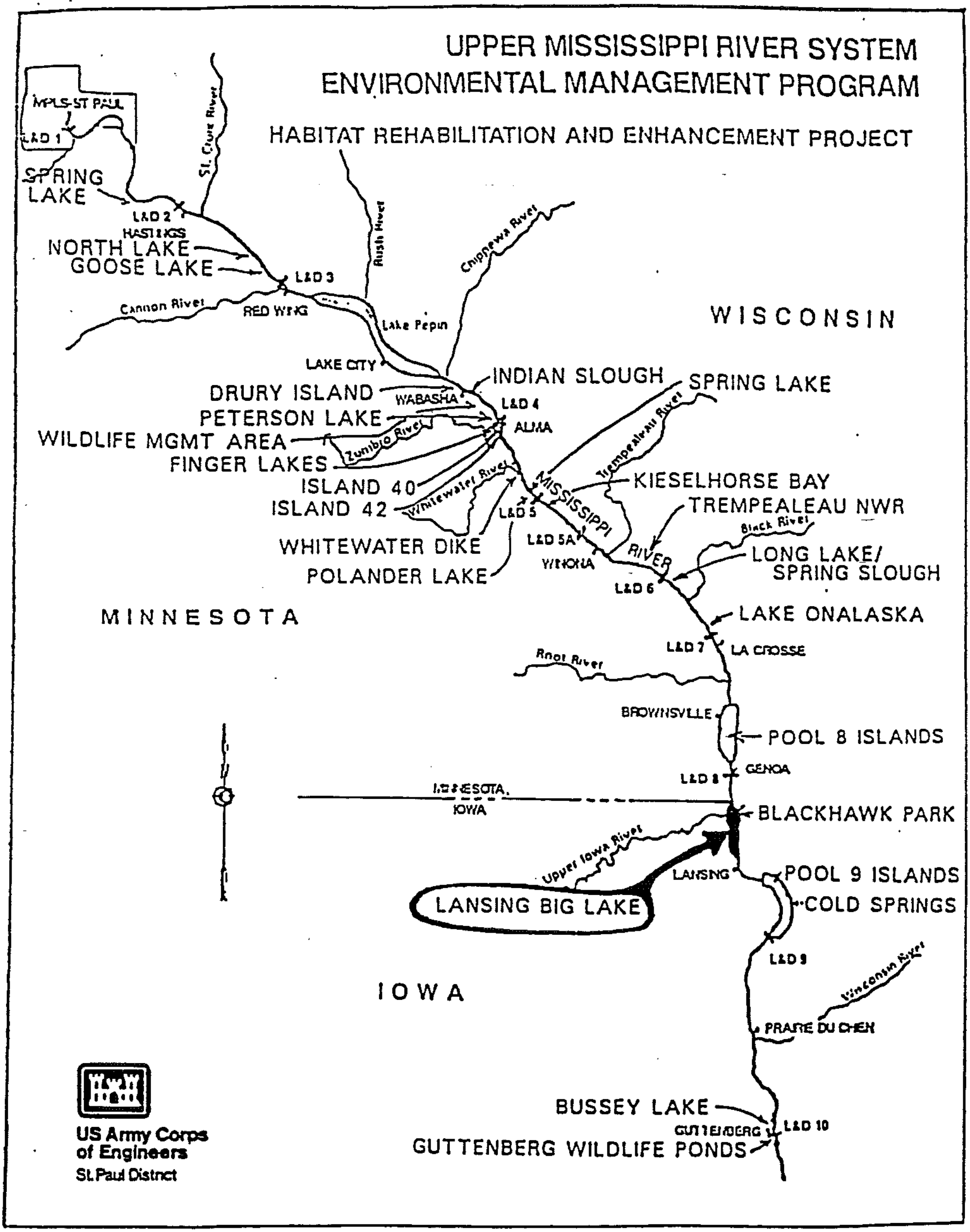
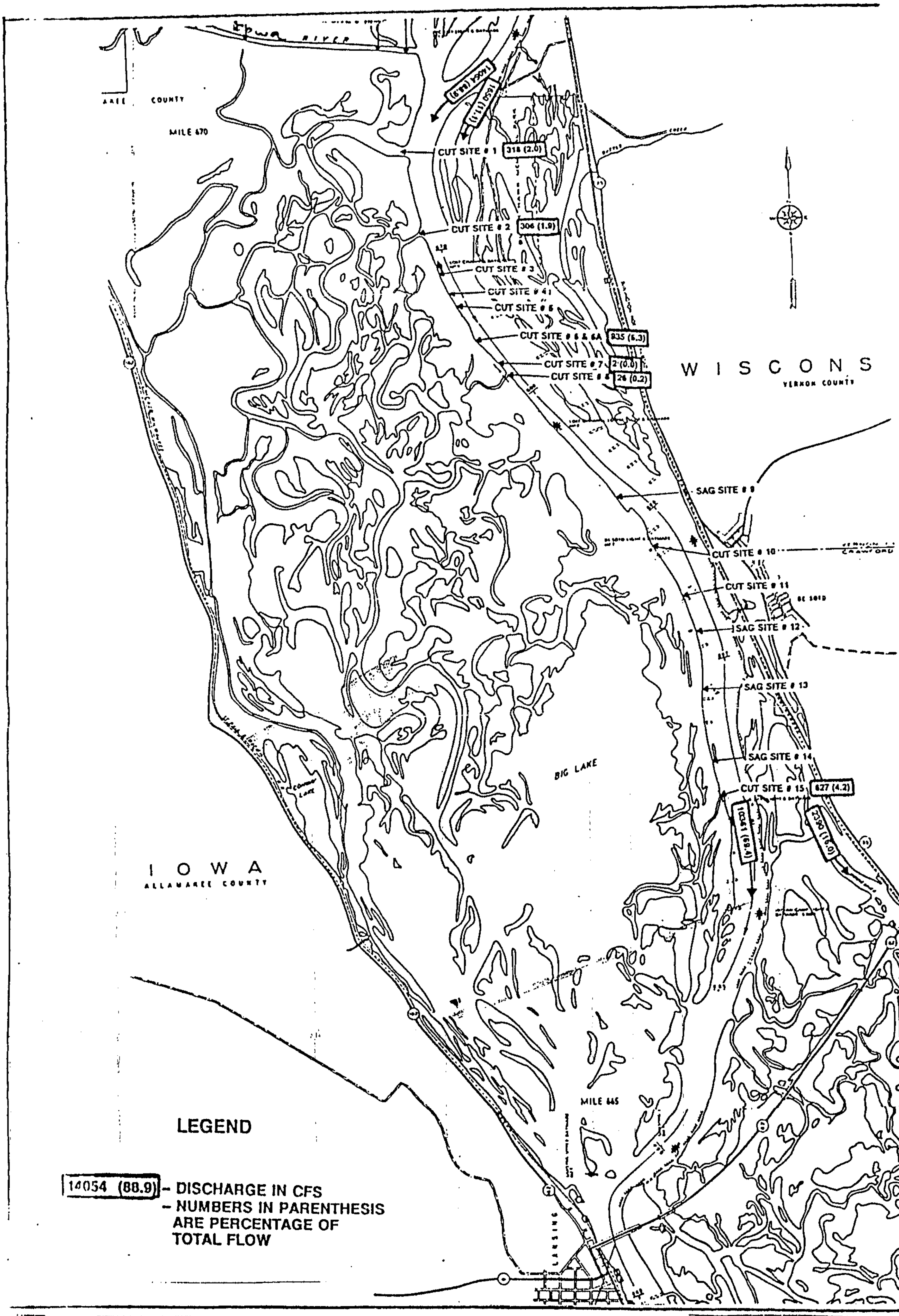

