UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-15F)

GARDNER DIVISION
HABITAT REHABILITATION AND ENHANCEMENT

SEPTEMBER 2000

US Army Corps
of Engineers
Rock Island District

POOL 21, MISSISSIPPI RIVER
MILES 332.5 THROUGH 340.2
ADAMS COUNTY, ILLINOIS

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT. CORPS OF ENGINEERS
CLOCK TOWERB UILDING – P.O.B OX 2004
ROCK ISLAND. ILLINOIS 61204-2004

REPLY TO
ATTENTION OF:

CEMVR-PM-M

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ACKNOWLEDGEMENT

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EXECUTIVE SUMMARY

The Gardner Division Habitat Rehabilitation and Enhancement Project (HREP) is located 5 miles upstream of Quincy, Illinois, near the midpoint of Pool 21. The project area lies in Adams County, Illinois, between Upper Mississippi River Miles (RM) 332.5 and 340.2. Gardner Division is made up of several islands, of which Long, Shandrew, and Flannigan are the largest. The project area also contains a major backwater lake and several important side chutes—Canton, O' Dell, Smoots, and Shandrew. All project lands are in Federal ownership and are managed by the U.S. Fish and Wildlife Service (USFWS) as part of the Mark Twain National Wildlife Refuge.

Gardner Division is subject to yearly Mississippi River floods and is rapidly losing its valuable backwater areas and side chutes to siltation and vegetation encroachment. The project area also has one of the last high quality stands of bottomland forest in the middle reaches of the Upper Mississippi River.

The goals of the proposed project are to restore and protect aquatic, wetland, and terrestrial habitat for migratory birds, fish, and other wildlife. The following objectives have been identified to meet these goals: (1) reduce forest fragmentation, (2) increase bottomland hardwood diversity, (3) reduce island erosion, (4) increase habitat for overwintering fish, and (5) reduce sedimentation in side channels. The following enhancement measures were considered in detail to achieve the project goals and objectives:

1. Side Channel Restoration/Protection
   - No action.
   - Dredge the lower 5,000 feet of O'Dell Chute and construct an emergent closure structure immediately upstream of the dredged channel.
   - Dredge the lower 5,000 feet of O'Dell Chute and construct an emergent closure structure at the chute's head end.
   - Dredge the lower 8,400 feet of O'Dell Chute and construct an emergent closure structure immediately upstream of the dredged channel.

2. Shoreline Protection
   - No action.
   - Protect the shorelines and head ends of several small islands.
   - Protect the shorelines and head ends of three large islands.
   - Protect the shorelines and head ends of several small islands and three large islands.

3. Reforestation
   - No action.
   - Plant mast-producing trees on the eastern Long Island agricultural field's dredged material placement site (67 acres).
   - Plant mast-producing trees on the entire eastern Long Island agricultural field (184 acres).

Evaluation of the project enhancement features and construction options was accomplished using the Wildlife Habitat Appraisal Guide (WHAG) and annualization of outputs and costs. The WHAG evaluation methodology quantifies habitat output in the form of habitat units (HUs) that are used in conjunction with project cost data and functional life expectancy to compare the construction options of the proposed enhancement features. This incremental analysis identifies which combinations of enhancement features would be cost efficient and cost effective.

The recommended plan (shown on Figure ES-1) includes: dredging 5,000 feet of O'Dell Chute and constructing an emergent closure structure at the upstream end of the chute; protecting the shorelines and head ends of selected islands; and planting 67 acres of mast-producing trees on the dredged material placement site located on Long Island's eastern agricultural field.

Constructing an emergent closure structure in O'Dell Chute would reduce sedimentation by preventing heavy sediments from entering and settling in the chute. Dredging in O'Dell Chute would increase overwintering habitat for fish by providing reliable access to deeper, low-flow water areas protected by the new closure structure feature. Protecting the islands' shorelines and head ends would enhance aquatic habitat by adding substrate diversity, maintaining existing terrestrial habitat by reducing ongoing erosion, and ensuring that the small islands do not disappear completely. Planting mast trees would reduce forest fragmentation and increase bottomland hardwood diversity by converting the current agricultural field to forest and by reintroducing mast-producing species to an area dominated by silver maple and cottonwood.

Implementation of the recommended plan would increase the quality and quantity of preferred habitat at this 6,300-acre refuge. The project outputs are consistent with refuge master plan goals and objectives and support the overall goals and objectives of the Upper Mississippi River System-Environmental Management Program (UMRS-EMP), the North American Waterfowl Management Plan, and the Partners in Flight Program.

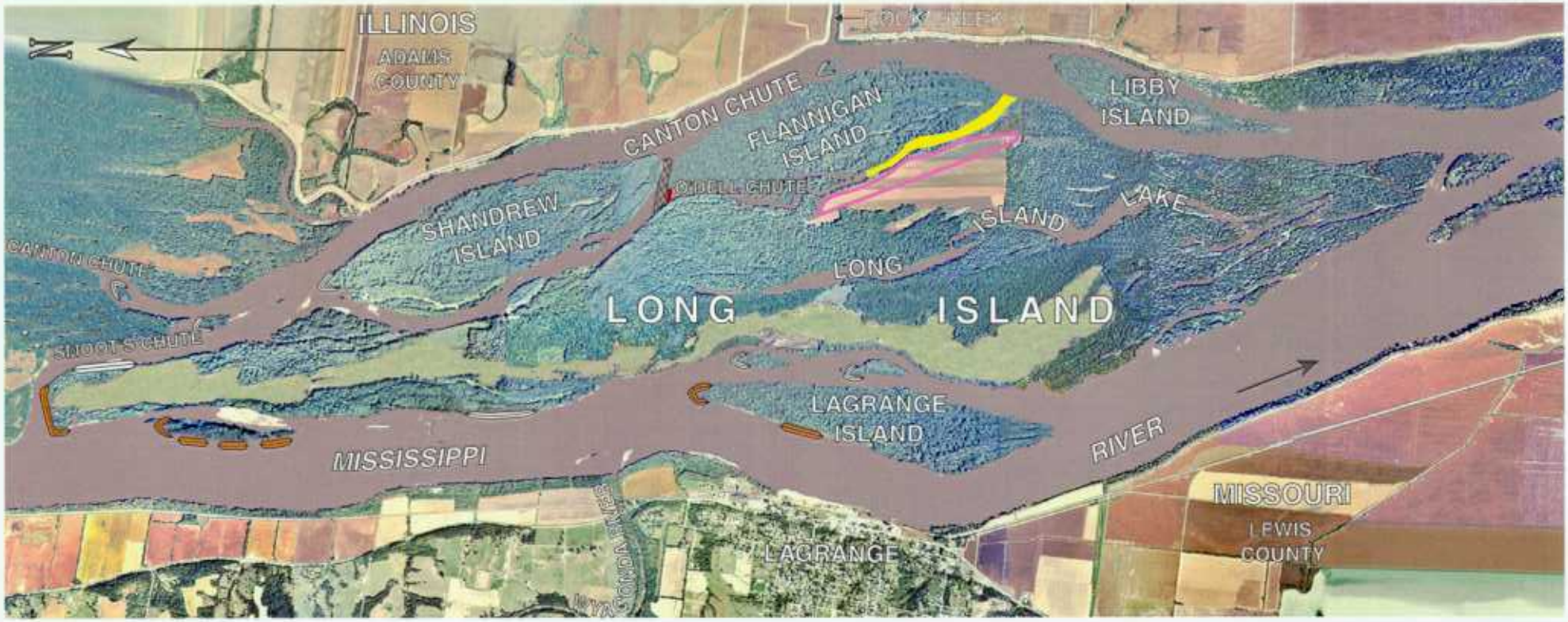
The U.S. Army Corps of Engineers will be responsible for the Federal share of any mutually agreed-upon rehabilitation of the project that exceeds the annual operation and maintenance requirements identified in the final Definite Project Report (DPR) and that is needed as a result of specific storm or flood events. Rehabilitation of the project is considered to be reconstructive work, which cannot be accurately estimated at this time.

All Gardner Division project features will be located on federally owned lands managed, through cooperative agreement, by the USFWS. As a result, first cost funding for enhancement features will be 100 percent Federal. Project operation and maintenance at an estimated average annual cost of $3,956 will be accomplished by the USFWS, the Federal project sponsor. The Illinois Department of Natural Resources is the non-Federal project sponsor.

The District Engineer has reviewed the project outputs and determined that implementation of the recommended plan is justified and in the Federal interest. Therefore, the Rock Island District Engineer recommends construction approval at an estimated Federal expense of $2,810,672 for the Gardner Division HREP. Total Federal cost, including general design and construction management, is $3,766,072.

UMRS EMP

Figure ES-1
GARDNER DIVISION HREP
Project Location Map



ES-3

0 1500 3000
SCALE IN FEET

LEGEND

- MAST TREE PLANTINGS/DREDGED MATERIAL PLACEMENT SITE
- O'DELL CHUTE CLOSURE STRUCTURE
- SECTION 1135 MAST TREE PLANTING AREA
- O'DELL CHUTE ACCESS DREDGING
- CLOSURE STRUCTURE ACCESS DREDGING
- HREP ROCK STABILIZATION
- CHANNEL O & M ROCK STABILIZATION

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1. INTRODUCTION

a. Purpose. The purpose of this report is to present a detailed proposal for the rehabilitation and enhancement of the Gardner Division project area. This report provides planning, engineering, and sufficient construction details of the recommended plan to allow final design and construction to proceed subsequent to approval of this document.

b. Resource Problems and Opportunities. Gardner Division is part of the U.S. Fish and Wildlife Service (USFWS) Mark Twain National Wildlife Refuge. The project area is comprised of several islands, of which Long, Shandrew, and Flannigan are the largest. The project area also contains a major backwater lake (Long Island Lake) and several important side chutes—Canton, O'Dell, Smoots, and Shandrew.

Gardner Division is subject to yearly Mississippi River floods and is rapidly losing its valuable backwater areas and side chutes to siltation and vegetation encroachment. The Gardner Division also has one of the last high quality stands of bottomland timber in the middle reaches of the Upper Mississippi River, despite the heavy loss of soft-mast trees during 1993 flooding.

Significant opportunities are available for preserving, enhancing, and improving habitat for migratory birds, aquatic mammals, fisheries, and endangered species by reducing the inflow of sedimentation, protecting the bankline from scouring and cutting, and reintroducing mast trees into the timber stand.

c. Project Selection. The USFWS nominated the Gardner Division Habitat Rehabilitation and Enhancement Project (HREP) for inclusion in the Rock Island District's habitat program. The Fish and Wildlife Interagency Committee (FWIC) then ranked the project habitat benefits based on critical habitat needs along the Mississippi and Illinois Rivers. After considering resource needs and deficiencies pool by pool, the Gardner Division HREP was recommended and supported by the FWIC and the River Resources Coordinating Team (RRCT) as providing significant aquatic, wetland, and terrestrial benefits with opportunities for habitat enhancement. Enhanced capability to manage the project area for migratory birds, fish, and wildlife use only will be achieved by implementing the proposed project enhancement features.

d. Scope of Study. The 6,300-acre Gardner Division project area is located in Adams County, Illinois, between River Miles (RM) 332.5 and 340.2 and is about 5 miles north of Quincy, Illinois, in Pool 21. All project lands are in Federal ownership. Plate 1 provides vicinity and general location maps for the Gardner Division. Plate 2 shows a site-specific plan.

The scope of this study focuses on proposed project features that would improve aquatic, wetland, and terrestrial habitat and enhance overall resource values. The project is consistent with agency management goals and was planned for the benefit of resident and migratory birds and fish and other wildlife.

Field surveys, aerial photography, and habitat quantification procedures were completed to support the planning and assessment of proposed project alternatives. Hydrographic soundings were performed in developing sedimentation rates and estimating excavation quantities. Soil borings were taken to determine sediment types and excavation difficulty. Bulk sediment tests were performed to determine the chemical characteristics of the material to be dredged. Baseline water quality monitoring was performed to define present water quality conditions/problems.

The USFWS and the Illinois Department of Natural Resources (ILDNR) have made wildlife and resident fish observations within the study area. These observations, along with future studies and monitoring, will assist in evaluating project performance.

e. Format of Report. The report is organized to follow a general problem-solving format. The purpose, problems, and project selection process are presented in Section 1. Section 2 establishes the baseline for existing resources. Section 3 provides the objectives of the project. Sections 4 and 5 propose and evaluate project alternatives. Section 6 describes the recommended plan and lists general design and construction considerations. Section 7 describes the schedule for design and construction. Section 8 contains cost estimates for initial construction and annual operation and maintenance. Section 9 assesses the environmental effects of the recommended plan. Section 10 details performance evaluation and monitoring plans. Section 11 describes real estate requirements. Sections 12 and 13 summarize implementation requirements and coordination. Sections 14 and 15 present the conclusions and recommendations. Section 16 contains a Finding of No Significant Impact statement. Drawings (plates) have been furnished to provide sufficient detail to allow review of the existing features and the recommended plan.

f. Authority. The authority for this report is provided by the 1985 Supplemental Appropriations Act (Public Law 99-88), Section 1103 of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662), Section 405 of WRDA 1990 (Public Law 101-640), Section 107 of WRDA 1992 (Public Law 102-580), and Section 509 of WRDA 1999 (Public Law 106-53). The proposed project would be funded and constructed under these authorizations.

2. ASSESSMENT OF EXISTING RESOURCES

a. Resource History and Description of Existing Features (see plate 1). Historically, the Gardner Division complex was formed with alluvial deposits made by unregulated river flows. Canton Chute cut the island from the main shoreline, and numerous smaller side channels between islands offered a place for fish to migrate during the winter to avoid the stronger flows of the main channel. Flood flows created shallow sloughs on the island that provided quiet ponds for broods of ducks to forage, spawning areas for fish, and habitat for frogs and salamanders to escape into or deposit their eggs. Flooded timber also provided spawning habitat for many species of fish. Seasonally flooded, mast-bearing trees such as pecan (*Carya illoensis*) and pin oak (*Quercus palustrus*) were very predominant on the island. Seeds such as acorns and pecans provided local wildlife and migrating ducks with high energy food, enabling better winter survival into the spring breeding and gestation periods. Main channel border habitat was used by river fishes to forage for food and offered a gravel and cobble bottom for some species, like walleye, to spawn over and a place for larval fish to grow.

Gardner Division has one of the last high quality stands of bottomland forest in the middle reaches of the Upper Mississippi River. Despite heavy loss of trees from the 1993 flood, the Division still contains some significant stands of mature hardwoods. The waters between the island and the main channel contain numerous wing dams with a silty sand bottom. Most of the side channels within the complex are filling in with sediments deposited during high water periods. Over time, these three habitats—bottomland forest, main channel border, and side channel—are losing their diversity and thus their value to many wildlife species.

The decline in habitat quality can be attributed to many events over the last 100 years. Watershed and floodplain development, together with navigation infrastructure and operations, have altered floodplain hydrology, increased sedimentation in aquatic habitats, increased degradation of some terrestrial habitats, reduced the quantity and quality of native vegetation communities, and jeopardized the sustainability of the large river-floodplain ecosystem. These factors will continue to influence the physical environment of the Gardner Division in the future.

b. Land Use and Current Area Management Objectives. Figure 2-1 on page 7 shows the dominant vegetation types in the Gardner Division area. Most lands along the river encompass typical bottomland forests, wetlands, and aquatic habitats associated with the main river channel. Landward of the levees, agriculture production dominates the floodplain.

The Gardner Division is currently managed by the USFWS as part of the Mark Twain National Wildlife Refuge. The primary management objective of the Refuge is to provide resting and feeding areas for migratory birds. In addition, habitat is provided for wintering bald eagles, nesting wood ducks, breeding neotropical migrants, and a wide variety of other wildlife species. Public use activities on the Gardner Division include wildlife observation, fishing, and squirrel, deer, and turkey hunting. The Corps of Engineers manages the Bear Creek boat ramp and campground facilities. The Division is open to limited public use all year.

The ILDNR manages blind sites for waterfowl hunting in waters around the project area and in the nearby Bear Creek Unit. Gardner Division is also known as Gardner Woods Natural Area, a significant tract of floodplain forest identified by the Illinois Natural Areas Inventory.

c. Aquatic Resources. A number of wing dams extend from Gardner Division to the main channel. The area between the wing dams is considered main channel border habitat. River flows are slower than those in the main channel due to the effectiveness of the wing dams. This area is shallow, flat, and comprised of a silty/sand substrate as a result of lower flows. However, directly downstream of each structure is a turbulent area where water cascading over each structure has scoured a deeper area.

Benthic species found within this dike field include papershell mussel species, tubeflex worms, may fly larvae, and other small invertebrates. Fish species found in this habitat are catfish, freshwater drum, and carp. In or near the deeper areas, walleye and other game species will forage for food and use this habitat to avoid the main channel currents. Herons and cormorants may forage for fish in the shallow water near the wing dams or perch on exposed trees that have washed into the area.

Shorelines of most islands within the Gardner Division complex are subject to bank erosion. Substrates are unstable and primarily comprised of sand, except where existing wing dam structures tie into the bank facing the main channel.

The availability of overwintering habitat is critical to the survival of many species of fish, such as largemouth bass and bluegill. Those fish with low energy reserves in the spring will be less likely to have healthy and successful spawn, maturation of their eggs, and emergence of fry. Suitable overwintering habitat provides well-oxygenated water with little or no current velocity, ensures sufficient depth to prevent ice cover from blocking fish egress, and promotes dissolved oxygen ingress. These conditions are generally not found in main channel or channel border habitats. Fishes will seek side channel and backwater habitats in the winter so that they can rest rather than expend energy on maintaining their position in the main channel. Many of the backwaters and side channel areas that historically provided this type of habitat have been degraded or lost altogether as a result of sedimentation or more direct physical alteration of the river and its floodplain.

d. Terrestrial Habitat Resources. The project area displays typical silver maple association forest cover. Silver maple is the dominant species, which produces an edible seed in the spring but does not provide any hard or soft mast for wildlife consumption in the summer or fall months. Due to the agricultural clearing and changed hydrologic conditions, mast-producing tree species such as oak, hickory, pecan, and walnut have declined in the Rock Island District portion of the Upper Mississippi River. Mature, hard mast-producing species such as oak or pecan are present on Gardner Division. Soft mast-producing species such as hackberry, sugarberry, and sycamore have had their numbers severely reduced by mortality resulting from severe flooding in 1993. Young, vigorous stands of mast trees are not common and, as such, river biologists and foresters are concerned about the future availability of mast as a winter food source for wildlife in the floodplain forests in the region. Under the authority of Section 1135 of WRDA 1986, approximately 430 acres of formerly cultivated agricultural fields on the western side of Long Island were planted in mast trees (acorns and bare root seedlings). However, the small size of planted stock resulted in limited survival in these locations.

Although Gardner Division once had a mosaic of forest and shallow sloughs, most of these sloughs have silted in. In the remaining sloughs, wood ducks forage for duck weed and invertebrates during the migration and brooding periods of the year. Other wildlife species using these sites include raccoons, deer, frogs, green herons, and warblers.

One actively cultivated agricultural field remains on the island. A certain percentage of crops is left each year as wildlife food. Squirrels and deer utilize this food throughout the winter. Ducks

and geese may use the field to forage for any waste grain remaining after harvest. In many years, the crop field is not planted due to spring floodwaters. In these years, invasive plant species dominate the site. Little wildlife value is derived at this site during those years.

e. Water Quality. The Illinois Environmental Protection Agency rated the water quality of the Mississippi River in the Gardner Division project area as "good" in their 1998 305b Report to Congress. The report stated the primary river contaminants in the project area are nutrients and sediment resulting from agricultural runoff. No water quality problems were observed during a 4-year baseline monitoring study performed at a site within O'Dell Chute. The relatively high velocities measured in O'Dell Chute resulted in sufficient dissolved oxygen concentrations to support indigenous aquatic life. A more detailed analysis of baseline water quality monitoring results can be found in Appendix F.

f. Endangered Species. The following is a list of federally endangered species potentially found in Adams County, Illinois:

Status	Common Name	Scientific Name
T	Bald Eagle	*Haliaeetus leucocephalus*
E	Fat Pocketbook Pearly Mussel	*Potamilus capax*
E	Higgins' Eye Pearly Mussel	*Lampsilis higginsi*
E	Indiana Bat	*Myotis sodalis*
E	Gray Bat	*Myotis grisescens*
T	Eastern Prairie Fringed Orchid	*Platanathera leucophaea*

T = threatened
E = endangered

Bald eagles use the Mississippi River corridor area near Gardner Division as a migratory route, as well as a nesting area in the past. The Division contains many mature trees that are potential eagle roosting sites. Although an aerie was made on Shandrew Island, it has not been used recently. The eagles concentrate at the lock and dam sites near Canton, Missouri, and Quincy, Illinois, during the winter.

Fat pocketbook pearly mussels and Higgins' eye pearly mussels usually inhabit coarse gravel, cobble substrate. Because of the dominance of sand and silty materials in the project area, these species are not likely to occur here.