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
MPLS-ST PAUL
L&D 1
SPRING LAKE
L&D 2
HASTINGS
NORTH LAKE
GOOSE LAKE
L&D 3
St. Croix River
Rush River
Chippewa River
Cannon River
RED WING
Lake Pepin
WISCONSIN
LAKE CITY
INDIAN SLOUGH
SPRING LAKE
DRURY ISLAND
WABASHA
L&D 4
PETERSON LAKE
ALMA
WILDLIFE MGMT AREA
Zumbro River
Trempealeau River
FINGER LAKES
ISLAND 40
Whitewater River
KIESELHORSE BAY
ISLAND 42
L&D 5
MISSISSIPPI
TREMPEALEAU NWR
WHITEWATER DIKE
L&D 5A
RIVER
Black River
WINONA
LONG LAKE/
SPRING SLOUGH
POLANDER LAKE
L&D 6
MINNESOTA
LAKE ONALASKA
L&D 7
LA CROSSE
Root River
BROWNSVILLE
POOL 8 ISLANDS
GENOA
L&D 8
MINNESOTA
IOWA
BLACKHAWK PARK
Upper Iowa River
LANSING
POOL 9 ISLANDS
LANSING BIG LAKE
COLD SPRINGS
L&D 9
Wisconsin River
IOWA
PRAIRIE DU CHIEN
BUSSEY LAKE
GUTTENBERG
L&D 10
GUTTENBERG WILDLIFE PONDS
US Army Corps
of Engineers
St. Paul District

Figure 1

Figure 2



CUT SITE # 1 318 (2.0)
CUT SITE # 2 306 (1.9)
CUT SITE # 3
CUT SITE # 4
CUT SITE # 5
CUT SITE # 5 & 6A 935 (6.3)
CUT SITE # 7 2 (0.0)
CUT SITE # 8 26 (0.2)
WISCONSIN
VERNON COUNTY
SAG SITE # 9
CUT SITE # 10
CUT SITE # 11
SAG SITE # 12
SAG SITE # 13
SAG SITE # 14
CUT SITE # 15 627 (4.2)
10341 (69.4)
BIG LAKE
IOWA
ALLAMAKEE COUNTY
MILE 670
MILE 665
LANSING
LEGEND
14054 (88.9) - DISCHARGE IN CFS
- NUMBERS IN PARENTHESIS ARE PERCENTAGE OF TOTAL FLOW

2. <u>Quantity and Source of Material</u> - Approximately 7,100 cubic yards (cy) of rock and 7,115 cy of sand would be used in the fill actions. The rock would be obtained from a nearby quarry. If the material obtained in the preparatory dredging work that would be done at sites 1, 2, and 6 was sufficiently free of fine material, it would be used as fill at the other seven sites. If this dredged material was not satisfactory, other material would be obtained from either a hole dredged immediately down gradient from site 6 or from stockpiles of material dredged in maintenance activities for the main channel. If one of these other sources of fill was used, the material obtained in forming the trenches at sites 1, 2, and 6 would be disposed of in an approved upland location. The fill material from any of the three sources would be clean sand. Any material obtained from the slough areas would be glacial deposit. The sand removed during maintenance operations on the 9-foot channel has been tested during the last year and found to be clean material.

E. <u>Description of Proposed Fill Placement Sites</u> - All 10 fill sites are located at the head of sloughs which pass water from the main channel of the Mississippi River into the Lansing/Big Lake backwater area. Sites 1, 2, and 6 are the major sources of inflow into the area. Each of these 3 sloughs is approximately 14 feet deep. The substrate is basically a sand mixture with small amounts of fines included. The remaining 7 openings are significantly smaller. Most of these smaller openings have continual flow, although 5A and 6A are dry when the river flow is below 15,000 cubic feet per second. The substrate in these smaller openings has a sandy composition but contains a larger percentage of fines than at the 3 larger openings. The fill sites at all 10 locations would be recessed from the main channel to decrease the potential for erosion caused by the current in the main channel (Figures 3 and 4). Material would be placed at the proposed sites as follows:

1. <u>Rock Fill</u> - At sites 1, 2, and 6, a 30-inch-deep trench would be dredged across the entire width of the opening (Figure 5) and extend down each opening as follows: Site 1 - 50 feet; Site 2 - 100 feet; and Site 6 - 200 feet. The trench would be backfilled with 10- to 30-inch rock. The volume and acreage involved at each site are as follows: Site 1 - 1,000 cy and 0.25 acre; Site 2 - 1,850 cy and 0.50 acre; and Site 6 - 4,250 cy and 1.0 acre.

2. <u>Earthen Fill</u> - Earthen material would be placed at sites 3, 4, 5, 5A, 6A, 7, and 8. The material would be placed to a height 2 feet above the adjacent banks. The structures would be 20 feet wide on the top, have a 1:3 riverward slope, and a 1:10 backside slope (Figure 5). The cubic yards of material placed and the acreage that would be covered at each site are as follows: Site 3 - 990 cy and 0.15 acre; Site 4 - 325 cy and 0.15 acre; Site 5 - 830 cy and 0.15 acre, Site 5A - 170 cy and 0.10 acre, Site 6A - 650 cy and 0.25 acre, Site 7 - 1,500 cy and 0.25 acre, and Site 8 - 2,650 cy and 0.50 acre.

F. <u>Timing and Duration of Dredged Material Disposal and Fill Activities</u> - If the project is approved, the construction would take place during the 1991 construction season.

G. <u>Description of Fill and Dredged Material Disposal Methods</u> - The material would be placed by clamshell bucket and front-end loader.

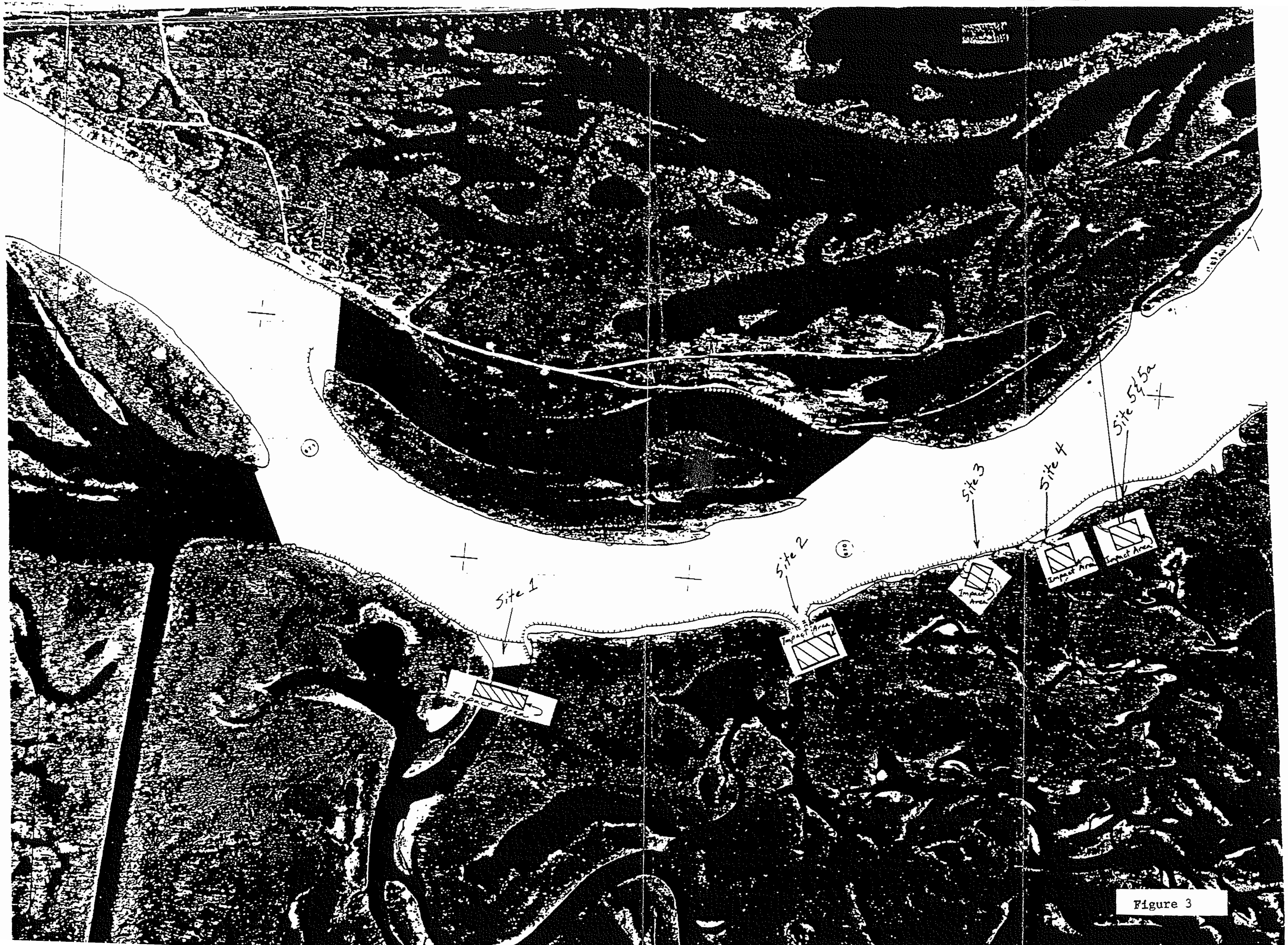

Site 1
Impact Area
Site 2
Impact Area
Site 3
Impact Area
Site 4
Impact Area
Site 5 & 5a
Impact Area

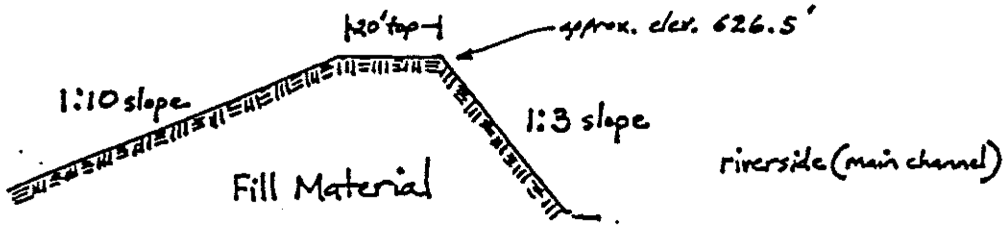
Figure 3


DE SOTO BAY
Site 6
Site 6a
Site 7
Site 8
Potential Limits of Impact
404-6

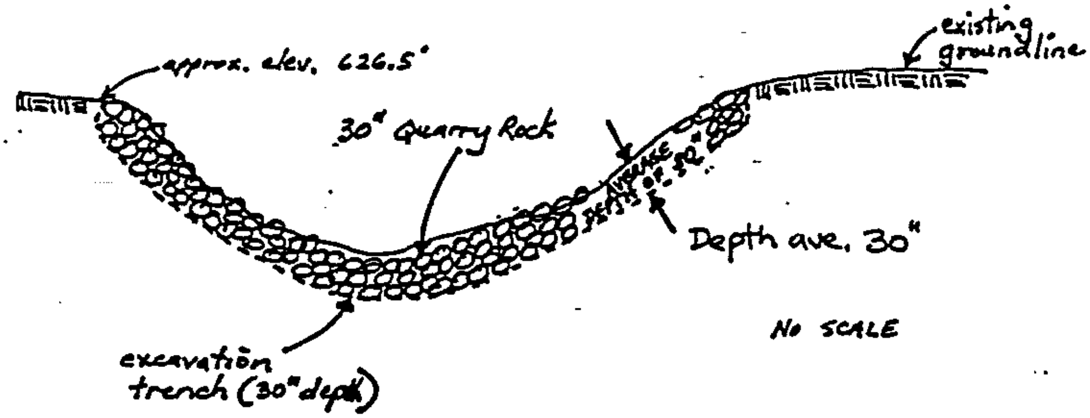
Figure 4

DETAIL CONCEPTS

Granular Fill Plug Sites (sites 3, 4, 5, 5A, 6A, 7, 8) :



Rock lined Side channel Openings (sites 1, 2, 6) :



Cross-section Views

Plan 5 - Selected Plan

Figure 5

II. Factual Determinations

A. Physical Substrate Determinations

1. Substrate Elevation, Slope and Composition - The elevation and slope of the affected area at sites 1, 2, and 6 would not be changed. The trench-like areas would be backfilled to assume their original shape. The composition of the substrate at these three fill sites would change from sand to rock. At the other seven sites, the fill would be similar to the existing substrate. The slope and elevation at these sites, however, would be drastically changed. The proposed action would place fill to a point several feet above the existing bank level over most of the fill area.