Indiana bats forage over streams and raise their young in riparian forests in this part of Illinois. In August 1999, five Indiana bats were mist-netted in the project area on Long Island and were later tracked using a radio transceiver to a roost tree on the south end of the island. Indiana bats also were recently encountered during surveys in 1997 conducted for the Cottonwood Island HREP, which is located in Missouri just downstream of the Gardner Division project area between RM 328.5 and 331.0.

Additional species that the State of Illinois has identified as species of concern include the veery (*Catharus fuscescens*) and the river otter (*Lutra canadensis*). Both species have been identified as potentially occurring in Quincy Bay, located just downstream of the project area at approximate RM 329.0 to 332.0L.

g. Historic Properties. A report by Anderson *et al.* documents the recent deposition that has formed most of the modern island complex.[1] Deposits of historical or post-settlement alluvium (PSA) ranging in thickness from 20 inches (50 centimeters) to well over 6.6 feet (2 meters) cover, or make up, the entire island and mask evidence of all but the most recent mid-20th century activity.

Anderson *et al.* documented no prehistoric cultural features.[2] Based on geomorphological data, most of the project area has no potential for containing prehistoric archaeological remains. Potential impacts from tree planting on a surface of PSA of more than 20 inches (50 centimeters) in thickness are considered to be negligible in light of the fact that these islands were historically forested. Today, the cushion of PSA provides site protection far greater than any that was present prior to the beginning of PSA accumulation in about 1850.

h. Sedimentation. A sedimentation analysis was conducted for Canton, Shandrew and O'Dell Chutes and is included as Appendix H of this report. The backwater area has filled in considerably since 1938 when Lock and Dam 21 went into operation, and the process continues, as demonstrated by the formation of new sandbars at the upper end of O'Dell Chute. The sediment load entering the area and the trap efficiency were used to estimate net sedimentation. The increase in river bottom elevation was then calculated by considering total area where deposition is likely and the compaction rate of the sediment. Sedimentation rates were estimated at 0.21 inch per year, on average.

i. Hazardous, Toxic, and Radioactive Waste. A hazardous, toxic, and radioactive waste (HTRW) compliance assessment was conducted. The project is located in an area that primarily is and historically has been agricultural land. There is little evidence that the land has been used for other purposes. There were no obvious indications of potential contamination sources or migration pathways from surrounding properties. It does not appear that there is a risk of HTRW contamination within the project area. See Appendix E for a copy of the HTRW Documentation Report.

[1] Jeffrey D. Anderson and others, *1988 Geomorphological Investigations: Mississippi River Pool 21, Illinois and Missouri with Archaeological and Historical Overviews* (1994).
[2] *Ibid.*

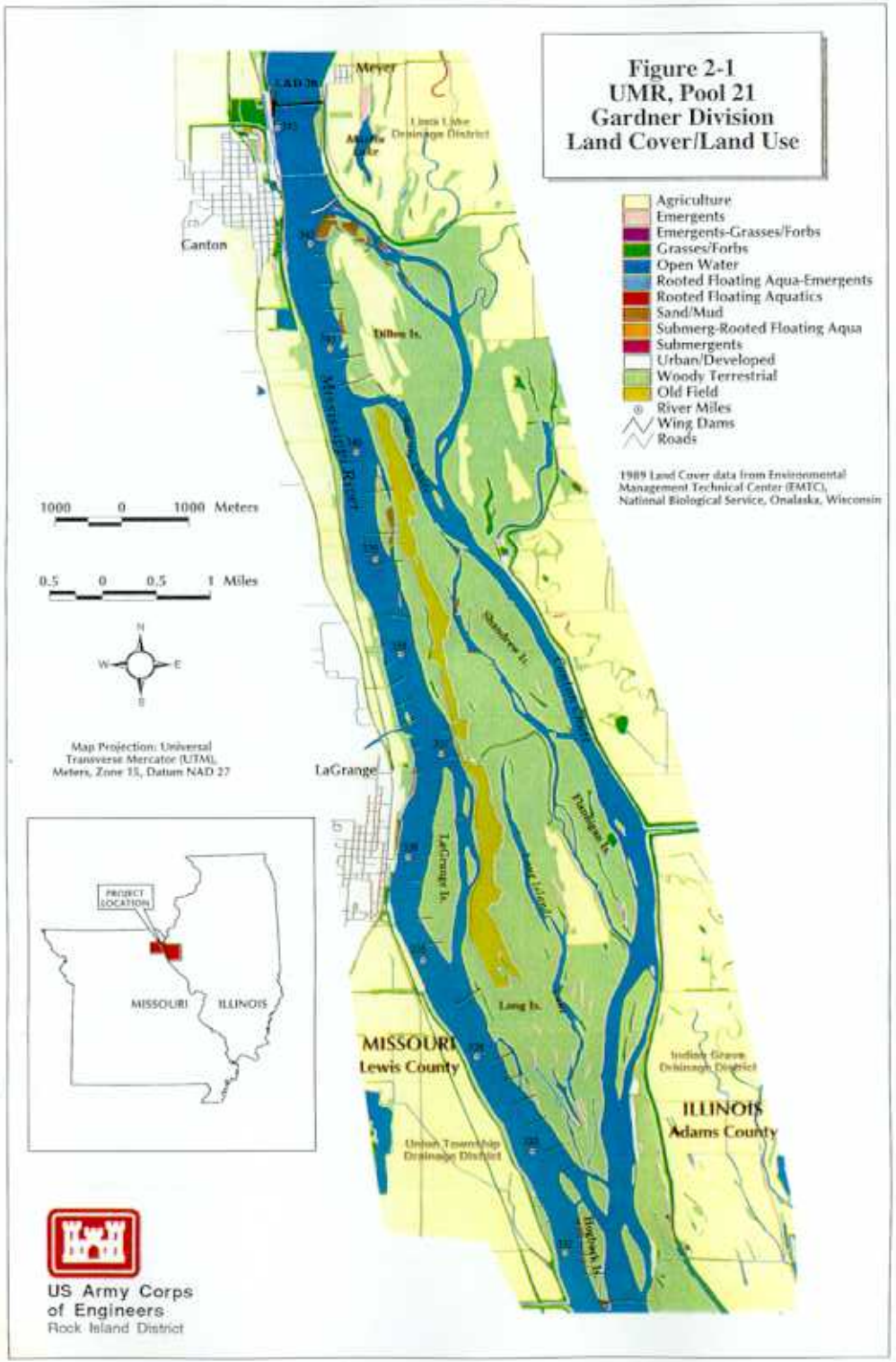
Figure 2-1
UMR, Pool 21
Gardner Division
Land Cover/Land Use
Agriculture
Emergents
Emergents-Grasses/Forbs
Grasses/Forbs
Open Water
Rooted Floating Aqua-Emergents
Rooted Floating Aquatics
Sand/Mud
Submerg-Rooted Floating Aqua
Submergents
Urban/Developed
Woody Terrestrial
Old Field
River Miles
Wing Dams
Roads
1989 Land Cover data from Environmental Management Technical Center (EMTC), National Biological Service, Onalaska, Wisconsin
1000 0 1000 Meters
0.5 0 0.5 1 Miles
N
W
E
S
Map Projection: Universal Transverse Mercator (UTM), Meters, Zone 15, Datum NAD 27
PROJECT LOCATION
MISSOURI
ILLINOIS
Canton
Meyer
Dillon Is.
LaGrange
LaGrange Is.
Long Is.
MISSOURI
Lewis County
ILLINOIS
Adams County
US Army Corps of Engineers
Rock Island District

3. PROJECT OBJECTIVES

a. Problem Identification. Prior to construction of Lock and Dam 21 in 1938, Gardner Division consisted of numerous large and small islands and interconnecting chutes with several areas of deep aquatic habitat. The entire vicinity of Long Island was forested habitat. After construction of the lock and dam, former side channels began to fill in, reducing the amount of deep aquatic habitat available for fisheries and other benefits. Additionally, waves and current have eroded several islands, thereby reducing the size and diversity of the island land masses. Three agricultural fields were established on Long Island several decades ago, which fragmented the island's forest. Two of these fields, located on the western side of the island, are no longer used for agricultural purposes and are beginning to revegetate. Additionally, acorns and bare root seedlings of mast-producing tree species were planted on approximately 430 acres of these fields as part of the Section 1135 Mast Tree Planting project between 1995 and 1998. Survival of these plantings has been low due to their vulnerability to flooding and competition from weeds and other woody vegetation.

(1) Loss of Off-Channel Deep Aquatic Habitat. Few areas of protected off-channel fisheries habitat exist in the Gardner Division project area, although some can still be found in parts of O'Dell Chute and Canton Chute. However, since construction of Lock and Dam 21, both chutes are experiencing sedimentation accumulation that has limited the availability of protected off-channel fisheries habitat. Access to deep water at the downriver end of O'Dell Chute is intermittent.

Areas of this nature are often referred to as centrarchid habitat due to research emphasis on species in the centrarchid, or sunfish, family. Species in this family include bluegill, largemouth bass, smallmouth bass, and white and black crappie. Many other species of fish also utilize protected off-channel lacustrine habitat either exclusively or for part of their life cycle. Therefore, the project objectives were developed based on existing knowledge of protected off-channel lacustrine habitat as it pertains to centrarchids with the assumption that other species also would benefit.

Recent studies by the Iowa Department of Natural Resources have illustrated the importance of backwater habitats as overwintering areas for centrarchids.[3,4] General characteristics of suitable overwintering sites include off-channel areas that do not freeze to the bottom and have suitable dissolved oxygen levels, slightly warmer waters (stratification), and protection from the current. Areas providing these types of habitat presently are minimal in the Gardner Division project area. O'Dell Chute provides some of this habitat, but the chute is silting in and there is no reliable access to deep water.

(2) Decreasing Migratory Bird Wetland and Terrestrial Habitat. Wave and current actions have eroded the islands. This erosion has resulted in a loss of some mature vegetation and trees as the island shores have slowly eroded. The loss of these trees and the reduction in land mass of the islands themselves have resulted in a loss of migratory bird habitat. Additionally, the erosion and eventual loss of some of the smaller islands will significantly decrease the diversity of the off-channel aquatic areas.

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[3] Iowa Department of Natural Resources, *Study No. 1, An Evaluation of Largemouth Bass Populations in the Upper Mississippi River* (Federal Aid to Fish Restoration Completion Report: Mississippi River Investigations Project No. F-109-R, 1992).

[4] R. Gent and others, "Largemouth Bass Response to Habitat and Water Quality Rehabilitation in a Backwater of the Upper Mississippi River," *North American Journal of Fisheries Management* 15 (1992): 784-793.

Three locations on Long Island, totaling 687 acres, were cleared of trees and vegetation several decades ago and used for agricultural purposes. This conversion to agricultural use has fragmented the forest throughout the island, decreasing its value for wildlife species that depend on large blocks of undisturbed forest during part of their life cycle. Additionally, the Flood of 1993 was particularly devastating to mast-producing trees and other hardwood species less tolerant of prolonged flooding than the willow, cottonwood, and silver maple that dominate the Upper Mississippi floodplain.

b. General Fish and Wildlife Management Goals. The Gardner Division is part of the Mark Twain National Wildlife Refuge, one of more that 500 National Wildlife Refuges managed by the USFWS. The mission of the National Wildlife Refuge System is to preserve a national network of lands and waters for the conservation of fish, wildlife, and plant resources of the United States for the benefit of present and future generations. Mark Twain was established specifically for the protection of migratory birds, although Refuge lands also provide important habitat for many other species of resident and migratory wildlife. The Refuge is currently developing a Comprehensive Conservation Plan to guide future management activities. Draft goals of the plan that relate to the problems described above include:

- Conserve and enhance the quality and diversity of wildlife habitat.
- Identify and reduce the impacts of sedimentation and other water quality factors on fish and wildlife resources.

c. Project Goals, Objectives, and Potential Enhancement Features. Based on the identified problems and the fish and wildlife management goals of the cooperating agencies, the following goals, objectives, and potential enhancement features were considered during development of the DPR (Table 3-1).

TABLE 3-1. Project Goals, Objectives, and Potential Enhancement Features

Goals	Objectives	Potential Enhancement Features
Restore and Protect Wetland and Terrestrial Habitat Restore and Protect Aquatic Habitat	Reduce forest fragmentation Increase bottomland hardwood diversity Maintain existing terrestrial habitat Provide additional still water feeding areas Increase habitat for overwintering fish Increase habitat diversity Reduce sedimentation in side channels Establish aquatic vegetation Reduce island erosion	Establish hardwood trees on existing agricultural fields Place rock along shoreline and island tips Construct an emergent rock dike Bankline revegetation Consolidate Long Island Lake bottom material Perform access dredging to side channels Create or elevate emergent closure structures to reduce the flow of sedimentation in side channels Lower or notch wing dams to reduce sedimentation buildup Dredge side channels Dredge Long Island Lake Create rock weirs Dredge deep holes for fish Construct passive management ponds and potholes Establish a moist soil management unit Construct an island sediment deflection levee Provide sediment control measures for the Bear Creek watershed

d. Criteria for Potential Enhancement Features. Table 3-2 presents general and specific criteria developed to assess potential enhancement features.

TABLE 3-2. Potential Enhancement Features Development Criteria

Item	Purpose of Criteria
A. General Criteria	
Locate and construct features consistent with EMP directives	Comply with program authorities
Construct features consistent with Federal, state, and local laws	Comply with environmental laws
Develop features that can be monitored (e.g., sedimentation, stability, water quality)	Provide baseline for project effects
Design features to facilitate operation and maintenance	Minimize operation and maintenance costs. Realize USFWS logistical difficulties in accessing the site
Locate and construct features consistent with best planning and engineering practices	Provide basis for project evaluation and alternative selection
Construct features which meet one or more of the project objectives	Meet project goals and objectives
B. Restore and Protect Aquatic Habitat	
Increase depth of side channels through dredging, dredge deep holes for fish, and dredge Long Island Lake	Ensure fisheries access to the main channel throughout the year and ensure adequate dissolved oxygen and depths during winter months and summer stress periods
Construct or elevate emergent rock structures/ create rock weirs/notch or lower wing dams. Provide sediment control structure for Bear Creek Watershed.	Decrease amount of sediment-laden water entering side and back channels
Create passive management ponds, potholes and/or a moist soil management unit	Provide additional still water feeding areas.
Consolidate Long Island Lake bottom material by draining lake to establish stable growing area	Enhance aquatic vegetation in Long Island Lake
C. Restore and Protect Wetland and Terrestrial Habitat	
Armor shoreline and island tips with riprap and plant bankline vegetation	Maintain existing terrestrial habitat and improve island stability by reducing shoreline erosion
Construct an island sediment deflection levee	Maintain existing terrestrial habitat by reducing the amount of sediment depositing on the island
Establish hardwood trees on existing agricultural fields	Increase bottomland hardwood diversity
Locate plantings in existing forest management/crop areas	Reduce forest fragmentation
Locate plantings on high ground	Maximize tree survival rate

4. POTENTIAL PROJECT FEATURES

This section describes and assesses a preliminary number of potential enhancement features that will meet the goals described in Section 3. Potential enhancement features were determined based on their ultimate contribution to the project goals and objectives, engineering considerations, and local restrictions or constraints. Features that were not considered feasible were not subject to further evaluation. These features are shown on plate 4, Potential Enhancement Features Not Evaluated. Section 5 discusses the evaluation of the feasible project alternatives. These features are shown on plate 5, Potential Enhancement Features Evaluated. For planning purposes, project life was established as 50 years.

a. Side Channel and Backwater Restoration/Protection. The side channels in the Gardner Division are experiencing continued sedimentation (see Appendix H for more information on sedimentation analyses). The proposed enhancement features included constructing closure structures at the heads of the side channels, notching existing and proposed wing dams, raising a closure structure, and dredging portions of the channels. The closure structures would divert heavy sediment loads from the side channels. The lower ends of the side channels would be dredged to create channels and periodic deep holes. The channels and deep holes would improve fish ingress and egress to the chutes and would provide critical overwintering habitat. The scope of side channel dredging was reduced to address the sponsor's concerns over the project life of dredged channels.

(1) O'Dell Chute Improvement with Closure at Upper End of 5,000-Foot Dredge Cut. This option consists of dredging a channel from the downstream entrance of O'Dell Chute approximately 5,000 feet upstream to connect existing deep water locations, which would ensure sufficient fish ingress and egress capabilities to Canton Chute during winter conditions. Dredged material from O'Dell Chute would be placed on Long Island's eastern agricultural field to enhance elevation for mast tree plantings. An emergent closure structure would be constructed at the upstream end of the dredge cut to decrease sediment transfer into the chute.

(2) O'Dell Chute Improvement with Closure at Head of Chute. This option consists of dredging the 5,000-foot channel and placing material on the Long Island agricultural field as described in paragraph (1) above, and constructing the emergent closure structure at the head of O'Dell Chute.

(3) O'Dell Chute Improvement with Closure at Upper End of 8,400-Foot Dredge Cut. This option consists of dredging a channel from the downstream entrance of O'Dell Chute approximately 8,400 feet upstream with placement of material on Long Island as described in paragraph (1) above, and constructing the emergent closure structure at the upstream end of the 8,400-foot dredge cut.

(4) Willow Island Deep Water Enhancement. This feature would enhance the deep water habitat in the vicinity of Willow Island, extending to the downriver end of Deadman's Island. The closing dam between Willow Island and Long Island would be raised to ensure overwintering protection for aquatic species. Additionally, a downstream wing dam in the vicinity of Hogback and Deadman's Islands would be lowered to allow sediment to move out of the backwater area. This feature was eliminated as a project feature since the project sponsor was independently pursuing these actions through the Rock Island District's Operations Division.

(5) Shandrew Island Enhancements. Dredging in Shandrew Island Chute was eliminated, except for the small amount needed to construct the closure structure at the head of

O'Dell Chute. The chute is significantly silted in, resulting in very shallow depths. Placing a closure structure at the head of the island alone would not improve the chute's habitat. Dredging the chute would have been cost prohibitive due to the shallow depths. Therefore, this option was eliminated from further consideration.

(6) Long Island Lake Dredging. Hydraulic dredging of upper Long Island Lake (approximate RM 335.0 to 336.5) was analyzed for creating a deeper water area for use by overwintering fish. The dredged material would be placed on Long Island's eastern agricultural field and/or incorporated into the O'Dell Chute closure structure. Planting of tubers also was considered, as there is currently a lack of aquatic vegetation in the Mississippi River's lower pools. Dredging to restore access to Long Island Lake also was discussed. This option was eliminated due to concerns about wildlife disturbance resulting from increased access to the lake.

Many public comments received regarding the March 2000 version of this DPR expressed concern with sedimentation at the Lower end of Long Island Lake. In order to minimize delays with the features already analyzed in this DPR, this feature's feasibility will be considered as part of a potential future habitat enhancement project.

Other improvements identified during the public comment period included the removal of ditch plugs from the upper end of Long Island. Natural channels were blocked years ago to facilitate access to agricultural fields. The feasibility of this feature, specifically regarding increased flows and the potential of these increased flows to improve habitat quality and reduce sedimentation in the lake, will be considered as part of a potential future habitat enhancement project.

(7) Corner Slough Dredging. Corner Slough connects Canton Chute and Indian Graves Lake near the upper end of Shandrew Island. The slough is shallow and currently does not provide year-round fish access to the lake. Dredging the lower portion of the slough was proposed to improve fish access to Indian Graves Lake. This was eliminated due to excessive maintenance, and after evaluations of channel depths, it was determined that there was less habitat to protect than was originally projected.

(8) Rock Weirs. At the upstream end of the dredged channels, "\ /" shaped rock weirs were proposed to direct flows into the channels to reduce sedimentation. This feature was eliminated since hydraulic analysis determined that they would not create enough flow to self-maintain the dredged channels.

(9) Passive Management Ponds. Construction of passive management ponds was considered to promote invertebrate production as a food source for birds and to provide brood habitat for ducks. The passive management ponds would be created by placing short dikes between ridges of higher elevation to temporarily retain water following higher river stages or heavy rainfall. The USFWS' Mark Twain National Refuge has constructed similar ponding areas at their Gregory Landing Management Unit. This feature was eliminated since gaining access to these remote sites with the equipment necessary to construct the berms would result in negative impacts that would not be offset by the potential benefits of this feature. Additionally, it was determined that sufficient amounts of still water feeding and brooding habitat existed within the Gardner Division.

(10) Potholes. This option consists of creating numerous potholes to provide secluded open water for waterfowl use. This feature was eliminated since Long Island Lake and other existing water bodies already provide significant areas of similar habitat. Pothole

construction also would have resulted in fragmentation of the largest existing block of forest in this portion of the river. This would have been contrary to the project goals and objectives.

(11) Moist Soil Management Units (MSMU). This option consists of constructing a large managed marsh complex (moist soil management unit) in the eastern agricultural field. This complex was considered as a method of disposing of materials from Long Island Lake dredging or other dredging features. Berms for the moist soil management unit would have been constructed with the dredged material. A water control structure would have been constructed to manage water levels within the unit. This feature was eliminated because past attempts at establishing MSMUs in this area were unsuccessful due to seepage problems. Remoteness of the project also would hamper operation by site managers.