2. Fill Movement - The use of rock fill at sites 1, 2, and 6 would insure that there would be little movement of this material. At the seven remaining sites, the sand/earthen material would be placed a short distance down the slough to protect it from the erosive forces of the current in the main channel. These locations and the gradually sloped sides of the structures would greatly reduce the potential of movement of this material.

B. Water Circulation and Fluctuations

1. General Water Chemistry - The rock fill would have minimal impact on the area's water chemistry. At the other seven sites, the clean fill material, the protected fill sites, and the mechanical placement techniques that would be used would insure that these actions would also have minimal impacts on the area's water column characteristics.

2. Current Patterns and Circulation - The rock fill placed at sites 1, 2, and 3 would not change the existing current and circulation patterns. The fill placed at the other seven sloughs would completely stop the flow through those openings. The sediment laden waters that would be prevented from entering the Lansing/Big Lake backwater would remain in the main channel. This increase in flow in the main channel could result in up to a 5 percent increase in flow into Winneshiek Slough, another important backwater area immediately downstream on the Wisconsin side of the river.

3. Sedimentation Patterns - The proposed action would decrease the sedimentation in the Lansing/Big Lake area by approximately 15 percent. Over the 50-year life of the project, this would result in a substantial decrease in the conversion of deep wetland/aquatic habitats into shallower habitat types. It is anticipated that approximately 150 acres of deep wetland/aquatic habitat would be preserved over the life of the project. The re-establishment of 1980 hydraulic conditions in this portion of pool 9 would theoretically result in a minor increase in the sedimentation rate in areas downstream. However it is doubtful if this could be measured at any given location.

C. Suspended Particulate/Turbidity Determinations

1. Suspended Particulates and Turbidity - The placement of the sand material would temporarily increase the turbidity and suspended particulates in the immediate project area. Any increase that would occur would be small and quickly dissipate, however, because of the coarse fill material, the mechanical placement techniques used, and the relatively

isolated fill location. The placement of the rock fill would have minimal impacts on these parameters.

2. Effects on Physical and Chemical Properties of the Water Column - Because of the use of clean, coarse fill material and mechanical placement techniques, only temporary, minimal impacts would be expected on physical and chemical properties of the water column.

3. Actions Taken To Minimize Impacts - Where possible, the fill sites have been located to minimize the potential for erosion of the material into the main channel. In addition, mechanical placement techniques would be used and the bank areas would be reseeded to minimize the potential for erosion from runoff and high water events.

D. Contaminant Distribution Determinations - Because of the clean, coarse fill material, mechanical placement techniques to be used, and the isolated nature of most of the fill locations, the proposed actions would not introduce, relocate, or increase contaminants in the river environment.

E. Aquatic Ecosystem and Organism Determinations - The proposed action would significantly modify all of the fill areas. The substrate at sites 1, 2, and 6 would be converted from sand to rock. The remaining 7 sites would be filled to above the ordinary high water mark. All of these actions would cause the permanent displacement of the benthic organisms currently found in the project area. Sites 1, 2 and 6 would retain their aquatic nature and the proposed changes would in fact increase the diversity, and productivity of the general area. The actions at the remaining sites would represent nearly a total loss of the aquatic habitat and organisms present. These seven areas would probably develop into floodplain forest habitat.

F. Proposed Disposal Site Determinations

1. Mixing Zone - The proposed fill activities would result in a minimal amount of resuspension because of the coarse grained material and mechanical placement techniques. Because of the limited mixing zone anticipated, no further analysis of the parameter was made.

2. Compliance with Applicable Water Quality Standards - The State of Iowa has classified this portion of the Mississippi River as a Class A/B(W) body of water. This requires that the area be protected for (1) primary contact recreation (Class A) and (2) wildlife, fish, aquatic and semiaquatic life, and secondary contact water uses (Class B(W)). The clean fill material, mechanical dredging techniques, and protected fill sites insure that these general standards and the specific criteria for these classifications would be met.

3. Potential Effects on Human Use Characteristics - The proposed action would close some of the existing openings which could be used by recreationists to enter the backwater area. The major access points at sites 1, 2, and 6 would remain open, however, and provide adequate entry opportunities to anyone wishing access to the backwater area.

G. Cumulative Effects on the Aquatic Ecosystem - Implementation of the proposed action would cause no significant cumulative impacts on the aquatic system.

H. Secondary Effects on the Aquatic Ecosystem - The proposed fill action would reduce sedimentation rates in the Lansing/Big Lake backwater by about 15 percent. The mechanism to achieve this goal, however, is anticipated to increase the rate of sedimentation in Winneshiek Slough, another backwater immediately downstream, by approxinately 5 percent. It is possible that the increased sedimentation in Winneshiek Slough could result in the loss of some deep wetland/aquatic habitat. However, these losses are anticipated to be relatively insignificant. The proposed action would have a net positive impact on the aquatic environment of the Upper Mississippi River Wildlife and Fish refuge.

III. Findings of Compliance or Noncompliance with Restrictions on Discharge

The proposed fill activities would comply with the Section 404(b)(1) guidelines of the Clean Water Act. The proposed plan was chosen because it offered a solution that was engineeringly and economically feasible and had the most positive environmental impacts. The proposed fill activities would also comply with Section 307 of the Clean Water Act and the Endangered Species Act, as amended.

The proposed fill activities would have no adverse impacts on human health and welfare. The use of clean fill material, mechanical placement techniques, and protected fill locations would ensure that there are only minimal negative impacts. The proposed action would result in an extended life for up to 150 acres of valuable open water habitat. On the basis of this evaluation, the proposed disposal actions are specified as complying with the requirements of the guidelines for the discharge of fill material.

12 Apr 91
Date

Roger L. Baldwin
Roger L. Baldwin
Colonel, Corps of Engineers
District Engineer

Attachment 4

Coordination

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Upper Mississippi River National Wildlife and Fish Refuge
51 East 4th Street
Winona, Minnesota 55987

IN REPLY REFER TO:

Mr. Ed McNally
St Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
180 E. Kellog Blvd
St Paul, MN 55101

Dear Mr. McNally:

This provides U.S. Fish and Wildlife Service comments on the draft Definite Project Report and Environmental Documentation (SP-9) for the Lansing Big Lake Habitat Rehabilitation and Enhancement Project. This project will benefit the biological resources of the Upper Mississippi River National Wildlife and Fish Refuge. The Service supports the selected plan, however, every effort should be made during plans and specifications to reduce cost. The cost per unit of increase in habitat value appears to be quite high.

This 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. A refuge compatibility statement has been forwarded to our Regional Director for his signature. This will be forwarded to you after his approval.

The Definite Project Report, which the Regional Director will comment on, must include a copy of the draft Memorandum of Agreement for operation, maintenance, and rehabilitation. In accordance with the Fourth Annual Addendum the Service will accept all operations and maintenance costs. The Regional Director's letter on the final draft definite project report will include the certification of support for operation and maintenance.

We request that the final report and all future HREP reports include a map which illustrates land ownership conditions within the project area.

These comments have been prepared under the authority of and in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; U.S.C. 661 et. seq) and are consistent with the intent of the National Environmental Policy Act of 1969.

The 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
Complex Manager

Enclosure

cc: SPFO
LTRM
Winona FAO
Iowa DNR
McGregor District

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES
State Office Building, Room 104
3550 Mormon Coulee Road
La Crosse, Wisconsin 54601
(608) 785-9004

Carroll D. Besadny
Secretary

June 21, 1990

8250

Mr. Louis E. Kowalski
Chief, Planning Division
Department of the Army
St. Paul District, C.O.E.
1421 USPO & Custom House
St. Paul, MN 55101-1479

Dear Mr. Kowalski:

I am writing to comment on the preliminary draft DPR for the Lansing Big Lake Habitat Rehabilitation and Enhancement Project (HREP). The Project Coordinator, Ed McNally, has been very helpful in explaining and responding to planning inquiries and recommendations to date.

As a result of this project, there is potential for increased sedimentation and habitat loss in the Winneshiek backwater area, the Department of Natural Resources is willing to offer support for the Plan 5 DPR proposal. Upper Iowa River sediment contribution problems are not unlike problems we are all facing with the Whitewater, Grant and Platte Rivers where watershed controls are the correct solution but we still must reduce their impacts as much as possible in the interim.

The basis for Wisconsin support is, according to Ed McNally, that projected benefits, even if reduced by losses in Winneshiek, are similar in cost value to other HREPs completed and/or being worked on now and there is a predicted net gain in habitat improvement that is an important EMP objective. We are aware of differing opinions of project benefits and negative offsite impacts. Our support could be eroded if additional analysis suggests lower project benefits and increased offsite impacts.

I would like to recommend that a discussion be included presenting analysis and justification for not closing or controlling Winneshiek side channel openings to reduce impacts outside of the project area. This is being done in the Hershey Island area opposite the Wisconsin sponsored Indian Slough Big Lake project.

It is important that more work be done on the project monitoring component of the plan to include documentation of sedimentation and habitat loss in the Winneshiek area. This is important because so many HREPs are not "stand alone" but have secondary impacts that must be better predicted in future projects.

Future HREPs involving nearby sediment sources should include an upstream sediment trap alternative that could delay Mississippi River impacts long enough to implement watershed management practices. This is recognizably a costly alternative for significant river discharges but could last quite a long time.

Before this DPR is advanced to the next stage, public meeting input should be strongly factored in. I believe important public interest items will be negative impacts in Winneshiek, net habitat improvement and project costs and benefits. These must be explained in a straight forward manner.

Thank you for the opportunity to comment. We look forward to the public meeting and continued DPR development.

Sincerely,

Terry A. Moe
Western Boundary Rivers Coordinator

tm

c: Tom Anderson, Iowa DNR
Keith Beseke, FWS Winona

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

Upper Mississippi River National Wildlife and Fish Refuge
51 East 4th Street
Winona, Minnesota 55987

July 2, 1990

Mr. Ed McNally
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
180 E. Kellog Blvd.
St Paul, Minnesota 55101

Dear Mr. McNally:

Enclosed is a signed compatibility determination for the selected alternative discussed in the draft Definite Project Report with Integrated Environmental Assessment (SP-9) for the Lansing Big Habitat Rehabilitation and Enhancement Project.

If you have any question please contact Keith Beseke, Environmental Management Program Coordinator at 507-452-4232.

Sincerely,

Richard F. Berry

Richard F. Berry
Complex Manager

Enclosure

cc: McGregor District
Chuck Gibbons, RO-SS

Upper Mississippi River National
Wildlife and Fish Refuge
Established 1924

Compatibility Study
Lansing Big Lake Rehabilitation

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 proposed project will be constructed in channels leading into the Lansing Big Lake complex. The features of the project include the following:

- rock lining of three side channel openings at their current size and capacity

- the plugging of seven additional small channel openings

- the construction of one performed scour hole below the largest side channel opening

This project would decrease the overall sediment deposition in this very valuable aquatic backwater lake complex for the 50-year project life. This will delay the conversion of this aquatic habitat to floodplain forest. The delay in the conversion of the aquatic habitat into floodplain forest would have a beneficial impact on diversity and interspersion in the project area. The dominant habitat type in the project area is presently floodplain forest, and there is a general tendency of the system towards the establishment of greater amounts of floodplain forest at the expense of the aquatic areas. These aquatic areas add substantially to the diversity of the project area, and their elimination would negatively affect this habitat characteristic. The reduction in the loss of aquatic habitat that would result from implementation of this project would be of benefit to the Lansing Big Lake area of the refuge.

Complete 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-9) Lansing Big Lake Habitat Rehabilitation and Enhancement, Pool 9, Upper Mississippi River, Allamakee County, Iowa" prepared by the St. Paul District, Corps of Engineers.

Anticipated Impacts on Refuge Purposes:

As a result of the project fish and wildlife 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 6/12/90
Project Leader Date

Richard F. Berry 6/18/90
Complex Manager

Reviewed by: Act [signature] 6/21/90
WAM I Date

Concurred by: [signature] 6/22/90
Acting Regional Director Date

July 23, 1990

Mr. Bob Whiting, Chief
Environmental Resources Branch
U.S. Army Corps of Engineers
1135 Post Office and Custom House
St. Paul, Minnesota 55101-1479

Dear Mr. Whiting:

This is in response to your July 16, 1990 letter concerning potential impacts on federally endangered or threatened species from the proposed Lansing/Big Lake Project located in Pool 9 of the Upper Mississippi River. The project is proposed for implementation under the Environmental Management Program.

Based on information contained in your above referenced letter and the nature of the proposed project, its location and the habitat requirements of the federally threatened (endangered in Iowa) bald eagle (Haliaeetus leucocephalus), endangered peregrine falcon (Falco peregrinus) and endangered Higgins' eye pearly mussel (Lampsilis higginsi), 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 indicates listed species may be affected, consultation with this office should be reinitiated. With respect to the bald eagle, we understand that such consultation will be reinitiated if the eagle nest in the vicinity of the project is active at the time of construction.