(12) Sediment Deflection Levee. Constructing a sediment deflection levee on Long Island was considered to reduce the sediment load entering Long Island's backwaters from the main channel. This option would be constructed on the upper agricultural field on the west side of Long Island. The deflection levee would require an area at least 100 feet wide. Material to construct the deflection levee would come from channel maintenance dredging at the nearby La Grange dredge cut or from dredging adjacent to the island. Dredging between La Grange Island and Long Island also was considered as a source of material; however, dredging in this area was dropped after hydraulic soundings indicated depths of 7 to 16 feet. The deflection levee would be capped with fines to encourage revegetation. This feature was eliminated because of possible flood-related erosion of the berm materials and movement of these materials into interior forested areas and sloughs. There also were concerns related to the uncertain timing of construction. Construction of this feature would depend upon the need for channel maintenance dredging at adjacent chronic dredge cuts. It was uncertain when the feature would be constructed and whether it could be constructed using material from a single dredging event. Finally, the field where the deflection levee would be constructed was planted with mast-producing trees under the Section 1135 Mast Tree Planting Project.

(13) Sediment Control Measures for the Bear Creek Watershed. Sediment control measures were considered in order to enhance aquatic habitat by reducing sediment in side channels, thus increasing overwintering fish habitat and habitat diversity. This option included upland sediment control measures for the Bear Creek watershed. Bear Creek enters Canton Chute on the Illinois bank across from the upper end of Long Island. Initially, there was a concern that materials from Bear Creek were a major contributor to sedimentation in Canton Chute and the other side channels. Hydrologic evaluations and coordination with the National Resources Conservation Service determined that Bear Creek was not a major contributor of sediment in the side channels due to the differences in the types of material being deposited in the side channels and the terrain through which Bear Creek passes. In fact, approximately 90 percent of the sediment found in the Gardner Division side channels was from the Mississippi River. Sediment control measures for Bear Creek were eliminated from further consideration because of private land purchase requirements, the cost involved with setting back tieback levees, and Bear Creek not being considered a major contributor to side channel sedimentation.

b. Potential Features for Shoreline Protection. This feature would protect the existing terrestrial habitat. Terrestrial habitat has been gradually reduced due to the erosion of island heads and banklines. As the islands erode, shoreline is lost, as well as vegetation that includes mature trees. The erosion of smaller islands is resulting in a decrease of habitat diversity in the project area. Armoring of the shoreline is proposed to stabilize the islands and reduce tree fall. The continued loss of terrestrial habitat and large trees is a concern, particularly since the trees have historically been used by the federally protected bald eagle. Large islands include Long Island,

La Grange Island, and Shandrew Island. Small islands include the islands designated as "A, B, C, D, E, and Small Island" on plate 5.

(1) Place Rock along Head Ends and Shorelines of Small Islands Only. This option consists of placing stone on the head ends and along some shorelines of the smaller islands identified by the USFWS as vulnerable to erosion. Most of the small islands identified for protection are located off the main channel or within side channels. Because of their size, these islands are particularly vulnerable and may disappear altogether if current rates of erosion continue. Their locations within side channels also contribute to the complexity of aquatic habitats within the Refuge.

(2) Place Rock on Head Ends and Shorelines of Large Islands. This option consists of placing stone along the shorelines and head ends of the larger islands (Long Island, La Grange, and Shandrew) to reduce erosion. Although the larger islands are unlikely to be completely lost as a result of erosion, a substantial amount of bottomland forest habitat could be lost in the project area if they remain unprotected. Some of the identified eroded areas are potentially adversely affecting the navigation channel. The Rock Island District's Operations Division will evaluate these areas.

(3) Place Rock on the Head Ends and Shorelines of Large and Small Islands. This option combines the features described in paragraphs b(1) and b(2).

(4) Construct an Emergent Rock Dike. Constructing an emergent dike from the head of Long Island to a small island downstream was considered to protect the island tip while creating aquatic habitat. This feature was eliminated due to excessive cost when compared with the anticipated benefits to the aquatic habitat. Associated dredging behind the rock dike also was eliminated.

c. Potential Features for Reforestation. This feature would improve migratory bird wetland and terrestrial habitat by restoring bottomland hardwood forest on portions of Gardner Division that historically have been altered by row crop cultivation. Reforestation would involve conversion of crop fields by natural succession and by planting mast-producing trees at selected locations. The objective of tree planting would be to improve the quality and quantity of forest habitat in the project area by re-introducing a component of mast-producing species to a forest community currently dominated by silver maple and cottonwood. Mast tree plantings would restore some of the historic diversity of the bottomland forest community and reduce forest fragmentation. Once matured, mast trees would provide food resources for multiple migratory and resident species and increase overall habitat diversity. Mast tree species to be planted would include pin oak, bur oak, swamp white oak, northern pecan, and sycamore.

(1) Plant Mast-Producing Trees on Eastern Long Island Agricultural Field at Higher Elevations. This option consists of planting mast trees on the eastern Long Island agricultural field's higher elevations. This would result in approximately 67 acres of the 184-acre agricultural field being planted. The remainder of the field would be allowed to naturally revegetate. Species like silver maple and cottonwood would eventually populate the unplanted portion of the site.

(2) Plant Mast-Producing Trees on Entire Eastern Long Island Agricultural Field. This option consists of planting mast trees over the entire 184-acre agricultural field, regardless of elevation.

(3) Plant Mast-Producing Trees on All Historic Long Island Agricultural Fields. This option consists of planting mast trees over the 503 acres of historically cultivated agricultural fields on the western side of Long Island, in addition to the 184-acre eastern field mentioned above, for a total of 687 acres planted. This option was evaluated for potential habitat benefits, but it was eliminated from the incremental analysis because the western fields are no longer cultivated and are currently in the early successional phase of revegetation to a cottonwood-silver maple bottomland hardwood forest community.

(4) Plant Mast-Producing Trees on Agricultural Fields at the Bear Creek Unit. This feature was eliminated because the small fields (~128 acres) targeted for plantings have been heavily revegetated with ash, maple, cottonwood, and willow trees.

d. Long Island Lake Drawdown (Consolidate Lake Bottoms). This feature was considered in order to consolidate the material at the bottom of Long Island Lake. By consolidating the lake bottoms, it was anticipated that submergent vegetation would develop and have a chance at survival when the lake was reflooded.

(1) Drain All of Long Island Lake. This option would consist of draining all of Long Island Lake. A barge with portable pumps would be located at the downriver end of Long Island. Closure dams would be constructed at the downstream end where the lake connects to the river. A review of one-foot contour maps determined that the lake, especially the lower portion, had several areas of connectivity to the Mississippi River. Additionally, there were several outshoots of the lake throughout the southern portion of Long Island, making it difficult to determine the number and location of berms or levees to make the lake independent from the river. Due to high costs of creating a bermed lake throughout the approximate 5-mile-long lake, this option was eliminated.

(2) Drain Upper Long Island Lake. Since the entire lake could not be drained, portions of the lake were identified that were generally connected and cohesive. Upper Long Island Lake, between RM 334.5 and 337, was such an area. To drain this portion of the lake, a closure structure would have to be constructed between the upper and lower portions (at approximately RM 334.5). Additionally, some earthen berms may need to be created along the lake at lower elevations to ensure that only the lake area would be drained, and to ensure that additional pumping of tributaries directly connected to the Mississippi River would not occur. A road to the closure structure would have to be created from the eastern barge landing, across the eastern agricultural field, to the proposed closure structure. Finally, a pumping station, whether temporary or permanent, would have to be created in the area of the closure structure and operated for sufficient time to drain the lake and to maintain the lake drained for a period sufficient to consolidate the lake bottoms. The pumping station likely would be operated on diesel fuel since there is no electricity on the island. After a general plan was evaluated, geotechnical boring results from the center of the island were reviewed (see plates 10 and 11). The material at the bottom of the lake primarily consisted of a fat gray clay. Since this material is already significantly consolidated, drying the material by draining the lake would not make it more accessible for additional plant growth. Through conversations with the USFWS and with District biologists, it was determined that draining the lake would not have the anticipated results, and this feature was eliminated. Additionally, due to the remote project location, the USFWS could not easily support the operation requirements for maintaining a managed water control structure to raise and lower the lake.

5. EVALUATION OF FEASIBLE PROJECT FEATURES AND FORMULATION OF ALTERNATIVES

This section describes the features that met the goals and objectives of this project. Each feature was evaluated to determine its potential for environmental restoration and enhancement. Costs also were derived for all feasible project features.

a. Environmental Output Evaluation. A habitat analysis was completed for the Gardner Division project, with the goal of enhancing terrestrial, wetland, and aquatic habitat. This analysis employed a multi-agency team approach with representatives from the Corps of Engineers, the USFWS, and the ILDNR.

Analysis of existing study area conditions, future conditions without the project, and impacts of several proposed features and alternatives was completed using the Wildlife Habitat Appraisal Guide (WHAG) procedures developed by the Missouri Department of Conservation and the USDA Natural Resources Conservation Service. The WHAG is a numerical habitat appraisal methodology based on USFWS Habitat Evaluation Procedures (HEP) (1980).

The WHAG procedures evaluate the quality and quantity of particular habitats for animal species selected by the WHAG team members. The qualitative component of the analysis is known as the Habitat Suitability Index (HSI) and is rated on a 0.1 to 1.0 scale. The quantitative component of the WHAG analysis is the measure of acres of habitat that are available for the selected evaluation species. From the qualitative and quantitative determinations, the standard unit of measure, the Habitat Unit (HU), is calculated using the formula (HSI x Acres = HUs).

Changes in the quality and/or quantity of HUs will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HU derived over the life of the project. Cumulative HUs are annualized and averaged. This determines what is known as the Average Annual Habitat Units (AAHUs). AAHUs are used as an output measurement to compare all the features and project as a whole. For a more detailed description of the habitat analysis, refer to Appendix D of this report.

b. Feasible Project Features. Plate 5, Potential Enhancement Features Evaluated, shows the locations of all feasible project features described below.

(A) Side Channel Restoration/Protection.

(1) No Action (A0). No action would result in no additional management efforts. No AAHU gain or loss would be realized than what may occur naturally. If no action would take place, it is anticipated that existing deep waters would become silted in and overwintering protection for fish would be lost.

(2) O'Dell Chute Improvement with Closure at Upper End of 5,000-Foot Dredge Cut (A1). This option consists of dredging a channel from the downstream entrance of O'Dell Chute approximately 5,000 feet upstream to connect existing deep water locations, which would ensure sufficient fish ingress and egress capabilities to Canton Chute during winter conditions. Dredged material from O'Dell Chute would be placed on Long Island's eastern agricultural field to enhance elevation for mast tree plantings. An emergent closure structure would be constructed at the upstream end of the dredge cut to decrease sediment transfer into the chute.

(3) O'Dell Chute Improvement with Closure at Head of Chute (A2). This option is the same as the previous option, except that the emergent closure structure would be constructed at the upriver end of O'Dell Chute.

(4) O'Dell Chute Improvement with Closure at Upper End of 8,400-Foot Dredge Cut (A3). This option consists of dredging a channel from the downstream entrance of O'Dell Chute approximately 8,400 feet upstream with placement of material on Long Island as described in paragraph (2) above, and construction of the emergent closure structure at the upstream end of the 8,400-foot dredge cut.

(B) Shoreline Protection. The USFWS identified several significant erosion areas in the project area. Some of these areas are potentially adversely affecting the navigation channel. In the spirit of cooperation, the Rock Island District's Operations Division (OD) has offered to repair those erosion areas that impact the navigation channel (see Executive Summary, Figure ES-1). For purposes of this report, the areas that OD will repair were included in the environmental analysis, but excluded from the project cost estimate. This eliminates the need for separate documentation to achieve environmental clearance and saves the EMP approximately $1.5 million that can be used for other restoration efforts. This section discusses these areas.

(1) No Action (B0). No action would result in no additional management efforts. No AAHU gain or loss would be realized other than what may occur naturally. If no action would take place, it is expected that significant erosion of the islands would occur, and additional aquatic habitat provided through rock voids would not be made available.

(2) Shoreline Protection for Small Islands Only (B1). This option consists of placing stone on the head ends and along shorelines of the smaller islands identified as vulnerable to erosion by the USFWS (Islands A-E and Small Island). Most of the small islands identified for protection are located off the main channel or within side channels. Because of their size, these islands are in danger of disappearing altogether if current rates of erosion continue. Their locations within side channels contribute to the complexity of aquatic habitats within the Refuge.

(3) Shoreline Protection for Large Islands Only (B2). This option consists of placing stone on the head ends and selected shorelines of the three larger islands (Long, Shandrew, and La Grange). Although the large islands are not expected to completely erode, they could degrade to a point that a substantial amount of bottomland forest habitat would be lost.

(4) Shoreline Protection for Large and Small Islands (B3). This option consists of protecting the head ends and selected shorelines of the three larger islands (Long, Shandrew, and La Grange) as well as the smaller islands (Islands A-E and Small Island).

(C) Reforestation (Mast Tree Planting).

(1) No Action (C0). No action would result in no additional management efforts. No AAHU gain or loss would be realized other than what may occur naturally. If no action takes place, it is anticipated that the habitat would not regenerate mast-bearing trees on its own. Species like silver maple and cottonwood would eventually dominate these areas.

(2) Plant Mast-Producing Trees on the Eastern Long Island Agricultural Field's Dredged Material Placement Site (Higher Elevations) (C1). This option consists of planting mast trees on the eastern Long Island agricultural field at higher elevations. Naturally higher portions of the field would be further augmented by placing material dredged from O'Dell

Chute. This would result in approximately 67 acres of the 184-acre agricultural field being planted The remainder of the field would be allowed to naturally vegetate to a bottomland forest cover.

(3) Plant Mast-Producing Trees on the Eastern Long Island Agricultural Field (C2). This option consists of planting mast trees over the entire 184-acre eastern agricultural field, regardless of elevation.

c. Cost Estimates for Habitat Improvement Measures. Table 5-1 summarizes the outputs and costs associated with each management measure. A breakdown of costs is outlined in Section 8 - Cost Estimates.

TABLE 5-1. Environmental Output and Costs of Each Feature

Feature	Symbol	Output*	Cost**	Annualized Cost***
Side Channel Restoration/Protection				
No Action	A0	0	0	0
Closure structure at head of 5,000-foot dredge cut in O'Dell Chute (23 acres aquatic, 30% of area >6' depth)	A1	42.0	1064	76
Closure structure at head of O'Dell Chute with 5,000-foot dredge cut at lower end (45 acres aquatic, 16% of area >6'depth)	A2	61.4	1315	93
Closure structure at head of 8,400-foot dredge cut in O'Dell Chute (39 acres aquatic, 28% of area >6')	A3	60.0	1254	89
Shoreline Protection				
No Action	B0	0	0	0
Protect Smaller Islands Only (Small Island and Islands A, B, C, D, and E) (41 acres terrestrial, 36 acres aquatic)	B1	62.2	542	39
Protect Larger Islands Only (Long, Shandrew, and La Grange Islands) (86 acres terrestrial, 49 acres aquatic)	B2	152.5	759	54
Protect All Identified Islands (Large Islands plus Small, A, B, C, D, and E Islands) (127 acres terrestrial, 85 acres aquatic)	B3	206.8	1262	90
Reforestation				
No Action	C0	0	0	0
Plant mast-producing trees on the eastern ag field's dredged material placement site only (67 acres)	C1	358.3	234	17
Plant mast-producing trees on entire eastern ag field (184 acres)	C2	366.0	647	46

* Outputs are calculated as Average Annual Habitat Units (AAHUs).
** All costs in $1,000s. Represents initial construction costs only.
*** Annualized cost is initial construction cost based on a 50-year project life, 6-7/8% interest rate

d. Incremental Analysis of Alternatives. Cost-effectiveness analysis has been used to assist the decision-making process to determine what project features should be built based on habitat benefits (outputs) that meet the goals and objectives of the project and at the same time are the most cost effective. The Corps of Engineers has incorporated cost-effectiveness analysis into its planning documents for some time, mostly in mitigation planning. A cost-effectiveness analysis is conducted to ensure that least cost alternatives are identified for various levels of output. After the cost effectiveness of the alternatives has been established, subsequent incremental cost analysis is conducted to reveal and evaluate changes in cost for increasing levels of environmental output.

Cost-effectiveness and incremental analysis is basically a three-step procedure: (1) calculate the environmental outputs of each feature; (2) determine a cost estimate for each feature; and (3) combine the features to evaluate the best overall project alternative based on habitat benefits and cost. While cost and environmental output are necessary factors, other factors such as constructibility and meeting the goals and objectives (Tables 3-1 and 3-2) of the sponsor are very important in deciding on the preferred alternative.

Environmental outputs were calculated as average annual habitat units (AAHUs). The annualized costs were calculated by applying a 6-7/8% interest rate to the construction costs over the 50-year life of the project. All costs are shown in thousands of dollars ($ 1,000s). The incremental analysis for each feature was accomplished using the methodology described in Robinson *et al.*[5] Further information on the analysis can be found in Appendix D of this report. This project was evaluated using guidance prepared by the Corps of Engineers Institute for Water Resources.[6]

For the side channel restoration/protection, the outputs, costs, and average cost per AAHU are presented in Table 5-2. The incremental analysis for side channel restoration and protection evaluated Alternatives A0, A1, A2, and A3. In the early stages of project planning, only A0 and A2 were identified and evaluated for the incremental analysis. Following sponsor review of the feature design, the interagency team identified two additional alternatives for this feature (A1 and A3). Both of the new alternatives involved the same components as A2; however, neither A1 nor A3 required access dredging in Shandrew Chute, which had minimal environmental benefits. Table 5-2 presents the results of the incremental analysis for A0, A1, A2, and A3.

[5] Ridgley Robinson and others, *Evaluation of Environmental Investments Procedures Manual - Interim: Cost Effectiveness and Incremental Cost Analysis, Report No. 95-R-1* (U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources, Alexandria, Virginia, 1995).
[6] *Ibid.*

TABLE 5-2. Side Channel Restoration and Protection: Alternative Features with Incremental Cost Per Unit

Feature Alternative	Symbol	Annual Cost	Output AAHUs	Avg. Cost	Inc. Cost	Inc. Output	Inc. $/AAHU
No Action	A0	0	0	0	0	0	0
Dredge 5,000' with closure at head of cut	A1	76	42.0	1.810	69	42.0	1.810
Dredge 8,400' with closure at head of cut	A3	89	60.0	1.483	13	18.0	0.722
Dredge 5,000' with closure at head of chute	A2	93	61.4	1.515	4	1.4	2.857

The incremental analysis for shoreline protection evaluated Alternatives B0, B1, and B3. The increments were determined based on overall island acreage. The initial analysis determined protecting the large islands (B2) to be the cost-effective alternative. The interagency team, relying on their background and experience in environmental restoration, determined that protecting the small islands in order to preserve the diversity of the side channel habitat was crucial to ensure that more project goals and objectives were maintained. Therefore, only Alternatives B0, B1, and B3 were evaluated. Table 5-3 shows the results.

TABLE 5-3. Shoreline Protection: Alternative Features with Incremental Cost Per Unit

Feature Alternative	Symbol	Annual Cost	Output AAHUs	Avg. Cost	Inc. Cost	Inc. Output	Inc. $/AAHU
No Action	B0	0	0	0	0	0	0
Protect small islands only	B1	39	62.2	0.627	36	62.2	0.627
Protect small and large islands	B3	90	206.8	0.435	51	144.6	0.353

The incremental analysis for reforestation evaluated Alternatives C0, C1, and C2. The increments included no action (C0), planting the higher elevations of the agricultural field, raised with material dredged from O'Dell Chute (C1), and planting the entire agricultural field (C2). Table 5-4 shows the results of this analysis.

TABLE 5-4. Reforestation:
Alternative Features with Incremental Cost Per Unit

Feature Alternative	Symbol	Annualized Cost ($1000s)	Output (AAHUs)	Average Cost ($/AAHU)	Incremental Cost ($1000s)	Incremental Output (AAHUs)	Incremental Cost per Unit ($/AAHU)
No Action	C0	0	0	0	0	0	0
Plant placement site (67 ac) on eastern ag field	C1	17	358.3	0.047	17	358.3	0.047
Plant eastern ag field (184 ac)	C2	46	366.0	0.126	29	7.7	3.766

e. Summary. The results of the incremental analyses shown in this section were considered with other factors, including site topography, management objectives of the resource agencies, critical needs of the region, and ecosystem needs of the Upper Mississippi River System.

The results of the incremental analysis for side channel restoration and protection showed that Alternative A3 exhibited the lowest incremental cost per unit. For shoreline protection, the incremental analysis showed that Alternative B3 had the lowest incremental cost per unit. For reforestation, Alternative C1 had the lowest incremental cost per unit. Each of these alternatives was consistent with agency goals.

Comments received during public review of the draft DPR caused the interagency team to reevaluate the alternatives for side channel restoration and protection. Specifically, input from local residents concerned over the potential loss of aquatic habitat in O'Dell Chute upstream of the proposed closure structure in the A3 alternative design prompted a recalculation of the habitat analysis to account for this loss in the quantification of net benefits. After recalculation of habitat benefits and consideration of public and agency comments, the Corps and the interagency team instead selected the A2 alternative (closure at the head of O'Dell Chute and dredging 5,000 feet at the lower end of the chute) as part of the recommended plan. Additional information on the results of the habitat analysis is included in Appendix D.