These comments have been prepared under the authority of and in accordance with provisions of the Endangered Species Act of 1973, as amended.

Sincerely,

James L. Smith
Assistant Field Supervisor

CC: WI Department of Natural Resources, Madison
WI Department of Natural Resources, LaCrosse
IA Department of Natural Resources, Des Moines
IA Department of Natural Resources, Guttenberg

August 6, 1990

Floodplain Management
and Small Projects
Planning Division

Mr. Terry Moe
WDNR - La Crosse Office
3550 Mormon Coulee Rd.
La Crosse, Wisconsin 54601

Dear Mr. Moe:

Enclosed is the DRAFT Definite Project Report/Environmental Assessment for the Lansing Big Lake Environmental Management Program (EMP) project. Please review this report and provide us with any formal comments by August 30, 1990.

Thank you for your cooperation. If you have any questions regarding this request, please call Ed McNally at (612) 220-0387.

Sincerely,

Louis Kowalski
Chief, Planning Division

Enclosures:
Definite Project Report
Distribution List

Identical Letters sent to distribution list

August 10, 1990

Dear Librarian:

The St. Paul District, Corps of Engineers has recently distributed a public notice regarding a draft report which we are seeking public comments upon. A copy of that document is attached.

A public meeting has been scheduled for September 10, 1990, at 7:00 p.m. in the Kee High School at Lansing, Iowa.

Citizens interested in this project may wish to become familiar with the proposed project prior to attending the public meeting and copies of the report are limited. Your help in providing them with an opportunity to review the report is important. Therefore, I request that you make this report available to interested citizen by placing it in your reference section.

Thank you very much for your assistance in making this document available to the public. If you have questions regarding this request, please contact Mr. Ed McNally of my staff at 612-220-0387.

Sincerely,

Charles E. Crist
Louis E. Kowalski
Chief, Planning Division

Enclosure
Lansing Big Lake Report

See Distribution List

Plan Formulation Branch
Planning Division

August 20, 1990

Mr. Ralph Terkle
IDNR - Water Quality Planning
Wallace Office Building
Des Moines, IA 50319

Dear Mr. Terkle:

In accordance with Section 401 of the Clean Water Act, we request State clean water certification for fill activities proposed for an area below the ordinary high water elevation at Lansing Big Lake in Pool 9 of the Upper Mississippi River.

The proposed action entails the placement of earthen and rock fill materials into ten side channel sites leading into the Lansing Big Lake backwater area. This construction is part of the Environmental Management Program (EMP) for the Upper Mississippi River. A complete description of the subject action and resulting impacts on the aquatic environment is contained in the enclosed report which includes the Environmental Assessment and Section 404(b)(1) evaluation.

Thank you for your assistance. If you have any questions concerning the project, please contact Ed McNally at 612-220-0387.

Sincerely,

Louis Kowalski
Chief, Planning Division

Enclosure

STATE OF IOWA

TERRY E. BRANSTAD, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
LARRY J. WILSON, DIRECTOR

August 24, 1990

ATTENTION: PLANNING DIVISION,
FLOODPLAIN MGMT. AND SMALL PROJECTS

Mr. Louis Kowalski, Chief of Planning
St. Paul District Corps of Engineers
1421 U.S. Post Office & Custom House
St. Paul, Minnesota 55101-1479

Dear Mr. Kowalski,

The Iowa Department of Natural Resources staff has reviewed the preliminary draft of the Definite Project Report for the Lansing Big Lake Habitat Rehabilitation & Enhancement Project. We are in agreement with the planning and engineering recommendations that have been developed for the project, although we are somewhat disappointed that an acceptable alternative was not available that would provide a greater degree of protection to this important natural resource area.

We understand the constraints that preclude development of a more effective sedimentation barrier at that point and concur that the selected plan (No. 5) constitutes a reasonable and effective remedial measure for prolonging the life of this very productive backwater habitat.

The Lansing Big Lake Complex provides exceptional fish and wildlife habitat for a wide variety of fish and wildlife species that utilize the area. It is definitely in the public interest to extend the life of this aquatic area to the degree possible. Plan 5 is considered to be the most acceptable method of meeting this objective.

The Iowa Department of Natural Resources staff has cooperated with the Corps of Engineers and Fish & Wildlife Service representatives toward development of this plan of action and we look forward to continued cooperation during the implementation phase of this project.

Sincerely,

Larry J. Wilson
Director, Iowa Department of Natural Resources

WALLACE STATE OFFICE BUILDING / DES MOINES, IOWA 50319 / 515-281-5145

State Historical Society of Iowa

The Historical Division of the Department of Cultural Affairs

August 29, 1990

In reply refer to:
RC# 890503005

Colonel Roger L. Baldwin
District Engineer
St. Paul Corps of Engineers
1135 U. S. Post Office & Custom House
St. Paul, MN 55101-1479

RE: COE - ALLAMAKEE COUNTY - LANSING BIG LAKE - HABITAT REHABILITATION AND ENHANCEMENT PROJECT - POOL 9, UPPER MISSISSIPPI RIVER - MODIFYING TEN EXISTING SIDE CHANNEL OPENINGS

Dear Mr. Baldwin:

Based on the information you provided, we find that there are no historic properties which might be affected by the proposed undertaking. Therefore, we recommend project approval.

However, if the proposed project work uncovers an item or items which might be of archeological, historical or architectural interest, or if important new archeological, historical or architectural data come to light in the project area, you should make reasonable efforts to avoid or minimize harm to the property until the significance of the discovery can be determined.

Should you have any questions or if the office can be of further assistance to you, please contact the Review & Compliance program at 515-281-8743.

Sincerely,

Laurine Rogers

for James E. Jacobsen
Deputy State Historic Preservation Officer
Bureau of Historic Preservation

/mtm

Allamakee County
Tourism & Economic Development Commission

101 Allamakee St. Waukon, IA 52172 319-568-2624

September 17, 1990

Mr. Ed McNally
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
180 E Kellog Blvd
St. Paul, MN 55101

RE: Comments on Lansing Big Lake Project & Related Concerns

Dear Mr. McNally:

Our Commission is concerned about the future of the Mississippi River environment and its benefits to county residents. We are pleased to see cooperation by federal or state agencies on the river.

We are impressed by the quality of analysis of the Big Lake sedimentation problem. We are hopeful that our Commission's network of local officials and citizen leaders can be kept informed on continuing Mississippi River planning issues and projects to help educate the public on river issues.