In cooperation with the USFWS and ILDNR, the Corps has planned and designed a project that serves the needs of the resources and the resource managers, while being cost conscious. The preferred alternative has an overall output of 626.5 AAHUs for a total construction cost of approximately $2,810,672. These figures are summarized in Table 5-5.

TABLE 5-5. Recommended Plan:
Environmental Output and Costs of Each Feature

Feature Alternative	Symbol	Output (AAHUs)	Annual Cost ($1000s)	Annualized Cost per Unit AAHU ($1000s)
Closure structure at head of O'Dell Chute with 5,000' dredge cut at lower end	A2	61.4	1315	93
Protect small and large islands	B3	206.8	1262	90
Plant placement site (67 ac) on eastern ag field	C1	358.3	234	17
TOTAL		**626.5**	**2811**	**200**

6. RECOMMENDED PLAN: DESCRIPTION WITH DESIGN, CONSTRUCTION, OPERATION, AND MAINTENANCE CONSIDERATIONS

a. General Description. The preferred alternatives for the project are: Side Channel Restoration and Protection (includes O'Dell Chute Dredging, Closure Structure, and Dredged Material Placement Site); Shoreline Protection; and Reforestation. Plate 2 shows the recommended plan.

b. Recommended Plan.

(1) Side Channel Restoration and Protection: O'Dell Chute Dredging. The recommended plan involves dredging the downstream end of O'Dell Chute for approximately 5,000 linear feet in an upstream direction. The width of the dredge cut would be 50 feet, with proposed vertical sides. A dredge cut depth of 7.5 feet (elevation 462.5) is required to ensure a 6-foot depth below flat pool at the end of the project life (50 years) to maintain fisheries benefits. Dredging depth was based on water clearance, as shown in Table 6-1.

TABLE 6-1. Basis of Channel Dredging/Excavation

Elevation (feet NGVD 1912)	Description
470.0	Pool 21 flat pool
0.0	Present low-flow winter regulation
-6.0	Maintained water depth [1]
-1.5	50 years of sediment [2]
462.5	Minimum dredging depth

[1] A depth of 6 to 8 feet is typical of existing side channels.
[2] Further in formation on sedimentation rates is discussed in Appendix H - Sedimentation.

The shallow depths and narrow widths of O'Dell Chute limit hydraulic dredging equipment to mudcat-type (8-inch-diameter pipeline) dredges. Mudcat dredge and mechanical dredge production rates are similar, both averaging about 100 cubic yards/hour. However, the shoreline of this chute is heavily vegetated with mature trees. Using mechanical dredging equipment in a narrow chute could necessitate the removal of a significant portion of these trees. To reduce the impact to the mature vegetation along the shoreline, hydraulic dredging would be used.

To decrease dredging costs, the shaping of the channel sides to a specified slope would not be required. It is presumed that the sides of the dredged area would slump to their natural angle of repose as the material is being dredged. Based on borings at the project site, the material is a sandy material. The natural angle of repose is expected to be a 2:1 (Horizontal: Vertical) slope. When the contractor cuts a bottom width of 50 feet, the slopes will naturally fall to a 2:1 slope as described in Appendix G. Plate 8 shows the minimum amount of material that the contractor will be required to dredge. The appearance of the dredge cut immediately following the contractor's activities will exhibit dredge cut sides with approximately 2:1 slopes and a 50-foot bottom width. Plates 9a and 9b exhibit typical channel dredging profiles.

The volume of sandy material that would be removed is approximately 51,400 cubic yards, which includes the excess dredging necessary to maintain project dimensions. The material would be placed (using booster pumps as appropriate) on the eastern agricultural field of Long Island that runs adjacent to this chute (see paragraph b.(5)). In order to ensure that this dredged deep habitat remains, a closure structure would be constructed in O 'Dell Chute to reduce the infiltration of materials downstream.

(2) Side Channel Restoration and Protection: O'Dell Chute Closure Structure. For the purposes of this report, the slough located between Shandrew and Long Islands is referred to as Shandrew Chute. The slough located between Flannigan and Long Islands is referred to as O 'Dell Chute. A closure structure would be constructed at the upstream end of O'Dell Chute which would be emergent approximately 90 percent of the year and would be submergent the rest of the time. Dredging activities would have to be performed prior to constructing the closure structure to ensure access to this location. Construction access would be obtained by dredging upstream of the closure structure, between Flannigan and Shandrew Islands out towards Canton Chute. Approximately 31,600 cubic yards of dredged material would be removed and placed (using booster pumps as appropriate) on Long Island's eastern agricultural field (see paragraph b.(5)).

The main bedload in O'Dell Chute is sand, which moves downstream in waves. In order to stop the sand from migrating downstream, the structure would have to be emergent during most river stages. The interagency team determined that significant sediment transfer into O'Dell Chute should be prevented approximately 90 percent of the time. The resulting elevation for the top of the closure structure was determined to be 474 feet, or 4 feet above flat pool.

The maximum chute width is about 300 feet, with an average width closer to 150 feet. The closure structure would run the entire width of the channel at the proposed location. The structure would be keyed into the current chute floor to ensure that the rock remains in place during high water conditions. The structure's side slopes would be 2:1 (Horizontal: Vertical). The top of the structure would be approximately 5 feet in depth due to using 400-pound stone. Approximately 4,400 tons of rock would be required for construction. Plate 7 exhibits a typical (and maximum size) rock closure structure, and Appendices F and G provide the analysis for the closure structure's proposed design.

Serious consideration was given to the effects on dissolved oxygen levels downstream of this structure. Deepening the chute would allow for a greater volume of oxygen to diffuse into the dredged channel, which would sustain aquatic species during ice-covered periods. Seepage through the closure structure also would allow oxygenated water to flow into the chute. Over time, the voids in the closure structure will fill with sediment and eventually there will be little, if any, seepage through the structure. Routine monitoring of dissolved oxygen levels would be required to ensure that aquatic species are not impacted negatively. If a decrease in dissolved oxygen is noted, the closure structure would be notched to allow additional oxygen passage.

Locating the closure structure at the upper end of O'Dell Chute will not appreciably increase the sediment deposition in Canton Chute. If all the sediment deposited in O'Dell Chute in a given year was deposited in Canton Chute, it would add an average of 0.01 of an inch a year. This is unlikely to happen as even with the closure structure, the flows down Shandrew Chute will still spread out between Shandrew and Flannigan Island and deposit any suspended sand before this sand would enter Canton Chute. The most likely result will be that some fraction of the sand now deposited in O'Dell Chute will end up in Canton Chute.

There were some discussions about the possibility of increased flows between Shandrew and Flannigan Islands potentially scouring the area. While the flows at the lower end of Shandrew Chute will be higher than they are now (until the closure structure is overtopped), they will not be higher than the flows at the upper reaches of Shandrew Chute. Because no scouring has occurred at this location, it is unlikely to occur at the lower end after the closure structure is constructed.

(3) Side Channel Restoration and Protection: Dredged Material Placement. Material dredged from O'Dell Chute and from the closure structure's access channel would be placed at the designated dredged material placement site. This site is located on the 184-acre eastern agricultural field, as shown on plate 2. Field elevations are shown on plate 19. The highest elevations of this agricultural field were targeted as potential planting sites in order to improve tree survivability during this project's reforestation efforts. The dredged material would be placed within this targeted area to further increase ground elevations and, therefore, tree survivability. Up to 8 inches of the sandy dredged material, when incorporated with the present agricultural soil, will support mast tree growth. To ensure that this depth is not exceeded, the dredged material would be spread over a 60- to 80-acre site. Reforestation is further discussed in paragraph b.(5) below.

A berm would enclose the placement site on three sides to ensure that the material settles before draining towards Long Island Lake. Since the dredged material consists of fine to medium sand and is expected to settle quickly, a column settling analysis would not be required. The berm would be constructed before placing material by moving about 3,200 cubic yards of soil at the agricultural field. Due to the naturally high elevations between the placement site and O'Dell Chute, a berm would not be required in this location. The berms would maintain a natural appearance and would be approximately 2 feet high with no greater than a 2:1 (Horizontal:Vertical) slope. Plate 8 exhibits a typical berm cross section.

(4) Shoreline Protection. This feature consists of placing rock along island shorelines. This rock is anticipated to preserve existing terrestrial habitat as well as provide additional benefits for fisheries purposes. The USFWS identified 3,200 linear feet of shoreline within the Gardner Division project area that needs rock protection. The majority of the areas that require protection typically have nearly vertical slopes 12 feet in length. In order to access the identified erosion areas, special considerations may be necessary for contractors to transport rock to this area. The erosion areas are all on islands, with no vehicle access, and access may be difficult during low river conditions.

Since the current slopes are already significantly degraded, the cost of rock protection alone was prohibitive. The recommendations in the geotechnical and hydraulic appendices were based on providing rock protection without grading the shoreline. After performing the preliminary cost estimates, the HREP team determined that it would be more cost effective to grade the slopes to a 2:1 (Horizontal: Vertical) slope before rock placement. This type of gradation protection was evaluated by geotechnical, hydraulic, and environmental engineering personnel and was determined to provide adequate shoreline protection. Grading the slopes would require some vegetation removal along the shoreline as well as some debris removal within the channels themselves. To obtain a 2:1 slope, approximately 7,500 cubic yards of material would be excavated from the upper portion of the shoreline slope and placed at the foot of the shoreline slope.

After the slope is graded, bedding stone and 400-pound rock would be placed on the shoreline. One foot of bedding stone would be required, with Illinois Gradation CA6 (or equivalent) being the preferred type of rock. Two feet of riprap would be required, with the preferred protection coming from Illinois Gradation No. 5 erosion protection stone (or equivalent). Erosion protection

requirements are discussed in Appendix G - Geotechnical Considerations and Appendix I - Hydrology and Hydraulics. Quantities to ensure this protection were calculated to be approximately 16,600 tons of riprap and approximately 9,700 tons of bedding stone. Plate 6 exhibits typical rock protection sections and the anticipated slope gradation.

(5) Reforestation. Reforestation would occur on Long Island's 184-acre eastern agricultural field, as shown on plate 2. Field elevations are shown on plate 19. The highest elevations of this agricultural field were targeted as potential planting sites in order to improve tree survivability. The dredged material from the side channel enhancement efforts would be placed within this targeted area to further increase ground elevations and, therefore, tree survivability. Planting activities would occur on the field's highest 67 acres. The rest of the field would be allowed to vegetate naturally.

Restoration of a mast-producing tree component to this area would provide wildlife with an additional winter food source for a period of up to 100 years and a seed source for natural revegetation. Pin oak, swamp white oak, bur oak, northern pecan, and sycamore would be planted on a 30-foot spacing, and the species would be intermixed at each site to avoid solid blocks of individual species. This type of planting would allow for a natural appearance. Table 6-2 shows planting rates per acre.

TABLE 6-2. Mast Tree Planting Rates

Common Name	Scientific Name	Planting Rates Per Acre	Number of Mast Trees
Pin Oak	*Quercus palustris*	15	1,005
Sycamore	*Platanus occidentalis*	8	536
Bur Oak	*Quercus macrocarpa*	10	670
Northern Pecan	*Carya illoensis*	10	670
Swamp White Oak	*Quercus bicolor*	10	670
Total/Acre		**53**	**3,551**

The survival of newly planted trees is affected by many factors, including weather, competition from competing vegetation, and animal damage. Previous reforestation efforts within the Mississippi River floodplain have shown that the survival of planted trees is positively correlated with the size and health of the seedling that is planted. At a minimum, trees planted shall be at least 1/2-inch caliper and 4 feet in height. The contractor would have the option of planting container-grown or balled and burlapped (B&B) trees. Container-grown trees shall have a minimum container size of 5 gallons. Trees shall have been grown from acorns or seeds obtained from a bottomland source located within 100 miles of the project site. Trees would be planted either in the spring between March 1 and May 15, or in the fall between October 1 and December 10.

Abandoned crop fields and other disturbed sites often become dominated by annual weed species such as giant ragweed and cucumber vine, which can kill young trees by quickly overtopping and shading the planted trees within a short period of time. A rapid influx of cucumber vine on dredged material at the Big Timber, Iowa HREP (RM 443.5 to 445.0) required remedial applications of herbicide to protect planted trees.

To help alleviate this problem, all planting areas would be sprayed with a pre-emergent herbicide to a 6-foot-wide band around each tree immediately after planting. Weed barriers (mats) would also be placed around each tree. Additionally, a cover crop of red top grass and annual grains would be temporarily established on the tree planting sites to help control unwanted weed species. Additional herbicide applications would be used, if necessary, to control any competing vegetation that threatens the survival of the planted trees. Follow-up spraying would be performed during the following growing season if the trees are threatened by competing vegetation. Following an establishment period, the surrounding ground in all planting areas would be allowed to assume natural regrowth.

Despite good planting techniques and control of competing vegetation, some tree mortality within the first year after tree planting is inevitable. Unavoidable mortality due to natural causes would not be expected to exceed 10 percent. For this reason, the tree planting density was increased from a design number of 48 trees per acre to 53 trees per acre to account for a potential 10 percent mortality during the first year. Similar tree stock planted at the Bay Island, Missouri HREP (RM 311.0 to 312.0), for example, experienced less than 1 percent mortality after 1 year.

Since planting at elevations that are anticipated to flood at least annually and planting on a dredged material site are both experimental ventures, certain contingencies for tree mortality would need to be incorporated into the plans and the operation and maintenance manual. The contract for tree planting would likely require the contractor to replant the trees if the mortality occurs within a predetermined time period (e.g., 1 year). After this time period, excessive tree mortality may occur (due to flooding, droughts, disease, or other natural causes). Additionally, the contract would require the contractor to plant trees over a 3-year time period to ensure that the risk of mortality is diffused over time. The survivability of the reforestation efforts would be monitored through performance evaluations. The results of the monitoring efforts could then be used on future projects. However, if there is any mortality observed after the contractor's period of responsibility, no further efforts under this project would be undertaken to replant the trees.

c. Project Feature Summary. Table 6-3 summarizes project data.

TABLE 6-3. Gardner Division Project Feature Summary Table

Feature	Measurement	Unit of Measure
Side Channel Protection and Enhancement		
O'Dell Chute Dredging		
Length	5,000	feet
Bottom Wic...	...	feet
Depth Below Flat Pool	7.5	feet
Side Slopes	Vertical	--
Dredged Amount	51,400	cubic yards
O'Dell Chute Rock Closure Structure-Access Dredging		
Bottom Width	50	feet
Depth Below Flat Pool	6	feet
Side Slopes	Vertical	--
Dredged Amount	31,600	cubic yards
Total Excavation/Dredging [1]	83,000	cubic yards
O'Dell Chute Rock Closure Structure-Construction		
Approximate Height	9	feet
Depth Rock Placed Below Chute Bottom	3	feet
Structure Top Width	5	feet
Slope	2:1	Horizontal: Vertical
Length	300	feet
Rock Quantity	4,400	tons
Dredged Material Placement Site		
Material for Placement	83,000	cubic yards
Placement Area	60-80	acres
Earth Work for Berm Construction	3,200	cubic yards
Maximum Placement Depth	8	inches
Shoreline Protection		
Linear Length	3,200	feet
acement	7,500	
Bedding Stone Quantity	9,700	tons
Reforestation		
Field Elevations	477-480	feet MSL
Mast Tree Plantings	67	acres
Pin Oak	1,005	trees
Sycamore	536	trees
Bur Oak	670	trees
Northern Pecan	670	trees
Swamp White Oak	670	trees
Total Trees	3,551	trees

[1] All dredged material amounts were calculated using land survey information and three-dimensional computer analysis programs.

d. Construction Considerations.

(1) Storm Water Pollution/Erosion Control. The potential for storm water pollution during construction is minimal for this project. Storm water runoff from nearly all construction activity would be contained within the confines of the Gardner Division. Overall, the long-term storm water runoff characteristics of the site would not be expected to change.

(2) Permits. A public notice, as required by Section 404 of the Clean Water Act, will be made prior to submission of this report for final approval. A Section 401 water quality certificate from the State of Illinois and a Section 404(b)(1) Evaluation will be included in the final submission of this report. Because all land disturbances associated with this project are addressed in the 404(b)(1) Evaluation, a National Pollutant Discharge Elimination System (NPDES or Section 402) permit for storm water discharges will not be required.

(3) Historic Properties. Portions of the Gardner Division have a low to moderate potential for containing buried archeological sites—both prehistoric and historic in origin. However, these islands are covered by recent alluvium that varies in depth. Given these facts, limits have been placed on how deep that soil disturbance can extend on different parts of the island.

If, despite these limitations on disturbance, this project uncovers an item or item that might be of archaeological, historical, or architectural interest, or if important data come to light in the project area, the Corps will ensure that reasonable efforts to avoid or minimize harm to the property are made until the significance of the discovery can be determined as provided for in 36 CFR 800.11.

(4) Construction Sequence. The probable construction sequence is summarized in Table 6-4; however, no sequence will be required contractually.

e. Operational Considerations. This project has no general operating requirements.

f. Maintenance Considerations. The proposed features have been designed to ensure low annual maintenance requirements. Maintenance may include performing shoreline inspections, adding riprap to the closure structure and to the shoreline protection locations, and performing routine tree planting maintenance activities. The estimated annual maintenance costs are presented in Table 8-2. These quantities and costs may change during final design.

TABLE 6-4. Probable Construction Sequence

Sequence	Construction Work Item	Instructions	Purpose
1	Side Channel Dredging	Dredge during elevated water conditions.	Dredging during elevated water conditions will improve site accessibility.
2	Place Dredged Material on Placement Site	Minimize impact to shoreline vegetation (especially mature trees).	Placing material prior to tree planting will give the material sufficient opportunity to dewater.
3	Construct O'Dell Chute Closure Structure	Perform after access dredging.	Must perform after access dredging in order for contractors to work at the proposed site.
4	Prepare Agricultural Fields for Planting	Allow dredged material to drain, and incorporate (plow, etc.) into original land. Disk fields prior to planting.	Increases mast tree survival
5	Mast Trees*	Plant between March 1 and May 15 or after October 1 and before December 10. Plant after dredged material site has been dried and incorporated. Ensure fields have been disked prior to planting.	Increases mast tree survival
6	Excavate Shoreline for Protection	Do not clear trees between May 1 and August 31. Do not clear trees when bald eagles are present. Perform vegetation and debris removal prior to excavation. Place rock protection at a reasonable time after excavation has been completed. Perform rock placement during high water to ease boat access to sites.	Reduce the impact to endangered species. Reduce further shoreline erosion.
7	Shoreline Protection*	Place rocks along shoreline during higher water conditions.	Shoreline will not be accessible during low-water conditions.

* Mast Tree Planting and Shoreline Stabilization are interchangeable and/or could occur simultaneously for construction purposes.

7. SCHEDULE FOR DESIGN AND CONSTRUCTION

Table 7-1 presents the schedule for project completion steps.

TABLE 7-1. Project Implementation Schedule

Requirement	Scheduled Date
Submission of Draft DPR for review to Corps of Engineers Mississippi Valley Division	Oct 99
Distribution of DPR for public and agency review	Mar 00
Submission of final DPR to Mississippi Valley Division	Sep 00
Receive plans and specification funds	Sep 00
Construction approval by Mississippi Valley Division	Oct 00
Independent Technical Review of plans and specifications	Oct 00
Advertise contract	Nov 00
Award contract	Jan 01
Complete construction	Sep 03

8. COST ESTIMATES

A discussion of the basis for project element and contingency costs is presented in Appendix J. This appendix includes an analysis of the fully funded estimate (FFE) and the current work estimate (CWE). Table 8-1 compares these costs.

TABLE 8-1. Gardner Division Habitat Rehabilitation and Enhancement
Fully Funded Estimate vs. Current Work Estimate
August 2000 Price Level

ACCT CODE	ITEM	FFE	CWE
01	LANDS AND DAMAGES	$ 400.00	$ 400.00
02	RELOCATIONS	$	$
06	FISH AND WILDLIFE FACILITIES	$2,888,669.00	$2,810,672.00
30	PLANNING ENGINEERING AND DESIGN	$ 695,000.00	$ 695,000.00
31	CONSTRUCTION MANAGEMENT	$ 268,320.00	$ 260,000.00
	TOTAL	$3,852,389.00	$3,766,072.00

The FFE was calculated based on the proposed construction schedule, expected escalation costs, and a contingency factor, and represents the money expected to be spent at the end of project construction. The CWE, with a 20- percent contingency factor, was used for annualized costs in the incremental analysis and is shown in a detailed estimate of project design and construction costs as presented in Table 8-2.

A detailed estimate of operation, maintenance, and rehabilitation costs is presented in Table 8-3. Table 8-4 presents the estimated annual monitoring costs. These tables use the August 2000 price levels.