The Commission supports the plan's objective of keeping inlets 1, 2, and 6 open to recreational boat access. We also support the signing of the Big Slough Canoe route as the Fish & Wildlife Service is planning to do. I've enclosed a copy of a recent canoe guide we produced for this route. I've been in contact with Hank Schneider of the Winona Fish & Wildlife Service office. We will be producing another guide for the Lansing to Waukon Junction stretch.

We were hoping that this project would provide greater than an 8% reduction in sedimentation over the 50 year project life, but we understand the adverse spin-off effects elsewhere. We are concerned about avoiding and reducing sedement build-up in the Winneshiek Bottoms.

The Commission is interested in the historic and cultural heritage of the river valley. In this regard, we would appreciate it if the Corps and/or Fish & Wildlife Service could inform us of any such documents, maps, photos or other such items concerning Pool 9 which we could use in helping to promote public interest in and support for river issues.

Also, we would like to request that our Commission be entered on your "Distribution List" for future materials or notices regarding your work on the river along our county border.

You may be aware that Allamakee County leaders have for many years been interested in a small sandbar area across from Lansing due to the loss of sandbar space and to minimize the increasing boat traffic around the sharp Lansing channel bend. This need still exists and we would like to request your involvement in further pursuing this question. It would be a small extension of your beneficial use spoil area already established there. We understood that certain restrictions and policing efforts would be our responsibility. Can we hear from you on this in the near future?

In conclusion, we are happy to see your involvement in our area for the betterment of part of our environmental quality and we support this present Big Lake project.

Sincerely yours for the Commission,

Executive Committee:

Joseph L Cunningham

Joe Cunningham, Chairman

Ed Kozelka by WB

Ed Kozelka, Vice-Chairman

Bill Schneeberger

Bill Schneeberger, Treasurer

JC:sc

cc: Tom Anderson, IDNR
Dean Dalziel, IDNR

Enclosure: Canoe Trail Brochure

Environmental Resources Branch
Planning Division

Mr. Valdas V. Adamkus
Administrator
U.S. Environmental Protection Agency
Region V
230 South Dearborn Street
Chicago, Illinois 60604

Dear Mr. Adamkus:

We have enclosed a copy of the Definitive Project Report/Environmental Documentation for the Habitat Rehabilitation Project for the Lansing/Big Lake backwater area in Pool 9 of the Upper Mississippi River. This report contains the following documentation and evaluation for the proposed action: Environmental Assessment (pp 28 - 32), Finding of No Significant Impact (FONSI) (Attachment 2), and the 404(b)(1) evaluation (Attachment 3).

We ask that you review these documents and return your comments to us within 30 days. If we have not received your comments by that time, we will assume that you concur with our findings and sign the FONSI.

If you have any questions about the project, please call Mr. Richard Beatty at (612) 220-0273.

Sincerely,

Roger L. Baldwin
Colonel, Corps of Engineers
District Engineer

Enclosures

Send identical letter to:
Mr. James C. Gritman
Regional Director
U.S. Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

McNally

September 27, 1990

Floodplain Management
and Small Projects
Planning Division

Mr. Charles Gibbons
U.S. Fish and Wildlife Service
Federal Building - Fort Snelling
Twin Cities, Minnesota 55111

Dear Mr. Gibbons:

Enclosed for your review is the draft Definite Project Report/ Environmental Assessment (DPR) including the finding of no significant impact (FONSI), environmental assessment, and Section 404(b)(1) Clean Water Act Evaluation for the proposed activities associated with a habitat rehabilitation and enhancement project at Lansing Big Lake in pool 9 of the Upper Mississippi River in Allamakee County, Iowa.

We request that you provide a statement assuring that the Fish and Wildlife Service will assume operation and maintenance responsibilities for the project in accordance with Section 906(e) of the Water Resources Development Act of 1986. General operation and maintenance responsibilities are outlined in the draft DPR, and a draft operation and maintenance agreement is contained in attachment 6 of the report. (Specific operation and maintenance features of the project will be fully developed during the plans and specifications phase of project design.)

We appreciate the assistance your staff has provided in the development of this project. If you have any questions about the proposed work or our requests, please contact Ed McNally, project manager (220-0387).

Sincerely,

Enclosure

Louis Kowalski
Chief, Planning Division

United States Department of the Interior

FISH AND WILDLIFE SERVICE
FEDERAL BUILDING, FORT SNELLING
TWIN CITIES, MINNESOTA 55111

IN REPLY REFER TO:

FWS/ARW-SS

OCT 11 1990

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:

The U.S. Fish and Wildlife Service (Service) has reviewed the Definite Project Report/Environmental Assessment (SP-9) dated July 1990 for the Lansing Big Lake Habitat Rehabilitation and Enhancement Project. This project, located in Pool 9 of the Mississippi River, is proposed under the Water Resources Development Act of 1986 (Public Law 99-662) as part of the Upper Mississippi River System Environmental Management Program.

The Lansing Big Lake project has been coordinated with the Service and we approve and support the project as planned and described in the Definite Project Report. The Service agrees with the preferred alternative described in the Environmental Assessment. On June 18, 1990, the Refuge Manager, Upper Mississippi River National Wildlife and Fish Refuge, found the project compatible with the purposes for which the refuge was established, as required by the National Wildlife Refuge Administration Act.

The Service will ensure that operation and maintenance requirements of the project will be accomplished in accordance with Section 906(e) of the Water Resources Development Act of 1986. The Service will perform the operation and maintenance requirements for this project, including inspection, riprap replacement, and erosion repairs, in accordance with the policies stated in the Fourth Annual Addendum.

This project being located on refuge lands, the Service will complete its 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 our continued cooperative efforts in developing habitat rehabilitation and enhancement projects under the Environmental Management Program.

Sincerely,

James C. Gritman
Regional Director

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES
State Office Building, Room 104
3550 Mormon Coulee Road
La Crosse, Wisconsin 54601
(608) 785-9004

Carroll D. Besadny
Secretary

October 12, 1990

File Ref: 3500

Mr. Harold Taggetz
St. Paul District CORPS of Engineers
1421 US Post Office & Customs House
St Paul, MN 55101-1479

Dear Harold:

The Wisconsin Department of Natural Resources endorsed the the Lansing Big Lake HREP subject to written endorsement at the Channel Maintenance Forum meeting August 28 and 29 (number 28). Wisconsin flooding interests were addressed by the WDNR Floodplain Specialist, Gary Lepak and he found no reason for concern. Following Mr. Lepak's review the WDNR grants full endorsement of the Lansing Big Lake Habitat Project to form a concensus on the project.

I have attached a copy of the floodplain review for your records.