TABLE 8-2. Gardner Division Habitat Rehabilitation and Enhancement Project Cost Summary, August 2000 Price Level

Acct Code	Item	Quantity	Unit	Unit Price	Amount	Contingency	Cont. %
01	**LANDS AND DAMAGES**						
	Real Estate	1	LS	$ 400.00	$ 400.00	$	0%
02	**Relocation**	1	LS	$	$ -	$	0%
06	**FISH AND WILDLIFE FACILITIES**						
06.3	**WILDLIFE FACILITIES AND SANCTUARIES**						
	Shoreline Protection						
	Illinois Gradation No. 5 erosion stone	16,600	tons	$ 40.34	$ 669,644.00	$ 133,928.80	20%
	Illinois Gradation CA6 bedding stone	9,700	tons	$ 36.33	$ 352,401.00	$ 70,480.20	20%
	Clearing and Grubbing [1]	1.4	acres	$ 3,546.77	$ 4,965.48	$ 993.10	20%
	Debris Removal [2]	3,200	linear foot	$ 3.55	$ 11,360.00	$ 2,272.00	20%
	Grade Shoreline (Excavate/Place) [3]	7,500	cubic yards	$ 1.75	$ 13,125.00	$ 2,625.00	20%
	TOTAL	**Shoreline Protection**			**$ 1,051,495.48**	**$ 210,299.10**	
	Side Channel Protection and Enhancement (O'Dell Chute Dredging)						
	Mobilization/Demobilization	1	lump sum	$ 238,878.00	$ 238,878.00	$ 47,775.60	20%
	Dredge Cut (Hydraulic)	51,400	cubic yards	$ 4.17	$ 214,338.00	$ 42,867.60	
	Dredged Material Placement	51,400	cubic yards	$ 2.10	$ 107,940.00	$ 21,588.00	20%
	Side Channel Protection and Enhancement (O'Dell Chute Closure Structure Dredging)						
	Mobilization/ Demobilization	0	lump sum	$ 238,878.00	$ -	$	20%
	Dredge Cut (Hydraulic)	31,600	cubic yards	$ 4.17	$ 131,772.00	$ 26,354.40	20%
	Dredged Material Placement	31,600	cubic yards	$ 2.10	$ 66,360.00	$ 13,272.00	20%
	Side Channel Protection and Enhancement (O'Dell Chute Closure Structure)						
	400 pound stone [4]	4,400	tons	$ 37.55	$ 165,220.00	$ 33,044.00	20%
	Side Channel Protection and Enhancement (Dredged Material Placement Site)						
	Construct and Shape Berm	3,200	cubic yards	$ 10.48	$ 33,536.00	$ 6,707.20	20%
	Level Material [5]	373,500	square yards	$ 0.37	$ 138,195.00	$ 27,639.00	20%
	TOTAL	**Side Channel Protection/ Enhancement**			**$ 1,096,239.00**	**$ 219,247.80**	
	Reforestation [6]						
	Soil Preparation (Plow) [7]		acres	$ 32.12	$ 2,152.04	$ 430.41	20%
	Disk Fields (3 times)	201	acres	$ 7.14	$ 1,435.14	$ 287.03	20%
	Pin Oak	1,005	tree	$ 40.34	$ 40,541.70	$ 8,108.34	20%
	Sycamore	536	tree	$ 40.34	$ 21,622.24	$ 4,324.45	20%
	Bur Oak	670	tree	$ 40.34	$ 27,027.80	$ 5,405.56	20%
	Northern Pecan	670	tree	$ 40.34	$ 27,027.80	$ 5,405.56	20%
	Swamp White Oak	670	tree	$ 40.34	$ 27,027.80	$ 5,405.56	20%
	Weed Barrier at Trees	3,551	tree	$ 4.86	$ 17,257.86	$ 3,451.57	20%
	Herbicide Application [8]	3,551	tree	$ 3.02	$ 10,724.02	$ 2,144.80	20%
	Cover Crop (red top grass/wild rye grass)	67	acres	$ 299.95	$ 20,096.65	$ 4,019.33	20%
	TOTAL	**Reforestation**			**$ 194,913.05**	**$ 38,982.61**	
	FISH AND WILDLIFE FACILITIES COST SUBTOTAL				$ 2,342,647.53		
	Contingencies Subtotal					$ 468,529.51	
	Corrections [9]				$ (505.03)		
	FISH AND WILDLIFE FACILITIES COST TOTAL				$ 2,810,672.00		

TABLE 8-2 (Continued)

0	**PLANNING ENGINEERING AND DESIGN**	
	Definite Project Report	$ 580,000.00
	Plans and Specifications	$ 60,000.00
	Engineering During Construction	$ 55,000.00
	SUBTOTAL	$ 695,000.00
1	**CONSTRUCTION MANAGEMENT**	
	Contract Administration	$ 137,800.00
	Shop Drawing Review	$ 49,400.00
	Inspection and Quality Assurance	$ 72,800.00
	SUBTOTAL	$ 260,000.00
	TOTAL PROJECT COST	$ 3,766,072.00

Notes:

[1] Clearing and Grubbing consists of removing vegetation to allow for shoreline grading.

[2] Debris Removal consists of removing any dead trees, rocks, and other items that are along the shoreline which would interfere with the placement of excavated material.

[3] Grade Shoreline consists of excavating materials and then placing the materials in a manner which will result in a more gradual slope for rock placement.

[4] This stone will be used for constructing the closure structure. The cost is slightly less than that required for shoreline protection since the quality of stone required is not specified.

[5] Leveling Material consists of using a bulldozer or similar method during dredged material placement to spread the material across the placement site.

[6] Reforestation will only occur on 67 acres of the dredged material placement site.

[7] Soil Preparation consists of incorporating the dredged material into natural soils.

[8] Herbicide Application is scheduled to occur once after tree planting.

[9] Unit prices were rounded in the MCASES process. To address these rounded numbers and to ensure that the final cost estimate provided in this chapter is consistent with the Appendix, this correction factor was added.

TABLE 8-3. Estimated Annual Operation and Maintenance Costs
(August 2000 Price Level)

Operation				$	
Maintenance					
Shoreline Protection Inspection	40	Hr	$ 25.00	$	1,000
Riprap for Shoreline	29	Ton	$ 38.00	$	1,102
Riprap for Closure Structure	5	Ton	$ 38.00	$	190
Planting Maintenance	67	Acre	$ 15.00	$	1,005
Rehabilitation [1]			$ -	$	
			Subtotal:	$	3,297
Contingencies (20%)				$	659
			Total:	$	3,956

[1] Rehabilitation cannot be accurately measured. Rehabilitation is the reconstructive work that significantl y exceeds the annual operation and maintenance requirements identified above and that is needed as a result of major storms or flood events.

TABLE 8-4. Estimated Post-Construction Annual Monitoring Costs
(August 2000 Price Level)

Item			**Annual Cost**
Engineering Data			$ 4,000
Natural Resource Data			$ 2,000
	Subtotal		$ 6,000
	Contingencies (20%)		$ 1,200
		Data Subtotal:	$ 7,200
Planning, Engineering, Design [1]			$ 1,500
		Total:	**$ 8,700**

[1] Includes cost of annual evaluation report.

9. ENVIRONMENTAL EFFECTS

a. Summary of Effects. The Gardner Division is a large, complex site with a variety of terrestrial and aquatic habitats that vary in quantity and quality. Overall goals for the project area are to protect some of these resources from future reductions in quantity and quality and to increase the quantitative and qualitative values of other resources. Increasing the value of some habitat types usually occurs at the expense of other habitat types. In most cases, the trade-off for higher quality habitat is a loss of lower quality habitat. In other cases, habitats of similar quality may be altered in order to carry out management objectives for the site (e.g., conversion of cropfield to bottomland hardwood habitat).

The primary goals for the Gardner Division HREP are to enhance aquatic, wetland, and terrestrial habitat. Project objectives are to protect and restore side channel aquatic habitat for the benefit of fisheries and other aquatic life, to protect existing floodplain terrestrial habitat from shoreline erosion, and to restore diversity of woody vegetation on floodplain terrestrial habitat for the benefit of resident and migratory wildlife. Management measures selected to meet these objectives include dredging in O 'Dell Chute and constructing a closure structure, placing riprap bank protection on selected islands within the Gardner Division complex, and planting mast-producing trees on Long Island's eastern agricultural field.

The management measures planned for this project are consistent with and support the goals of the North American Waterfowl Management Plan and the Partners in Flight Program.

b. Economic and Social Impacts.

Community and Regional Growth. No short- or long-term impacts to the growth of the community or region would be realized as a result of the recommended plan.

Community Cohesion. The proposed habitat restoration project would not impact community cohesion. No public opposition has been expressed, nor is any expected.

Displacement of People. The project would not result in any residential relocations.

Property Values and Tax Revenues. The project would have no direct impact on property values or related tax revenues. Project lands are owned by the Corps of Engineers and managed by the USFWS and the State of Illinois for wildlife management.

Public Facilities and Services. Construction activity may cause some temporary disruption of recreational use in the project area; however, the proposed habitat rehabilitation and enhancement project allows for increased recreation potential by providing opportunities for hunting and fishing, as well as the non-consumptive recreational enjoyment of wildlife.

Life, Health, and Safety. The proposed project poses no threats to the life, health, or safety of recreationists or others in the area.

Business and Industrial Activity. Changes to business and industrial activity during project construction would be insignificant; no long-term impacts would result. The project would require no business relocations.

Employment and Labor Force. There could be a slight increase in short-term employment opportunities resulting from project construction. There would be no effect on permanent employment or labor force in Adams County, Illinois.

Farm Displacement. The eastern agricultural field on the island is currently cultivated under an agricultural lease with a portion of the crop left in the field after harvest to provide a food source for wildlife management. As part of the proposed project, this field would be planted in mast trees. No farms would be displaced as a result of the project. The proposed action would not result in the conversion of any prime, unique, or designated state or locally important farmland to nonagricultural uses.

Aesthetics. The project would improve existing habitats for fish and other aquatic organisms and increase food and shelter for terrestrial wildlife, all of which would enhance the aesthetic environment of the Gardner Division complex.

Noise Levels. Project construction would generate a temporary increase in noise levels; however, the project is located on a complex of islands in the Mississippi River, away from any sensitive receptors or residential development.

c. Natural Resources Impacts. Effects of the project on natural resources were evaluated using WHAG.[7] This habitat evaluation method was used during project planning to evaluate various features in terms of increased benefits to wildlife resources. Optimization of benefits (expressed as habitat units, or HUs) in relation to project cost is considered to be the goal of feature selection. Results of the habitat evaluation are summarized in Table 5-1, with a more detailed analysis in Appendix D. Assessment of project impacts also was based on experience and sound management practices.

The proposed side channel protection/restoration feature would involve constructing a rock closure structure in O'Dell Chute to reduce future inflows of sediment into the side channel and removing some of the sediment currently in the chute by hydraulic dredging. Material removed from the channel would be placed on the adjacent agricultural field on the eastern side of Long Island. Placement of this material on the field would result in a slight raise in elevation and should enhance the site for implementation of the mast tree planting feature. Placement of rock shoreline protection on the selected islands would involve cutting and filling of the adjacent streambank to achieve the degree of slope needed for stabilization. This would require clearing several acres of mostly woody vegetation on existing overbank areas. This initial negative effect of construction is expected to be more than offset by protecting many additional acres of bottomland hardwood forest that would be lost to erosion if the shoreline protection feature was not implemented. Additionally, minor adjustments in the placement design should allow the retention of several large mature cottonwoods near the shore of La Grange Island. Planting mast-producing trees on a portion of the eastern agricultural field and allowing the remainder of the field to naturally revegetate would result in a loss of cropfield habitat in the Gardner Division complex. However, re-establishment of bottomland hardwood forest with a significant component of mast-producing tree species would restore the historic native plant community to this tract, increase diversity of plant species, and improve habitat quality for a wide variety of resident and migratory wildlife.

(1) Aquatic Habitat. Construction activity would temporarily increase turbidity immediately downstream of the mouth of O'Dell and Canton Chutes. Material dredged from

[7] D. L. Urich and others, "Habitat Appraisal of Private Land in Missouri," *Wildlife Society Bulletin* 12 (1984): 350-356.

O'Dell Chute would be placed on Long Island's eastern agricultural field. Minor increases in turbidity during construction are not expected to have any long-term impacts on aquatic resources. Disruption and loss of some benthic organisms would occur at construction sites, but these areas should be recolonized following project completion.

Fish use of O'Dell Chute is expected to increase as a result of the project, particularly during winter months. Construction of the closure structure is anticipated to reduce current velocities in O'Dell Chute, as well as reduce future sedimentation in this side channel. Dredging would increase the deep water area of the chute. For these reasons, the side channel protection/restoration feature is expected to increase the quality of existing side channel habitat and help to ensure its future availability in the Gardner Division complex.

Placement of rock shoreline protection on selected islands is expected to benefit aquatic resources by increasing substrate diversity and helping to maintain diversity of flow within side channels. Additional discussion of aquatic and water quality impacts is contained in Appendix B - Clean Water Act, Section 404(b)(1) Evaluation.

(2) Wetland and Floodplain Terrestrial Habitat. The primary benefits to wetland and floodplain terrestrial habitat include: (1) the preservation of existing bottomland hardwood forest acreage from future losses due to riverbank erosion; and (2) an increase in total bottomland hardwood forest acreage. Increases in forest acreage would be accomplished through a combination of active planting of mast-producing trees and passive enablement of natural succession processes on historically cultivated fields on Long Island.

The proposed project would take place entirely within the Mississippi River floodplain. No measurable change in floodplain storage would occur as a result of the proposed project, and the project would not directly or indirectly induce additional development within the floodplain.

(3) Endangered Species. The following is a list of federally endangered or threatened species potentially found in Adams County, Illinois:

Status	Common Name	Scientific Name
T	Bald Eagle	*Haliaeetus leucocephalus*
E	Fat Pocketbook Pearly Mussel	*Potamilus capax*
E	Higgins' Eye Pearly Mussel	*Lampsilis higginsi*
E	Indiana Bat	*Myotis sodalis*
E	Gray Bat	*Myotis grisescens*
T	Eastern Prairie Fringed Orchid	*Platanathera leucophaea*

T = threatened
E = endangered

The bald eagle occurs as a winter resident in the vicinity of Gardner Division. Bald eagle nesting was last recorded on Shandrew Island within the Gardner Division complex. Tree clearing for project construction would be limited to a zone approximately 20 feet wide on island shorelines immediately adjacent to rock placement sites. No tree clearing would take place in the interior of any islands. If necessary, clearing and other construction activity would be scheduled for periods when eagles are not present. The proposed project would not affect bald eagles or their habitats.

The fat pocketbook and Higgins' eye pearly mussels usually inhabit coarse gravel and cobble substrates. Because of the dominance of sand and silty materials in the project area, these species are not likely to occur in side channel or shoreline portions of the project area. For this reason, the proposed action is not expected to impact these mussel species.

The USFWS reported that a radiotelemetry investigation of Indiana bats identified a maternal roost tree located on the southern portion of Long Island. No trees would be cleared on the interior of any islands. Tree clearing for placement of rock shoreline protection would not be conducted during the April 1-September 30 timeframe. Prohibiting clearing activity during this 4-month time window would avoid potential impacts to summer roosting Indiana bats.

Gray bats prefer caves for both summer and winter habitat. No caves would be disturbed by project construction, and no caves are known to exist in the project area.

The eastern prairie fringed orchid occurs most frequently in mesic to wet unplowed prairies and meadows, but has also been found in old fields and roadside ditches, bogs, fens, and sedge meadows. None of these habitat types are found in the areas proposed for project feature construction. For this reason, no effects to this species are expected to result from the proposed project.

The state listed veery (*Catharus fuscescens*) and river otter (*Lutra canadensis*) have been identified as potentially occurring in the backwater complex of Quincy Bay, located at approximate RM 329.0 to 332.0L. Neither species would be adversely affected by construction of proposed project features.

(4) Hazardous, Toxic, and Radioactive Waste. A hazardous, toxic, and radioactive waste (HTRW) compliance assessment was conducted and is included as Appendix E to this report. A review of project features determined that there is very little potential for an HTRW impact. Very low concentrations of contaminants could be bound up in a few isolated spots in the dredge cut areas, and effluents from the dredged material placement area could contain low concentrations of pesticides, herbicides, and constitutes of fertilizers such as nitrates. However, these contaminants are expected to be well within the regulatory limits and would be addressed by complying with the water quality standards required for all dredging operations. No other project features should have any HTRW impact.

d. Historic Properties. No historic properties are expected to be affected by the proposed action. As summarized in Section 2, deposits of historical or post-settlement alluvium ranging in thickness from 20 inches (50 centimeters) to well over 6.6 feet (2 meters) cover the entire island complex, and the sites of proposed construction have low geomorphological potential for containing buried prehistoric or historic sites. In a letter dated June 23, 1999, the State Historic Preservation Officer (SHPO) concurred with the Corps' opinion that the project will have **no effect** on properties listed on or eligible for listing on the National Register of Historic Places (see Appendix A).

If the project uncovers an item or items which may be of archeological, historical, or architectural interest, or if important new data comes to light in the project area, the Corps will ensure that reasonable efforts to avoid or minimize harm to the property are made until the significance of the discovery can be determined as per 36 CFR 800.13.

e. Human Use. No mining activity is present in the project area, and no use of mineral resources would be affected by this project. The proposed action will not result in the conversion

of any prime, unique, or designated state or locally important farmland to nonagricultural uses. Construction activity may cause some temporary disruption of recreational use in the project area. No negative effects to navigation will result from the proposed actions. Placement of rock shoreline protection on islands directly adjacent to the main channel and main channel border areas may potentially have a beneficial effect on navigation by reducing sediment inflow resulting from shoreline erosion.

f. Cumulative Impacts. Although short-term impacts are likely to occur to local and migratory animals during construction, no negative cumulative impacts to fish or wildlife are expected. The proposed habitat measures should have positive long-term benefits to fish and wildlife using the project area. This project, in concert with other EMP HREPs on the Upper Mississippi River, should counter some of the long-term adverse impacts to the river ecosystem such as sedimentation, pollution, and general declines in riverine and floodplain habitat.

g. Adverse Impacts Which Cannot Be Avoided. Unavoidable adverse impacts will primarily result from the clearing of vegetation for placement of rock shoreline protection and closure structure construction. Clearing of vegetation will be limited to the minimum extent necessary for project construction.

h. Short-Term Versus Long-Term Productivity. Construction impacts (land clearing, equipment movement, etc.) will temporarily disrupt wildlife as well as human use. Conversion of the eastern agricultural field from row crop production to bottomland hardwood forest with mast-producing tree species as a significant component would result in a short-term loss of some herbaceous food plants used by some species of migratory waterfowl. However, long-term productivity would be enhanced as woody vegetation develops and matures, providing higher quality food and cover for a more diverse group of wildlife species.

Long-term productivity should be preserved by protecting existing bottomland hardwood habitat and side channel aquatic habitat. Long-term productivity also should be enhanced by increases in bottomland hardwood habitat (particularly mast-bearing trees) and substrate diversity in aquatic habitats.

i. Irreversible or Irretrievable Resource Commitments. The purchase of materials and the commitment of labor, fuel, and machinery to construct the project are considered irretrievable. Other than the aforementioned, none of the proposed actions are considered irreversible.

j. Relationship of the Proposed Project to Land-Use Plans. The proposed action is in agreement with the *Land Use Allocation Plan.*[8] The proposed project is not in conflict with any land-use plans currently being used for the site.

k. Compliance with Environmental Quality Statutes. Compliance with applicable environmental statutes is summarized in Table 9-1.

[8] U.S. Army Corps of Engineers, *Land Use Allocation Plan, Nine-Foot Channel Navigation Project, Mississippi River Pools 11-22* (1992).

TABLE 9-1. Relationship of Plans to Environmental Protection Statutes and Other Environmental Requirements

Federal Policies	Compliance
Archaeological and Historic Preservation Act, 16 U.S.C. 469, et seq.	Full compliance
Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	Full compliance
Clean Water Act, 33 U.S.C. 1857h-7, et seq.	Full compliance
Endangered Species Act, 16 U.S.C. 1531, et seq.	Full compliance
Federal Water Project Recreation Act, 16 U.S.C. 460-1(12), et seq.	Full compliance
Fish and Wildlife Coordination Act, 16 U.S.C. 601, et seq.	Full compliance
Land and Water Conservation Fund Act, 16 U.S.C. 460/-460/-11, et seq.	Not applicable
National Environmental Policy Act, 42 U.S.C. 4321, et seq.	Full compliance
National Historic Preservation Act, 16 U.S.C. 470a, et seq.	Full compliance
Rivers and Harbors Act, 33 U.S.C. 403, et seq.	Full compliance
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Not applicable
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Full compliance
Flood Plain Management (Executive Order 11988)	Full compliance
Protection of Wetlands (Executive Order 11990)	Full compliance
Farmland Protection Act	Full compliance
Analysis of Impacts on Prime and Unique Farmland (CEQ Memorandum, 11 Aug 80)	Full compliance

NOTES:

a. Full compliance. Having met all requirements of the statute for the current stage of planning

b. Partial compliance. Not having met some of the requirements that normally are met in the current stage of planning.

c. Noncompliance. Violation of a requirement of the statute.

d. Not applicable. No requirements for the statute required.

10. PROJECT PERFORMANCE ASSESSMENT MONITORING

This section summarizes the monitoring and data collection aspects of the project. The primary project objectives have been summarized elsewhere in this document, and the performance assessment is designed to gauge progress toward meeting these objectives.