Sincerely,

Terry Q. Moe

Terry Moe
Western Boundary Rivers Coordinator

cc Bob Welford - USFWS - St Paul
Steve Johnson - MDNR
Tom Anderson - IDNR
Dan Krumholz - COE Fountain City
→ Ed McNally - COE St. Paul

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
726 MINNESOTA AVENUE
KANSAS CITY, KANSAS 66101

October 31, 1990

Mr. Louis Kowalski
Chief, Planning Division
U.S. Army Engineer District, St. Paul
1421 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Mr. Kowalski:

RE: Lansing/Big Lake Habitat Rehabilitation and Enhancement Project, Pool 9, Mississippi River

In accordance with our responsibilities under the National Environmental Policy Act and Section 309 of the Clean Air Act, we have reviewed the draft Environmenal Assessment (EA), Finding of No Significant Impact (FNSI) and Section 404(b)(1) Evaluation for the project addressed above. The following comments are based on this review and an October 29, 1990, telephone conversation between Mr. Mike Bronoski and Mr. Dick Beatty of our respective staffs.

Our principal concern is for the impacts to Winneshiek Slough that may result from the restriction of flows into the Lansing/Big Lake complex. We believe that these potential impacts are not adequately documented. At the same time, we recognize the difficulty in attempting to forecast such impacts. Therefore, in accordance with the agreement reached in the telephone conversation referenced above, we concur with your intent to issue a FNSI for this project provided:

1. That the monitoring of sedimentation/deposition rates planned for the Lansing/Big Lake area be expanded to include some cross sections in Winneshiek Slough, and

2. The final EA or other public documentation address the possibility of mitigation at a later date for project induced impacts assuming that these impacts can be separated from naturally occuring, noninduced sedimentation/deposition.

Other comments of a lesser nature are enclosed separately.

Thank you for the opportunity to comment. Any questions on these comments should be directed to Mr. Mike Bronoski of my staff at 913/551-7291.

Sincerely,

Lawrence M. Cavin

Lawrence M. Cavin
Chief, Environmental Review
and Coordination Section

Enclosure

cc: Terry A. Moe, Western Boundary Rivers Coordinator, Wisconsin Department of Natural Resources, La Crosse, Wisconsin

Specific Comments

The 404(b)(1) Evaluation, page 404-4, subparagraph 2: In describing the quality of fill material, the term "sufficiently free of fine material" is not defined. The document should address how this term is defined.

It would appear that the material obtained from the slough areas would be alluvial deposit, not glacial deposit. It would be useful to include a description of the make-up of the material in quantitative terms such as percent fines and sands, for comparison with what is determined clean sand.

Page 404-8, Section II.A.1: The potential impacts of constructing the plug several feet above the existing bank level should be addressed. There is potential for floodwaters to erode a channel around the plugs if floodwaters must pass around the plugs before they can pass over the plugs.

November 14, 1990

Floodplain Management
and Small Projects
Planning Division

Mr. Lawrence M. Cavin
Chief, Environmental Review and Coordination Section
U.S. Environmental Protection Agency
Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101

Dear Mr. Cavin:

Thank you for your October 31, 1990 letter response to the Lansing Big Lake Definite Project Report and associated Environmental Assessment, FONSI, and Section 404(b)(1) evaluation.

Your comments (copy enclosed) have been incorporated into the revised report and associated environmental documentation as follows:

RESPONSE TO GENERAL COMMENT #1 - We have expanded our project performance monitoring to include two additional cross sections located in the Lake Winneshiek backwaters. These additional cross sections will be monitored in the same way as the cross sections located within the project area. Also, we have included the Winneshiek backwaters in our GIS evaluations of aerial photographs which will be taken every five years. This information, in combination with the new cross-section data, will provide the necessary data to accomplish the evaluations you have requested.

RESPONSE TO GENERAL COMMENT #2 - We have included a conclusions and findings section in the revised report. Item #6 of this section provides a mechanism five years into the monitoring/data collection program for an evaluation of impacts outside the project area.

RESPONSE TO SPECIFIC COMMENT #1 - Concur. Clarification regarding the fill material characterization has been included in the constructibility section of the revised text.

RESPONSE TO SPECIFIC COMMENT #2 - Concur. This change has been made to the revised text.

RESPONSE TO SPECIFIC COMMENT #3 - The ongoing operations and maintenance of the elevated closure structures will include a careful watch to insure that such erosion does not go unchecked.

Thank you for your comments. We hope that we have fully incorporated your concerns. If you have questions regarding this matter, please contact Ed McNally of my staff at 612-220-0387.

Sincerely,

Louis Kowalski
Chief, Planning Division

Enclosure

KRUCHTEN PD________

MCNALLY PD-PF______

WORKMAN PD-PF______

CRIST PD________

KOWALSKI PD________

STATE OF IOWA
TERRY E. BRANSTAD, GOVERNOR
DEPARTMENT OF NATURAL RESOURCES
LARRY J. WILSON, DIRECTOR

April 1, 1991

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

Dear Colonel Baldwin:

This is to inform you that the Iowa Department of Natural Resources supports construction of the Environmental Management Program Habitat Rehabilitation and Enhancement Project at Lansing Big Lake in Pool 9 near Lansing, Iowa as outlined in the draft Definite Project report dated July 1990. This letter also provides you with the assurance that the State of Iowa intends to assume the responsibilities for that project which are outlined in this report.

Upon completion and final acceptance of this project by the Corps of Engineers and the U.S. Fish and Wildlife Service, the Iowa Department of Natural Resources agrees to cooperate with the U.S. Fish and Wildlife Service and the Corps of Engineers to ensure that operation, maintenance and any mutually agreed upon rehabilitation as described in the Definite Project Report will be accomplished in accordance with Section 906(e) of the Water Resources Development Act of 1986.

Sincerely,

LARRY J. WILSON
DIRECTOR
IOWA DEPARTMENT OF NATURAL RESOURCES

cc: Moe, Wisconsin DNR
Beseke, USFWS
Dalziel, Iowa DNR

... STATE OFFICE BUILDING / DES MOINES, IOWA 50319 / 515-281-5145

Attachment 5

Distribution List

Distribution List
for
Public Notice (NEPA correspondence)

464 Individuals, Government offices, multi-media, and businesses. Notices were also provided to the following libraries:

Ames	-	Iowa State University	
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Lansing Big Lake Project

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Attachment 6

Memorandum of Agreement
and
Letters of Intent

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

LANSING BIG LAKE

ALLAMAKEE COUNTY, IOWA

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 Lansing Big Lake separable element of the Upper Mississippi River System - Environmental Management Program (UMRS-EMP). "The project is located on lands managed as a National Wildlife refuge within the meaning of Section 906(e) of the 1986 Water Resources Development Act and is managed by the U.S. Fish and Wildlife."

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. Under conditions of Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, all construction costs of those

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 55101-1479

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)

ROGER L. BALDWIN
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

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