Table 10-1 presents overall types, purposes, and responsibilities of monitoring and data collection.

Table 10-2 presents actual monitoring and data parameters grouped by project phase, as well as data collection intervals.

Table 10-3 presents sedimentation transect assignment to project objectives for post-construction monitoring.

Table 10-4 presents the post-construction evaluation plan, which displays the specific parameters and the levels of enhancement that the project hopes to achieve.

TABLE 10-1. Gardner Division Monitoring and Performance Evaluation Matrix

Project Phase	Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Implementation Instructions
Pre-Project	Sedimentation Problem Analysis	Define system-wide problem. Evaluate planning assumptions.	USFWS	USGS (UMESC)	LTRM	--
	Pre-Project Monitoring	Identify and define problems at HREP site. Establish need of proposed project features.	Sponsor	Sponsor	Sponsor	--
	Baseline Monitoring	Establish baselines for performance evaluation.	Corps	Field Station or Sponsor through Cooperative Agreements or Corps	HREP/-Sponsor	See Table 10-2.
Design	Data Collection for Design	Include quantification of project objectives, design of project, and development of performance evaluation plan.	Corps	Corps	HREP	See Table 10-2.
Construction	Construction Monitoring	Assess construction impacts; assure permit conditions are met.	Corps	Corps	HREP	See State Section 401 Stipulations.
Post-Construction	Performance Evaluation Monitoring	Determine success of project as related to objectives.	Corps (quantitative) Sponsor (field observations)	Sponsor through O&M, or Corps	HREP/-Sponsor	See Table 10-4

TABLE 10-2. Gardner Division Resource Monitoring and Data Collection Summary [1]

Type Measurement	Water Quality Data						Engineering Data			Natural Resource Data			Sampling Agency	Remarks
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Jun-Sep	Dec-Mar								
POINT MEASUREMENTS														
Water Quality Stations [2]														
Turbidity	2W	M			2W	M							Corps	
Secchi Disk Transparency	2W	M			2W	M							Corps	
Suspended Solids	2W	M			2W	M							Corps	
Dissolved Oxygen	2W	M			2W	M							Corps	
Specific Conductance	2W	M			2W	M							Corps	
Water Temperature	2W	M			2W	M							Corps	
pH	2W	M			2W	M							Corps	
Total Alkalinity	2W	M			2W	M							Corps	
Chlorophyll	2W	M			2W	M							Corps	
Velocity	2W	M			2W	M							Corps	
Water Depth	2W	M			2W	M							Corps	
Ice Thickness		M				M							Corps	
Snow Depth		M				M							Corps	
Wind Direction	2W	M			2W	M							Corps	
Wind Velocity	2W	M			2W	M							Corps	
Wave Height	2W	M			2W	M							Corps	
Air Temperature	2W	M			2W	M							Corps	
Percent Cloud Cover	2W	M			2W	M							Corps	
Elutriate Analysis [3]		1											Corps	
Boring Stations [4]														
Geotechnical Borings							1						Corps	

TABLE 10-2 (Cont'd)

Type Measurement	Water Quality Data						Engineering Data			Natural Resource Data			Sampling Agency	Remarks
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar								
TRANSECT MEASUREMENTS														
Sedimentation Transects[5] Hydrographic Soundings							1	1	5Y				Corps	
AREA MEASUREMENTS														
Mast Tree Survey[6]										1	1	5Y	Corps	
Mapping[7]														
Aerial Photography/ Remote Sensing											1		Corps	

LEGEND

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

TABLE 10-2 (Cont'd)

[1] See plates 12 and 13 for monitoring sites; plates 10 and 11 for boring locations.

[2] Water Quality Stations

Pre-Project
W-M336.6S, W-M333.8Q, W-M333.0N, W-M332.7M, W-M333.3K

Post-Project
W-M336.6S

[3] Elutriate Analysis

E-M366.1M, E-M334.2N, E-M333.4M

[4] Corps of Engineers Geotechnical Borings

Station Code	Geotechnical Boring	Date
GD-94-1	Long Island Lake	February 8, 1994
GD-96-1	O'Dell Chute	September 19, 1996
GD-96-2	O'Dell Chute	September 19, 1996
GD-96-3	O'Dell Chute	September 19, 1996
GD-96-4	O'Dell Chute	September 19, 1996
GD-96-5	Shandrew Island Chute	September 19, 1996
GD-96-6	Shandrew Island Chute	September 19, 1996
GD-96-7	Shandrew Island Chute	September 19, 1996
GD-96-8	Shandrew Island Chute	September 19, 1996
GD-96-9	Shandrew Island Chute	September 19, 1996
GD-96-10	Shandrew Island Chute	September 19, 1996
GD-96-11	Shandrew Island Chute	September 19, 1996

[5] Sedimentation Transects

Pre-Project Phase

SM337.0U, SM337.0S, SM336.5S, SM336.6K, SM336.6L, SM336.5R, SM336.4F, SM336.4H, SM335.2G, SM335.2F, SM334.1N, SM334.1M, SM332.8L, SM 332.8K

Post-Project Phase

SM336.5S, SM336.5R, SM335.X

[6] Mast Tree Survey (Post-Construction Phase)

[7] Mapping (Pre-Construction Phase)
April 1994 Color Aerial Photography
July 1995 Infrared Aerial Photography
November 1995 Black and White Aerial Photography
September 1996 Color Oblique Photography
Brown's photographs and maps for these river miles also were reviewed (dated early 1930's)

TABLE 10-3. Gardner Division Rehabilitation and Enhancement Project Sedimentation Transect Project Objectives Evaluation

	Project Objectives to Be Evaluated	
Transect	Increase Overwintering for Fish	Reduce Sedimentation in Chutes
SM336.5S-SM336.5R SM336.6	X	X
SM 335.X*	X	X

* This transect location will be near the downriver entrance to O'Dell Chute. Exact mileage will be determined during the performance evaluation process.

TABLE 10-4. Gardner Division Post-Construction Evaluation Plan

Enhancement Potential									
Goal	**Objective**	**Enhancement Feature**	**Unit**	**Year 0 Without Alternative**	**Year 1 With Alternative**	**Year 25 With Alternative**	**Year 50 Target With Alternative**	**Feature Measurement**	**Annual Field Observations by Site Manager**
Enhance Wetland and Terrestrial Habitat	Increase bottomland hardwood diversity	Establish hardwood trees on suitable sites in existing agricultural fields	Percent survival	NA	100%	50%	20%	Tree count/random sample	Estimate effective acreage and wildlife use
	Maintain existing terrestrial habitat	*Shoreline* protection	*Linear feet of* riprapped shoreline [1]	*0*	*7700*	*7700*	*7700*	*Surveys/aerial* photo interpreta-tion/mapping	*Maintenance of* bottomland hardwood habitat
Enhance Aquatic Habitat [2]	Increase habitat for over-wintering fish	Restore/protect O'Dell Chute (closure structure plus dredging)	Acres with depth of 6' or greater	39	39	39	39	Fish surveys	Fish presence or absence; reports of kills
	Reduce sedimentation in side channels	Rock placement along island tips and shorelines	Depth below flat pool at L/D 21	Varies	-8	-7	-6	Sediment transects	Observed depths in chute
	Increase habitat diversity		Linear feet of riprapped shore line	0	7700	7700	7700	Fish surveys: presence, species/age composition	Presence of fish, fishing activity

[1] Linear feet include riprapped shore line for both EMP and channel maintenance work.

[2] Currently, water quality improvement objectives are not needed for this project. The purpose of monitoring is to ensure that constructing a closure structure does not degrade water quality in O'Dell Chute.

11. REAL ESTATE REQUIREMENTS

a. General. Mississippi River Pool 21, Gardner Division Habitat Rehabilitation and Enhancement Project, is a separable element of the Upper Mississippi River System-Environmental Management Program (UMRS-EMP), authorized by Section 1103 of the Water Resources Development Act (WRDA) of 1986, Public Law 99-662, as amended (see paragraph 1.f.).

The multi-location project is located upstream of Mississippi River Lock and Dam 21, between RM 332.5 and 340.2. The project is located on lands owned by the United States of America. The Department of the Interior, USFWS, manages these lands under a cooperative agreement dated February 14, 1963, between the USFWS and the U.S. Army Corps of Engineers.

The USFWS is the sponsor for the project. The USFWS has been a sponsor on several Corps projects and has the experience to perform the required operation and maintenance upon project completion. Management of these project features after construction will be the responsibility of the USFWS.

b. Cooperation Agreement.

Federal Lands. Funding for the initial construction of the project features located on Federal Lands will be 100 percent Federal. Since the project lands are all managed as part of the Upper Mississippi River National Wildlife and Fish Refuge system, the WRDA of 1986 (Public Law 99-662) is the basis for the first cost of Federal funding and provides:

> Section 906. FISH AND WILDLIFE MITIGATION
>
> (e) the first cost of such enhancement
> shall be a Federal cost when:
> (3) such activities are located on
> lands managed as a national wildlife refuge.

A draft Memorandum of Agreement between the Corps of Engineers and the USFWS has been included in this report as Appendix C. Estimated operation and maintenance costs were presented in Table 8-3.

c. Land Interests. No land acquisition will be necessary since the project is located entirely on Government-owned lands.

The provisions of the navigational servitude do not apply. There are no known hazardous, toxic, or radioactive sites within the project area. There are no utilities or facilities that have been identified for relocation.

12. IMPLEMENTATION RESPONSIBILITIES AND VIEWS

a. Corps of Engineers. The U.S. Army Corps of Engineers, Rock Island District, is responsible for project management and coordination with the USFWS, the State of Illinois, and other affected agencies. The Rock Island District will submit the subject Definite Project Report (DPR); program funds; finalize plans and specifications; complete all NEPA requirements; advertise and award a construction contract; and perform construction contract supervision and administration.

b. U.S. Fish and Wildlife Service. The USFWS is the Federal project sponsor and will produce a Coordination Act Report (CAR) for this project. Operation and maintenance of the project, as described in Table 8-3, is the responsibility of the USFWS in accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580. These functions will be further specified in the Project Operation and Maintenance Manual to be provided by the U.S. Army Corps of Engineers prior to final acceptance of the project by the sponsors.

c. Illinois Department of Natural Resources. The ILDNR, the non-Federal project sponsor, has provided technical and other advisory assistance during all phases of the project and will continue to provide assistance during project implementation.

13. COORDINATION, PUBLIC VIEWS, AND COMMENTS

Coordination has been made throughout the planning and design process with the following State and Federal agencies:

Illinois Department of Natural Resources
Natural Resources Conservation Service
U.S. Fish and Wildlife Service
U.S. Environmental Protection Agency
Illinois State Historic Preservation Agency

a. Coordination Meetings. Ongoing coordination with project cooperators was demonstrated by the following meetings:

(1) November 8, 1989. Project site visit with the Corps, USFWS, and ILDNR.

(2) November 21, 1991. General scoping meeting with the Corps, USFWS, and ILDNR.

(3) October 21, 1992. WHAG meeting with the Corps, USFWS, and ILDNR.

(4) June 28, 1995. General scoping meeting with the Corps and USFWS.

(5) August 14, 1996. General scoping meeting with the Corps, USFWS, and ILDNR.

(6) November 13, 1997. General coordination meeting with the Corps, USFWS, and ILDNR.

(7) January 15, 1998. General coordination meeting with the Corps, USFWS, and ILDNR.

(8) October 28, 1998. General coordination meeting with the Corps, USFWS, and ILDNR.

(9) November 17, 1998. Corps in-house meeting; general project discussion.

(10) March 18, 1999. Corps in-house meeting; general project discussion.

(11) April 19, 1999. General coordination meeting with the Corps, USFWS, and ILDNR.

(12) May 5, 1999. Corps in-house meeting; general project discussion.

(13) May 27, 1999. WHAG meeting with the Corps, USFWS, and ILDNR.

(14) July 26, 1999. Telephone conference with the Corps and USFWS to discuss project features.

(15) October 29, 1999. Corps in-house meeting to initiate Independent Technical Review (ITR) of the DPR.

(16) February 17, 2000. Corps in-house meeting to initiate value engineering study.

b. Coordination by Correspondence. The following are contained in Appendix A - Correspondence:

(1) Funding Request for Project Planning, Gardner Division Restoration, and Fact Sheet dated March 11, 1988.

(2) Letter dated March 17, 1998, from Mike Tryba, District Conservationist, USDA Natural Resources Conservation Service, enclosing soil erosion information on the Bear Creek Watershed in Adams County.

(3) Letter dated June 23, 1999, from Ms. Anne Haaker, Deputy State Historic Preservation Officer, Illinois Historic Preservation Agency, concurring with Corps' opinion that the proposed project will have no effect on any historic properties.

(4) Fish and Wildlife Coordination Act Report for the Gardner Division HREP, dated January 7, 2000, prepared by the USFWS, Rock Island Field Office.

(5) Letter dated April 28, 2000, from Mr. Dennis L. Kennedy, Office of Water Resources, Illinois Department of Natural Resources, regarding District's application for a Section 404 permit.

(6) Letter dated May 11, 2000, from Mr. Deck Major, Regional Wildlife Biologist, Illinois Department of Natural Resources, regarding review of the Draft Gardner Division DPR.

(7) Stamped "No Objection" by U.S. Fish and Wildlife Service, Rock Island Field Office, dated June 7, 2000, on Rock Island District Public Notice dated May 25, 2000.

(8) Letter dated June 12, 2000, from Mr. Robert W. Schanzle, Permit Program Manager, Illinois Department of Natural Resources, stating no objection to issuance of Permit No. 390600.

(9) Letter dated June 19, 2000, from Mr. James R. Hartwig, Bureau of Land and Water Resources, Illinois Department of Agriculture, stating that the project meets the intent of the Illinois Farmland Preservation Act.

(10) Letter dated June 29, 2000, from Mr. Dennis L. Kennedy, Office of Water Resources, Illinois Department of Natural Resources, requesting additional project information to assist his office in processing the permit.

(11) Letter dated July 11, 2000, from Mr. Michael T. Chezik, Office of Environmental Policy and Compliance, United States Department of the Interior, stating that the Draft Gardner Division DPR adequately addresses their environmental concerns.

(12) Memorandum dated August 8, 2000, from Ms. Karen Westphall, Mark Twain National Wildlife Refuge, providing comments on the Draft Gardner Division DPR.

(13) Letter dated August 22, 2000, from Mr. Bruce Yurdin, Watershed Management Section, Illinois Environmental Protection Agency, issuing certification for the project under Section 401 of the Clean Water Act.

(14) Letter dated August 31, 2000, from Mr. Joseph Raoul, Jr., P. E., Chief, Engineering Division, U.S. Army Corps of Engineers, Rock Island District, to Illinois Department of Natural Resources providing project information.

(15) Letter dated August 31, 2000, from Mr. David L. Martin, Hydraulics Section, U.S. Army Corps of Engineers, Rock Island District, to Mr. Mike Diedrichsen, Illinois Department of Natural Resources, providing hydraulic information on the project.

14. CONCLUSIONS

Full realization of the potential habitat value in the Gardner Division project area has been hindered by ongoing sedimentation of vital side channels and the flood-related loss of a mast tree component, which have led to the loss of important terrestrial and aquatic habitats. Establishing reliable terrestrial food sources and off-channel areas containing reliable aquatic habitat would allow the project area to realize the highest benefit to migratory birds, local wildlife, and wintering fish.

The recommended project features for the Gardner Division Habitat Rehabilitation and Enhancement Project (O'Dell Chute closure structure and dredging, erosion protection for small and large islands, and mast tree plantings) are designed to meet the project's goals of restoring and protecting aquatic, wetland, and terrestrial habitat. These goals would be met by reducing forest fragmentation, increasing bottomland hardwood diversity, maintaining existing terrestrial habitat, increasing habitat for overwintering fish, increasing habitat diversity, and reducing sedimentation in side channels.

Assessment of the future with-project scenario shows definite increases in total habitat units over the 50-year project life for the target species, as well as for a majority of other wetland-dwelling species considered. These increases represent quantification of the projected outputs—improved habitat quality and increased preferred habitat quantity.

The project is consistent with and fully supports the overall goals and objectives of the Upper Mississippi River System-Environmental Management Program, the North American Waterfowl Management Plan, and the Partners in Flight Program.

15. RECOMMENDATIONS

I have weighed the outputs to be obtained from the full implementation of this habitat rehabilitation and enhancement project against its estimated cost and have considered the various alternatives proposed, impacts identified, and overall scope. In my judgment, this project, as proposed, justifies expenditure of Federal funds. I recommend that the Secretary of the Army for Civil Works approve the proposed project to include constructing an emergent rock closure structure; dredging in O'Dell Chute; placing rock protection along shorelines and head ends of selected islands; and planting mast-producing trees on an agricultural field site.

The current estimated Federal construction cost of this project is $2,810,672. Total Federal estimated project cost, including general design and construction management, is $3,766,072.

At this time, I further recommend that funds in the amount of $60,000 be allocated for the preparation of plans and specifications.

William J. Bayles
Colonel, U.S. Army
District Engineer

16. FINDING OF NO SIGNIFICANT IMPACT

I have reviewed the information provided by this Environmental Assessment, along with data obtained from Federal and State agencies having jurisdiction by law or special expertise, and from the interested public. I find that the proposed habitat enhancement project at Gardner Division would not significantly affect the quality of the human environment. Therefore, it is my determination that an Environmental Impact Statement is not required. This determination may be reevaluated if warranted by further developments.

An array of management features and alternatives was considered for habitat enhancement. Features considered were:

a. No Federal Action

b. Side Channel Restoration/Protection

c. Shoreline Protection

d. Reforestation (Mast Tree Planting)

The preferred alternative consists of: protecting and restoring O'Dell Chute by constructing a closure structure and dredging to increase depth, placing riprap on selected islands to prevent erosion and loss of bottomland forest, and reforesting an agricultural field on the east side of Long Island through planting mast-producing trees.

Factors considered in making a determination that an Environmental Impact Statement was not required were as follows:

a. The project is anticipated to improve the value of Gardner Division for migratory and resident birds, fish, and wildlife species.

b. Aside from temporary disturbance during construction periods, no long-term adverse effects to natural or cultural resources are anticipated. No State or Federal endangered or threatened species would be affected by the proposed action.

c. The project is in compliance with Sections 401 and 404 of the Clean Water Act.

d. No significant economic impacts are expected to occur in the project area.

25 September 2000
(Date)

William J. Bayles
Colonel, U.S. Army
District Engineer

APPENDIX A

CORRESPONDENCE

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-15F)

GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 21, MISSISSIPPI RIVER MILES 332.5 THROUGH 340.2
ADAMS COUNTY, ILLINOIS

APPENDIX A
CORRESPONDENCE

CONTENTS

UPPER M ISSISSIPPI RIVER SYSTEM

ENVIRONMENTAL MANAGEMENT PROGRAM (EMP)

FUNDING REQUEST

FOR PROJECT PLANNING

GARDNER DIVISION RESTORATION

MARK TWAIN NWR

INTRODUCTION

Project Authority

The 1985 Supplemental Appropriations Act (Public Law 99-88) provides authorization and appropriation for a ten-year environmental program for the Upper Mississippi River that includes fish and wildlife habitat rehabilitation and enhancement. This proposed project would be funded under this authorization.

Project Location

The Gardner Division of the Mark Twain NWR is located within Pool 21 on the Mississippi River approximately five miles north of Quincy, Illinois (Attachment No. 1). The area represents some of the last high quality old growth bottomland timber in the middle reaches of the Upper Mississippi River system.

Resource Problems and Opportunities

The Gardner Division, a complex of 32+ islands, is subject to yearly floods of the Mississippi River and is rapidly losing its valuable backwater areas and side chutes to siltation and vegetation encroachment. The erosive forces of the spring/fall floods are cutting away the banks and openings to many of the channels and depositing the silt loads in these more shallow waters. Long Island Lake has been reduced in depth from an 8-12 foot deep natural lake to a shallow 2-3 foot deep body devoid of most aquatic vegetation.

Significant opportunities for preserving habitat for migratory birds, aquatic mammals, recreational fisheries, and endangered species are available by reducing this inflow of sedimentation and elimination of bank scouring and cutting.

Backwater complexes such as the Gardner Division are becoming increasingly rare in this reach of the Upper Mississippi. Without restoration, use by wildlife and the public will continue to decline, and this link in the chain of resting and feeding areas for migratory birds and endangered species may be lost.

Proposed Solution and Improvements

Dredging of approximately eight miles of backwater chutes and lake channels will be accomplished to improve fishery and waterfowl habitat and public access to these areas. Spoil will be deposited on abandoned farm units within the islands or removed from the area by pumping onto barges for transport to off-site locations.

A natural high-flow cut (see attachment for location) will be deepened by dragline to permit continuous water exchange through Long Island Lake and to permit flushing of silt deposits during flood stages. The fishery resource will benefit as will waterfowl broods that use this area during the spring and summer months.

Riprap protection will be added along selected north and west sections of the islands to prevent further cutting and bank erosion and the loss of large trees during flooding. These trees serve as important day-use perches for the endangered bald eagle as well as providing a protective aesthetic screen from farming activities for the nature/wildlife photographer and casual visitor who boats along these waterways.

If these actions are not taken, this 6,000-acre backwater complex will continue its degradation into a muddy sump little used by the wildlife resource and of little recreational value to future generations.

EMP Goals and Objectives

This project will restore, protect and vastly improve wildlife and fish habitat that has deteriorated over the years due to siltation, wave action caused by both wind and navigational traffic, and natural flooding. This project addresses the highest priority goal of Upper Mississippi River Basin Association (UMRBA) EMP goals and objectives which is to reduce naturally-occurring impacts to the environment caused by floods, wind and navigation. This project satisfies all the UMRBA EMP eligibility criteria and is sponsored by state and federal agencies, requires no land acquisition and has minimal operation and maintenance costs.

Estimated Engineering and Design Costs

Estimated engineering and design costs for the project are $56,000. The cost would be all federal as the entire project is on federal land. The primary purpose of Gardner Division of the Mark Twain National Wildlife Refuge is to preserve, maintain and improve habitat for migratory wildlife.

Project implementation costs are estimated to be $1,600.000. This figure will be refined during the planning and general design phase.

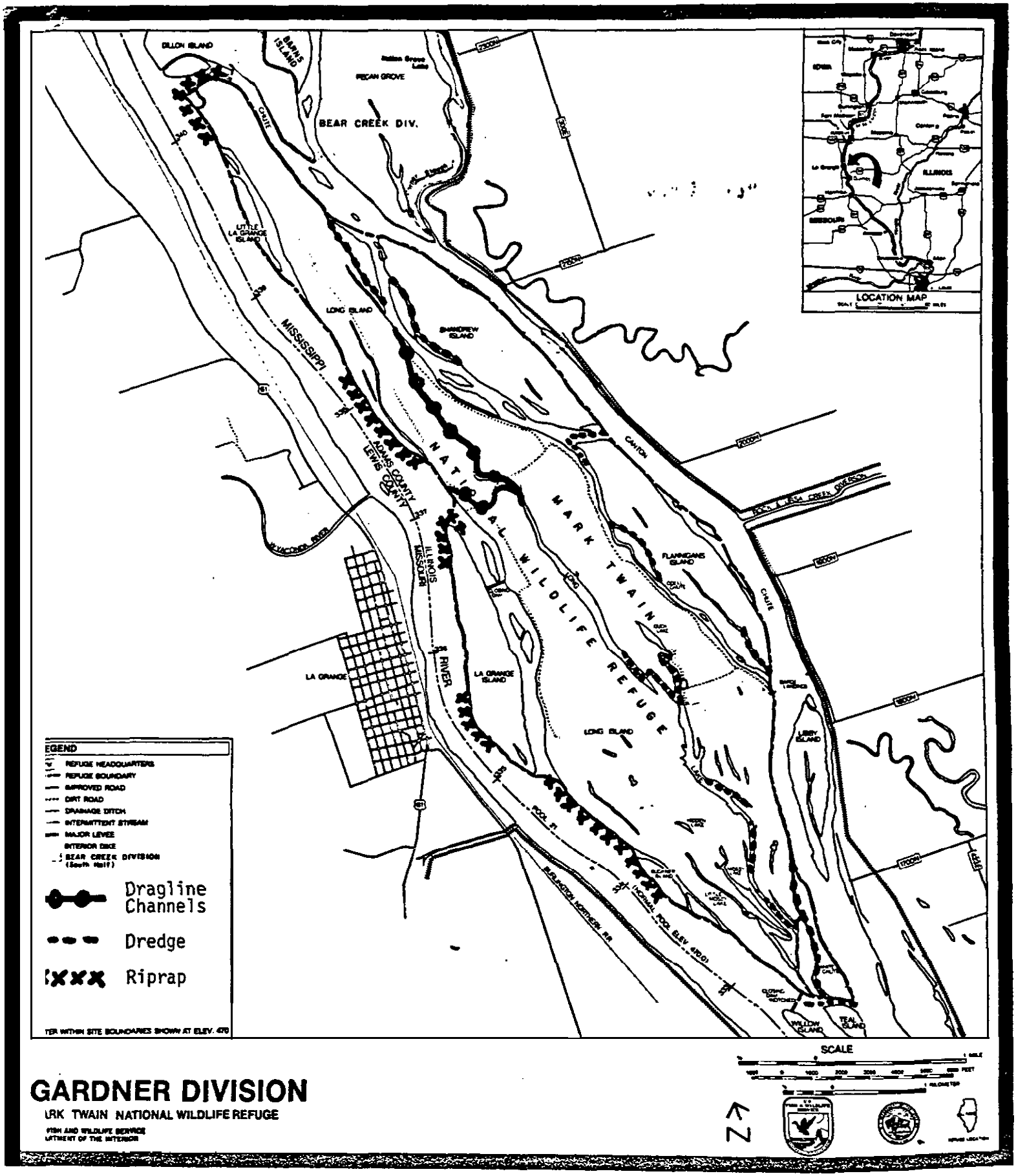
Compliance with the National Environmental Policy Act of 1969 and other environmental statues and regulations would be identified during the engineering and design phase.

Project Participants

The primary project participants would be the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service, with involvement by the Illinois Department of Transportation. The U.S. Army Corps of Engineers will be responsible for the planning and engineering design with assistance on the planning and biological input from the U.S. Fish and Wildlife Service. Construction and project administration will also be handled by the U.S. Army Corps of Engineers.

Project Schedule

It is estimated that planning and general design for this project would be completed within one year following the receipt of the funds.


BEAR CREEK DIV.
LOCATION MAP
MISSISSIPPI
MARK TWAIN NATIONAL WILDLIFE REFUGE
ILLINOIS
MISSOURI
LA GRANGE
LONG ISLAND
LEGEND
Dragline Channels
Dredge
Riprap
SCALE
GARDNER DIVISION
LRK TWAIN NATIONAL WILDLIFE REFUGE

CENCR-PD-R 11 March 1988

UPPER MISSISSIPPI RIVER SYSTEM - ENVIRONMENTAL MANAGEMENT PROGRAM
FACT SHEET

GARDNER DIVISION REHABILITATION
POOL 21, ILLINOIS

LOCATION: The Gardner Division of the Mark Twain National Wildlife Refuge is a 6,000 acre backwater complex of 32 islands covered by old growth bottomland timber with associated backwater lakes and side chutes on the Illinois side of the Mississippi River navigation channel. It is located between approximate river miles 332.5 and 340.2 and is about five miles north of Quincy, Illinois.

RESOURCE PROBLEM: Yearly flooding is resulting in bank and side channel erosion and silt deposition in backwater lakes. Vegetation is beginning to choke some of the side channels, while Long Island Lake has been reduced in depth from an 8-12 foot deep natural lake to a shallow 2-3 foot deep lake devoid of most aquatic vegetation. This area has one of the last high quality stands of bottomland timber in the middle reaches of the Upper Mississippi River. Without restoration, habitat value for migratory birds, aquatic mammals, fish and endangered species will continue to decline and this link in the chain of resting and feeding areas for migratory birds and endangered species may be lost.

PROPOSED PROJECT: The proposed project, pending planning, engineering, and environmental review, would involve selective dredging of backwater and lake channels. A natural high flow cut will be deepened to permit continuous water exchange and high flow flushing of Long Island Lake. Riprap will be selectively placed to prevent further cutting and bank erosion and the consequent loss of large trees.

PROJECT OUTPUTS: Dredging will improve fisheries and waterfowl habitat, clearing choked side channels and providing more diverse depths as well as the return of natural flushing of sediments. As water clarity improves in Long Island Lake, submergent and emergent vegetation used by waterfowl can become reestablished. Reduction in tree fall from bank erosion will help preserve the vanishing old bottomland hardwoods, maintaining the day-use perches used by the endangered bald eagle.

FINANCIAL DATA: The general design cost is estimated to be $167,000 with total construction costs estimated at $1,696,000. Because the project would be located on lands of the National Fish and Wildlife System, all implementation costs would be 100 percent Federal.

USDA - NRCS
338 South 36th Street
Quincy, IL 62301

George Staley - ED-HH
Rock Island Dist. Corp of Engineers
Clock Tower Bldg. PO Box 2004
Rock Island, IL 61204-2004

3/17/98

Dear Mr. Stanley:

Enclosed is some information you requested on Bear Creek Watershed in Adams County, concerning soil erosion.

Back in 1990-91 a resource planning group developed a resource plan on Bear Creek. A lot of resource and background data is covered in this plan. A copy of that plan is enclosed for your review.

Also enclosed is an estimate of sediment yield from the watershed. SCS (now NRCS) Engineers came up with that information. This information is based on natural resource inventories done in 1979. This is the most current information we have.

We know that especially streambank erosion is very severe on Bear Creek. Our report is our best estimate of gully and streambank erosion.

If I can be of further help, don't hesitate to call me at 217/224-9307 Ext. 3

Mike Tryba
District Conservationist

encl.

3-23-98

my estimate of bed load was 30,480 tons. 10% of the SCS total load of 470,587 is 47,060 tons which is NOT VERY DIFFERENT.

George Staley

: Mike Tryba , DC

om: Mike Andreas, AE

sed on the 1979 PSU information and using updated land use from current ASCS photograghy the following table summari zes the land use in the Ac

oan	Water	Cropland	Pasture	Woodland
,600	11,200	149,500	24,700	36,400
5%)	(5%)	(64%)	(11%)	(16%)

2320.

e percent of cropland in each of the eight hydrologic units was evaluated on the percent of cropland compared to the overall drainage area of

HU#	% cropland of entire drainage Area	Acres
5180	4	5,980
2180 ✓	11	16,445
0140	13	19,435
3160 ✓	10	14,500
7160	10	14,500
.120 ✓	7	10,465
1140 ✓	2	1,990
2160	7	10,465
ta l	64%	

PSU information is insufficient at this time to address the sheet and rill erosion. I suggest you utilize the past NRI information.

PSU data (phase II) was used to estimate the streambank and gully erosion. This inventory conducted in 1979, identifies the eroded and no. gth, width and height of the eroding area. This information was used to estimate the sediment volume produced in each hydrologic unit.

following summarizes this for the 232,380 acre water shed:

Hu#	Ac-Ft/Yr (Gross)	Sed. Del. Rate (%)	Sed. Volume (Acre-Feet)	TONS (tons)
80	5	.29	1.5	9450
80	9	.28	2.5	17,964
40	145	.30	43.5	170420
60	44	.28	12.3	24,354
60	14	.32	4.5	24,354

'140	4	.42	1.7	7584
160	24	.33	7.9	45,504

total 84.8 ac/per yr. is delivered to Miss River

n was used to estimate the sediment volume produced in each hydrologic unit.

470,587 tons - daily ~~[illegible]~~ to Miss. river

Illinois Historic
Preservation Agency

1 Old State Capitol Plaza • Springfield, Illinois 62701-1507 • (217) 782-4836 • TTY (217) 524-7128

ADAMS COUNTY
Mississippi River Islands
Gardener Division Habitat Rehabilitation
& Enhancement

PLEASE REFER TO:
IHPA LOG #990601003 K-A

June 23, 1999

Mr. Kenneth A. Barr, Chief
DoA/Rock Island District CoE
Environmental Analysis Branch
Clock Tower Building/Post Office Box2004
Rock Island, Illinois 61204-2004

Dear Mr. Barr:

Thank you for requesting comments from our office concerning the possible effects of the referenced project on cultural resources. Our comments are required by Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR 800: "Protection of Historic Properties".

Our staff has reviewed the specifications and assessed the impact of the project as submitted by your office. We concur with the Corps' s opinion that this project, as proposed, will have no effect on any Historic Properties. We, therefore, have no objection to the undertaking proceeding as planned.

Please retain this letter in your files as evidence of compliance with Section 106 of the National Historic Preservation Act of 1966, as amended.

Sincerely,

Anne E. Haaker
Deputy State Historic
Preservation Officer

AEH:FRK

United States Department of the Interior

IN REPLY REFER TO:

FWS/RIFO

FISH AND WILDLIFE SERVICE
Ecological Services
Rock Island Field Office
4469 48th Avenue Court
Rock Island, Illinois 61201
Tel: 309/793-5800 Fax: 309/793-5804

January 7, 2000

MFR: After the preparation of this draft CAR, the interagency team identified and evaluated two additional alternatives for side channel restoration/ protection (Section 5d of the DPR). The final CAR will reflect this change.

Colonel James V. Mudd
District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Mudd:

This letter constitutes our draft Fish and Wildlife Coordination Act (FWCA) report for the Gardner Division Habitat Rehabilitation and Enhancement Project (HREP), Mississippi River Pool 21, Miles 332.5 through 340.2, Adams County, Illinois and Lewis County, Missouri. It has been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat.401, as amended; 16 U.S. C. 661 et seq.); the Endangered Species Act of 1973, as amended; and in accordance with the Fish and Wildlife Service's Mitigation Policy.

The Gardner Division HREP is a component of the Upper Mississippi River System Environmental Management Program (EMP) authorized in Section 1103 of the Water Resources Development Act of 1986. The goal of the EMP is to implement "...numerous enhancement efforts...to preserve, protect, and restore habitat that is deteriorating due to natural and man-induced activities."

DESCRIPTION OF THE PROJECT AREA

All project lands are in Federal ownership and are managed by the U.S. Fish and Wildlife Service (Service) as part of the Mark Twain National Wildlife Refuge. The project area in Pool 21 is about five miles north of Quincy, Illinois. The 6,300 acre Gardner Division project area was formed with alluvial deposits made by unregulated river flows. The island complex is comprised of several islands, of which Long, Shandrew, and Flannigan are the largest. A major backwater lake (Long Island Lake) and several important side chutes - Canton, O'Dell, Smoots, and Shandrew make up the project area.

Gardner Division is subject to yearly Mississippi River floods and is rapidly losing its valuable backwater areas and side chutes to siltation and vegetation encroachment. Gardner Division has one of the last high quality stands of bottomland timber in the middle reaches of the Upper Mississippi River, despite heavy losses of soft-mast trees during 1993 flooding. As with many island complexes in the Upper Mississippi River, Gardner Division is comprised mostly of a monotypic bottomland forest dominated by silver maple (*Acer saccharinum*) and cottonwood (*Populus deltoides*) with few remaining mast-producing trees. The waters between the island and the main channel contain numerous wing dams with a silty sand bottom. Most of the side channels within the complex are filling in with bedload sediments and additional deposits during high water periods. Most lands along the river are made up of typical bottomland hardwood wetland habitat, some emergent and other wetland habitats, and aquatic habitats associated with the main river channel. Landward of the levees, production agriculture dominates the floodplain.

Watershed and floodplain development, together with navigation infrastructure and operations, have altered floodplain hydrology. Increases in sedimentation in aquatic habitats and in the degradation of some terrestrial habitats have reduced the quantity and quality of native vegetative communities, and jeopardized the sustainability of the large river-floodplain ecosystem.

PROJECT OBJECTIVES

The goals of the Gardner Division HREP are to rehabilitate, enhance, and protect aquatic habitats for fish, and both resident and migratory birds. To evaluate the area for potential improvements, the project area was divided into an aquatic (fishery) component and migratory bird wetland and terrestrial habitat components. Specific objectives for each of the components were developed according to the management plans and input of State and Federal biologists. Several alternatives were considered for each component to determine the best way to meet the project objectives.

The array of alternatives includes combinations of construction features and management practices that will (1) reduce suspension of sediments; (2) create areas with flow and depth diversity; (3) increase abundance and diversity of aquatic plants; (4) improve migratory bird wetland and terrestrial habitat by restoring bottomland hardwood forest; (5) reduce sedimentation in backwaters; and (6) increase wintering fish habitat for centrarchids and associated species.

DISCUSSION OF PROJECT FEATURES

While other features could be implemented in the Gardner Division project area, the inter-agency planning team felt that the features evaluated best met the project goals and objectives as well as meeting their respective agencies' goals and objectives.

Table 4. Features Evaluated:

Side Channel Restoration/Protection
A0 No Action
A1 Closing Structure/Dredging O'Dell Chute

Shoreline Protection
B0 No Action
B1 Small islands only
B2 Large islands only
B3 All islands

Reforestation
C0 No Action
C1 Placement site (67 acres)
C2 East Agricultural Field (184 acres)

SIDE CHANNEL RESTORATION/PROTECTION

Side channel restoration/protection was evaluated for O'Dell Chute. The feature includes constructing a closing structure and dredging. The closing structure is designed to block an estimated 90 percent of bedload sediment from entering the chute. It would be constructed with erosion protection stone and be keyed into the current chute floor approximately 3 feet in depth to ensure that the rock would remain in place during high water conditions. The structure must be emergent during most river stages and would be built to 90 percent depth in order to stop 90 percent of the sediment from migrating down O'Dell Chute. Dredging of the downstream end of O'Dell Chute for approximately 5,000 linear feet in an upstream direction is planned. The width of the dredge cut would be 50 feet. Restoration of aquatic habitat is based on the presumption that dredging would increase the amount of deep water area for overwintering (6 feet or greater) in O'Dell Chute.

SHORELINE PROTECTION

Protection of selected island shorelines with riprap will provide benefits to both terrestrial and aquatic habitat. Protection of all identified islands with riprap, the preferred alternative, is expected to prevent the loss of 127 acres of bottomland hardwood forest due to erosion. Placement of riprap on all identified island shorelines will also benefit approximately 85 acres of aquatic habitat. This feature yields a relatively small amount of the aquatic habitat units because it presumes only the addition of riprap as substrate on the submerged portion of protected shorelines.

REFORESTATION

The preferred alternative involves the restoration of historic bottomland hardwood forest on the eastern agricultural field on Long Island and involves cessation of row crop cultivation and planting mast-producing tree species such as pin oak, swamp white oak, bur oak, northern pecan, and sycamore. A total of 184 acres would be directly converted from cropfield to forest habitat by implementation of this feature. Mast trees would be planted on areas of higher elevation within the eastern field (approximately 67 acres) and the remaining 117 acres would be allowed to revegetate naturally. While the loss of cropfield habitat would reduce habitat for some game species such as mallard and Canada goose, numerous other bird and mammal species, represented by the remaining five evaluation species referred to in the table below, would derive substantial benefits from reduced forest fragmentation, increased cover, and improvements to the available food base provided by increased presence of mast-producing trees.

METHODOLOGY

Habitat analysis of existing study area conditions, future conditions without the project, and impacts of the several proposed alternatives and increments was accomplished using the Wildlife Habitat Appraisal Guide (WHAG) procedures developed by the Missouri Department of Conservation and the USDA Natural Resources Conservation Service. The WHAG is a numerical habitat appraisal methodology based on USFWS Habitat Evaluation Procedures (HEP) (1980). The analysis employed an inter-agency team approach with representatives from the Corps of Engineers, the Illinois Department of Natural Resources, and the U.S. Fish and Wildlife Service.

The WHAG analysis is a numerical system for evaluating the quality and quantity of particular habitats for animal species selected by the WHAG team members. The evaluation species used in this analysis are an established set in the WHAG model. Although a set list of species has been used, each species represents a guild of other similar species that utilize the habitat in similar ways. Each species represents an array of habitat variables for the species being evaluated. These species represent key management goals and objectives of the Gardner Division HREP (see table below for list of evaluation species). The qualitative component of the analysis is known as the Habitat Suitability Index (HSI) and is rated on a 0.1 to 1.0 scale. The quantitative component of the WHAG analysis is the measure of acres of habitat that are available for the selected evaluation species. From the qualitative and quantitative determinations, the standard unit of measure, the Habitat Unit (HU), is calculated using the formula (HSI x Acres = HUs).

Evaluation Species Selected for Habitat Analysis

Species	Scientific Name	Habitat Evaluated
Channel catfish	*Ictalurus punctatus*	aquatic

Species	Scientific Name	Habitat Evaluated
Sauger	*Stizostedion canadense*	aquatic
Largemouth bass	*Micropterus salmoides*	aquatic
Gizzard shad	*Dorosoma cepedianum*	aquatic
Carp	*Cyprinus carpio*	aquatic
Bluegill	*Lepomis macrochirus*	aquatic
Black bullhead	*Ictalurus melas*	aquatic
Mallard	*Anas platyrhynchos*	nonforested wetland
Canada goose	*Branta canadensis*	nonforested wetland
Green-backed heron	*Butorides striatus*	nonforested wetland
Wood duck	*Aix sponsa*	forested wetland
Beaver	*Castor canadensis*	forested wetland
Northern parula	*Parula americana*	forested wetland
Prothonotary warbler	*Protonotaria citrea*	forested wetland

Seven fish species were used to evaluate restoration and protection of side channel habitat and the aquatic component of protection of island shorelines. Important sport fishing species such as the Channel catfish, sauger, and gizzard shad commonly inhabit main channel and channel border habitats. Largemouth bass and bluegill are centrarchids that inhabit side channels and backwaters, and are also important sport fish species. Carp and black bullhead are common and abundant in backwater habitats. All seven species utilize backwater areas as spawning habitat.

Seven wildlife species were used to evaluate the reforestation of agricultural fields on Long Island. Mallard and Canada goose are migratory waterfowl that utilize early successional wetland habitat and have socioeconomic importance as game species. The green-backed heron is a wading bird found in midsuccessional herbaceous and shrub dominated wetland habitat. The beaver is a resident furbearing mammal that utilizes early successional forest habitat. The wood duck is a waterfowl species that favors mature forested wetland habitat with abundant snags and cavity trees. The parula and prothonotary warbler are neotropical migrant songbirds that utilize mature forested wetland habitat during the breeding season.

Changes in the quality of the habitats and HUs for each species will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HU derived over the life of the project. Cumulative HUs are annualized and averaged. This

determines what is known as the Average Annual Habitat Units (AAHUs). AAHUs are used as an output measurement to compare all the features and the project as a whole.

To complete the habitat evaluation, the study team reviewed aerial photography, topographic maps, and preliminary design drawings. The study team based much of the existing condition information on prior sampling of the study areas. Assumptions were developed regarding existing conditions and project/post-project conditions relative to limiting factors and management practices.

For project planning and impact analysis, project life was established as 50 years. To facilitate comparison, target years were established at 0 (existing conditions) 1, 25, and 50 years. HSI and AAHU for each evaluation species were calculated to reflect expected habitat conditions over the life of the project.

Selected data will be presented in this report with reference to the habitat analysis but to avoid duplication of tables, we refer the reader to the Habitat Evaluation and Quantification Appendix in the main body of the Draft Definite Project Report for the complete tabular results of HSI and AAHU values for each of the project features.

THREATENED AND ENDANGERED SPECIES

To facilitate compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, Federal agencies are required to obtain from the Fish and Wildlife Service information concerning any species, listed or proposed to be listed, which may be present in the area of a proposed action.

Therefore, we are furnishing you the following list of species which may be present in the concerned area:

Classification	Common Name	Scientific Name	Habitat
Threatened	Bald eagle	*Haliaeetus leucocephalus*	Breeding, Winters along major rivers and reservoirs
Endangered	Higgins' eye pearly mussel	*Lampsilis higginsi*	Mississippi River
Endangered	Fat pocketbook pearly mussel	*Potamilis capax*	Mississippi River
Endangered	Gray bat	*Myotis grisescens*	Caves, mines; rivers and reservoirs adjacent to forests

Classification	Common Name	Scientific Name	Habitat
Endangered	Indiana bat	*Myotis sodalis*	Caves, mines; small stream corridors with well developed riparian woods; upland forests
Threatened	Eastern prairie fringed orchid	*Platanthaera*	Mesic to wet prairies

Bald eagles winter along the Mississippi River, including Pool 21. Bald eagle nesting was last recorded on Shandrew Island within the Gardner Division complex. Tree clearing for project construction would be limited to a zone approximately 20 feet wide on island shorelines immediately adjacent to rock placement sites. No tree clearing would take place in the interior of any islands. If necessary, clearing and other construction activity would be scheduled for periods when eagles are not present. The proposed project would not affect bald eagles or their habitats.

The endangered Higgins' eye pearly mussel (*Lampsilis higginsi*) and Fat pocketbook pearly mussel (*Potamilis capax*) prefer sand/gravel substrates with a swift current and are most often found in the main channel border or an open, flowing side channel. Because of the dominance of sand and silty materials in the project area, these species are not likely to occur in side channel or shoreline portions of the project area.

The endangered Indiana bat (*Myotis sodalis*) is listed as occurring in Adams County, Illinois. During the summer, the Indiana bat frequents the corridors of small streams with well developed riparian woods as well as mature upland forests. It forages for insects along the stream corridor, and within the canopy of floodplain and upland forests. It has been shown that the foraging range for the bats varies by season, age and sex and ranges up to 81 acres (33ha). It roosts and rears its young beneath the loose bark of large dead or dying trees. Radiotelemetry investigation of Indiana bats identified a maternal roost tree located on the southern portion of Long Island. No trees would be cleared on the interior of any islands. Tree clearing for placement of rock shoreline protection would not be conducted during the April 1 - September 30 timeframe. Prohibiting clearing activity during this 4-month time window would avoid potential impacts to summer roosting Indiana bats. If Indiana bats are known to be present, they must not be harmed, harassed, or disturbed when present.

No suitable habitat exists for the Gray bat and eastern prairie fringed orchid within the project area. The State listed veery (*Catharus fuscescens*) and river otter (*Lutra canadensis*) have been identified as potentially occurring in the backwater complex of Quincy Bay, located at approximate RM 329.0 to 332.0L. Neither species would be adversely affected by construction of proposed project features.

The proposed HREP project will not adversely affect endangered species or their habitats. This precludes the need for further action on this project as required under Section 7 of the Endangered Species Act of 1973, as amended. Should this project be modified or new information indicate endangered species may be affected, consultation should be initiated.

EXISTING FISH AND WILDLIFE RESOURCES

Gardner Division provides habitat for a variety of wildlife including waterfowl, bald eagles, deer, frogs, and salamanders. Wood ducks have successfully nested on the islands and resting and feeding areas are provided for migratory waterfowl through a cooperative farming program for row crops and other food plants. The project area is an integral part of the Mississippi Flyway, a major migratory corridor for birds in the central United States.

Fish species found in the project area are catfish, freshwater drum, carp, and centrarchids. In or near the deeper areas, walleye and other game species will forage for food and use this habitat to avoid the main channel currents. Heron and cormorants may forage for fish in the shallow water near the wing dams or perch on exposed trees/logs that have been washed into the area.

A number of wing dams extend from Gardner Division to the main channel forming a dike field. The dike field between the wing dams is considered main channel border habitat. River flows are slower than those in the main channel due to the effectiveness of the wing dams. The river bottom is shallow, flat, and comprised of a silty/sand substrate as a result of lower flows. However, directly downstream of each structure is a turbulent area where water cascading over each structure has scoured a deeper area. Benthic species found within the dike field include papershell mussel species, tubeflex worms, mayfly larvae, and other small invertebrates.

Terrestrial vegetation within the Gardner Division complex is typical silver maple association forest cover. Silver maple is the dominant species. Due to the agricultural clearing and modified hydrologic conditions, mast-producing tree species such as oak, hickory, pecan, and walnut have declined, but are present on Gardner Division. Soft mast-producing species such as hackberry, sugarberry, and sycamore number have been substantially reduced by mortality resulting from severe flooding in 1993. Future availability of mast as a winter food source for wildlife is a concern.

Most of the slough areas within Gardner Division have silted in. In the remaining sloughs, wood ducks forage for duck weed and invertebrates during the migration, breeding and rearing periods of the year. Other wildlife species using these sites include raccoon, deer, frogs, green herons, and warblers.

One actively cultivated agricultural field remains on the island. A portion of the crops is left each year as wildlife food. Squirrels and deer utilize this food throughout the winter. Ducks and geese may use the field to forage for any waste grain remaining after harvest. In many

years, the crop field is not planted due to spring floodwaters. In these years, nettles and other invasive plant species dominate the site. Little wildlife value is derived at this site during those years.

The results of the WHAG analysis for existing conditions in the project area indicate a broad range of values for the evaluation species, reflective of the variety of habitat requirements for those species. The base HUs reflect conditions as they exist today, while with- and without-project HUs reflect TY50 conditions. The net HUs are the net gain reflected by subtracting the without-project habitat units from the with-project totals (Table 1). The following tables are excerpted from the U.S. Army Corps of Engineers Draft Definite Project Report for the Gardner Division HREP.

Table 1. Side Channel Protection/Restoration was evaluated for six species. Existing habitat suitability and corresponding Habitat Unit values for the six species.

SPECIES	Base HUs	Without Project	With Project	Net HUs
Channel catfish	7.4	3.6	15.2	11.6
Largemouth bass	6.2	2.9	12.6	9.7
Gizzard shad	5.7	2.7	11.8	9.1
Carp	4.7	2.2	9.7	7.5
Bluegill	5.8	2.7	11.9	9.2
Black bullhead	5.1	2.4	10.6	8.2

Output generated by the WHAG model is consistent with the on-site visits and discussions with local field biologists who manage the area. Note that without project HU values decline as more aquatic habitat is degraded by sedimentation.

The existing habitat unit (HU) values for the shoreline protection feature of this project and corresponding no action - HU values are presented below. Terrestrial and aquatic species associated with the proposed protection of selected island shorelines are evaluated and presented in Table 2.

Table 2. Shoreline protection existing habitat unit values and corresponding habitat unit values for 12 terrestrial and aquatic species.

SPECIES	Base HUs	Without Project HUs	With Project HUs	Net HUs
Green-backed heron	2210.3	2175.0	2208.1	33.1
Wood duck	2870.5	2824.6	2867.7	43.1
Beaver	2409.7	2371.2	2407.3	36.1
Northern parula	2368.2	2330.3	2365.8	35.5
Prothonotary warbler	2999.7	2951.7	2996.7	45.0
Channel catfish	55.2	55.2	59.5	4.3
Sauger	55.7	55.7	61.4	5.7
Largemouth bass	35.4	35.4	38.2	2.8
Gizzard shad	44.9	44.9	46.1	1.2
Carp	44.0	44.0	44.0	0.0
Bluegill	36.9	36.9	36.9	0.0
Black bullhead	48.2	48.2	48.2	0.0

Table 3. Existing Habitat Unit values for seven species and corresponding habitat unit values for the reforestation feature.

SPECIES	Base HUs	Without Project HUs	With Project HUs	Net HUs
Mallard	107.7	107.7	19.3	-88.4
Canada Goose	37.7	37.7	0.3	-37.4
Green-backed heron	0.0	0.0	110.2	110.2
Wood duck	0.0	0.0	84.0	84.0
Beaver	0.0	0.0	127.2	127.2
Northern parula	0.0	0.0	68.2	68.2

SPECIES	Base HUs	Without Project HUs	With Project HUs	Net HUs
Prothonotary warbler	0.0	0.0	94.5	94.5

FUTURE WITHOUT PROJECT

The No Federal Action alternative is considered the future without the project condition allowing the area to continue to function as is. Without active management, successional changes in habitat and further degradation by sedimentation will result in continued degradation of fisheries habitat being filled with sediments.

The without project analysis for side channel restoration/protection and shoreline protection indicated these habitats have a pool-wide affect on the fishery resource. Loss of these side channel and shoreline habitats affects aquatic acreage on a scale much greater than the actual project area dimensions. Evaluation of the side channel restoration/protection feature assumed that under without-project conditions, aquatic habitat, particularly deep water areas (6 feet or greater) in the chute would be essentially eliminated by target year 50. Under with-project conditions, the evaluation assumed that surface acreage would remain relatively stable and that the dredging component of the feature would slightly increase the amount of deep water habitat in the chute. The value of these areas as protected off-channel lacustrine fisheries habitat is currently limited due to a lack of depth and vegetation diversity. The shoreline protection feature included aquatic and terrestrial components. For the terrestrial component of the shoreline protection feature, the difference between with-project and without-project conditions is expressed by changing the acreage figures used in the analysis. Under future without-project conditions, a loss of bottomland hardwood forest habitat is assumed to occur over the 50-year period used in the analysis. Initial acreage losses occur with-project due to clearing of shoreline vegetation for construction. However, following completion of construction, the acreage of forested habitat is assumed to remain stable. Smaller islands were assumed to have a higher rate of acreage loss from erosion than larger islands.

Evaluation of the aquatic component of the shoreline protection feature assumed affected acreage to be limited to areas in close proximity to the protected sites, estimated to be a zone approximately 100 feet wide and five times the linear length of shoreline protection placement. Habitat conditions and affected acreage were assumed to remain stable over the 50-year project life, with the only change in habitat quality between future without-project and future with-project attributed to the addition of riprap. Analysis of both terrestrial and aquatic benefits assumed that, in addition to the 3,200 linear feet of shoreline protection proposed as part of the HREP, an additional 4,500 feet of shoreline protection would be placed on identified islands as part of ongoing channel maintenance in this reach of the river.

The without project analysis for the reforestation showed little or no change over time from the present values. Row crop cultivation would continue on historic agricultural fields throughout the 50-year project life. Initially, all three historic agricultural fields on Long Island, totaling 687 acres, were included in the analysis. However, cultivation of the two western fields (503 acres total) had already been discontinued prior to initiation of the WHAG analysis, and a portion of this acreage had previously been planted with acorns and bare root seedling mast trees as part of the Mississippi River Mast Tree Section 1135 project. For these reasons, the western cropfields were eliminated from further analysis

FUTURE WITH PROJECT

Enhancement options for the Gardner Division project included increasing the quality of existing habitat types, increasing the acreage of a particular habitat type(s), or a combination of both. Several increments of each alternative feature were evaluated to determine the best management of the habitat types at the most reasonable cost.

Side Channel Restoration/Protection

Implementation of this alternative would consist of protecting side channel habitat within O'Dell Chute by reducing the amount of sediment entering the chute at the upper end. The closing structure is designed to block an estimated 90 percent of the river bedload sediment from entering the chute. Restoration of aquatic habitat is based on the presumption that dredging would increase the amount of deep water area (6 feet or greater) in O'Dell Chute. Fisheries benefits beyond the boundaries of O'Dell Chute are expected, however evaluation of benefits was limited to the area directly affected by dredging and closure structure construction. Benefits to fish and wildlife resources include spawning, nursery, feeding, and refuge areas for fish like channel catfish, largemouth bass, and bluegill. The A1 increment of this feature generates 55.3 net AAHU's.

Shoreline Protection

Benefits to both terrestrial and aquatic habitat would be provided by the protection of selected island shorelines with riprap, armoring the islands against erosive river forces. Prevention of the loss of 127 of bottomland hardwood forest due to erosion is expected, creating habitat benefits for such species as wood duck, prothonotary warbler, and beaver. Continued loss of terrestrial habitat and the loss of large trees that have been historically used by the federally protected bald eagle will be abated. Stabilization of the island tips and reduction of tree fall are expected benefits. Placement of riprap on all identified island shorelines is also expected to benefit approximately 85 acres of aquatic habitat. The riprap on the islands would provide some fish habitat, as well as habitat for invertebrates. The rock would also provide habitat for aquatic invertebrates that prefer attachment to hard surfaces and increased feeding opportunities for various game and non-game species. With flows year-round, the habitat can be utilized for spawning, nursery/rearing, and adult fish. The B3 increment of this feature generates 192.8 net AAHU's.

Reforestation

Restoration of historic bottomland hardwood forest on the eastern agricultural field on Long Island will involve the cessation of row crop cultivation and planting mast producing tree species. While the loss of cropfield habitat will reduce habitat for some game species such as mallard and Canada goose, numerous other bird and mammal species will gain from this feature. Benefits include a reduction of forest fragmentation, increased cover, and overall improvements to the available food base provided by the increased presence of mast producing trees. Species such as the green-backed heron, wood duck, beaver and prothonotary warbler will be the primary beneficiaries from this feature. Increment C 1 of the reforestation feature generates 358.3 net AAHU's.

DISCUSSION

The primary goals of the Gardner Division HREP are to enhance aquatic and floodplain terrestrial habitat. Project objectives are to protect and restore side channel aquatic habitat for the benefit of fisheries and other aquatic life, to protect existing floodplain terrestrial habitat from shoreline erosion, and to restore diversity of woody vegetation in floodplain terrestrial habitat for the benefit of resident and migratory wildlife. The preferred alternative, therefore, includes management measures selected to meet these objectives including dredging in O'Dell Chute and constructing a closing dam at the head of the chute, placing riprap bank protection on selected islands within the Gardner Division complex, and planting mast-producing trees on the eastern agricultural field on Long Island.

The WHAG analysis indicates that the preferred alternative would provide the greatest habitat benefits in the most cost-effective manner. The preferred alternative meets HREP goals and objectives, adds habitat diversity as well as quality, and best meets the overall management objectives for the site. Benefits to both game and non-game species would be realized by increased fisheries habitat including the bald eagle and other piscivorous species.

CONCLUSIONS AND RECOMMENDATIONS

The Gardner Division HREP offers a unique multi-faceted opportunity to restore and enhance a diverse fishery and wildlife resource. In addition, the proposed HREP will contribute directly to achieving the goals of the North American Waterfowl Management Plan (an international inter-agency plan to increase waterfowl populations) for waterfowl species and the goals of the Partners for Flight program to protect and increase the habitats for neotropical migrants.

Therefore we recommend the preferred alternative which includes:

1. Construction of an emergent closure structure and dredging in O'Dell Chute.

2. Protection of the shorelines and head ends of selected islands.

3. Planting 67 acres of mast-producing trees on higher elevations of the eastern agricultural field on Long Island.

We appreciate the opportunity to provide these comments and look forward to continued coordination on this project. If you have any questions, please contact Ms. Heidi Woeber of my staff at (309) 793-5800, ext. 517.

Sincerely,

Richard C. Nelson
Supervisor

cc: USFWS/MTNWR (Steinbach, Ellis, Westphall, Sprunger)
ILDNR (Poulter, Sallee)

REFERENCES

Illinois Environmental Protection Agency. 1998. The Condition of Illinois Water Resources 1998. IEPA/BOW/98-006. 8 pp.

Iowa Department of Natural Resources. 1992. Study No. 1. An evaluation of largemouth bass populations in the Upper Mississippi River. Federal Aid to Fish Restoration Completion Report: Mississippi River Investigations Project No. F-109-R.

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

ILLINOIS
DEPARTMENT OF
NATURAL RESOURCES
Office of Water Resources

524 South Second Street, Springfield 62701-1787 George H. Ryan, Governor ● Brent Manning, Director

April 28, 2000

SUBJECT: Application for Permit #20004063

U.S. Army Corps of Engineers, Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Gentlemen:

Receipt of your application for an Illinois Department of Natural Resources, Office of Water Resources permit is acknowledged. Review of your proposed project to ensure its compliance with the Rivers, Lakes and Streams Act, 615 ILCS 5 (1998 State Bar Edition), will be completed by Office of Water Resources' engineer, Mike Diedrichsen (217/782-3863). **No work on the project should be initiated until an IDNR/OWR permit has been received.**

We are forwarding a copy of your application for permit form to the Illinois Historic Preservation Agency (IHPA) for their review. In accordance with Section 4 of the Illinois State Agency Historic Resources Preservation Act, 20 ILCS 3420/4 (1994 State Bar Edition), and the resulting IHPA "Rules for Review of State Agency Undertakings" (17 Ill. Adm. Code 4180), we are delegating to you responsibility to provide to IHPA any additional necessary documents regarding compliance of the project with the aforementioned Act. IHPA will contact you and this office regarding their jurisdiction within 30 days of their receipt of the forwarded application form. If you have any questions in this regard, please contact IHPA at 217/785-5027.

We are also providing a copy of your application to this agency's Office of Realty and Environmental Planning (OREP). Consultation with that office may be required regarding your project's compliance with the Illinois Endangered Species Protection Act, 520 ILCS 10 (1994 State Bar Edition), and the resulting rules for "Consultation Procedures for Assessing Impacts of Agency Actions on Endangered and Threatened Species" (17 Ill. Adm. Code 1075). If any further action regarding consultation is necessary, OREP will notify you within 30 days.

You are also advised that OREP reviews U. S. Army Corps of Engineers Sections 10 and 404 permit activities. If your project requires a Corps permit, you may receive comments or recommendations from OREP, primarily related to the biological effects of the work, which may be outside the purview of the Illinois Department of Natural Resources, Office of Water Resources permit process.

Sincerely,

Dennis Kennedy

Dennis L. Kennedy, P.E.
Senior Water Resources Engineer

DLK:MLD:crw
cc: Illinois Historic Preservation Agency w/encl.
OREP w/encl.

JOINT APPLICATION FORM

Application Number (to be assigned by Agency)	2. Date (Day / Month / Year)	3. For agency use only (Date Received)
20004063		APRIL 26, 2000

4. Name and address of applicant

U.S. Army Corps of Engineers,
Rock Island District
Clock Tower Bldg., P.O. Box 2004
Rock Island, IL 61204-2004

Telephone no. during business hours: A/C( ) ____ A/C( ) ____

5. Name, address, and title of authorized agent

Mr. Joseph Raoul, Jr., P.E., Chief,
Engineering Div., Rock Island District,
Corps of Engineers, P.O. Box 2004
Rock Island, IL 61204-2004

Telephone no. during business hours: A/C( ) (309) 794-5226 A/C( ) ____

6. Project Description and Remarks: Describe in detail the proposed activity, its purpose, and intended use. Also indicate the drainage area at the watershed to the downstream limit Use attachments if needed.

The Gardner Division habitat rehabilitation and enhancement project features include dredging portions of O' Dell Chute, erecting a closure structure at the upriver end of the dredge cut, performing shoreline protection along various islands within the Gardner Division complex, and restoring an existing agricultural field. A copy of the Definite Project Report is enclosed with this application. Chapter 6 describes the recommended plan. Detailed plates are also included in this report.

7. Names, addresses, and telephone numbers of all adjoining and potentially affected property owners, including the owner of the subject property if different from applicant.

U.S. Fish and Wildlife Service
Mark Twain National Wildlife Refuge
1704 North 24th St.
Quincy, IL 62301

8. Location of activity

Mississippi River
Name of waterway at location of the activity

Legal Description: 6,7,18, 19,29,30 (Sec.) 32 (Twp.) 1N (Rge.) 9W (P.M.) 4th

Address: Pool 21, Upper Mississippi River Miles 332.5 through 340.2
Street, road, or other descriptive location

Near Quincy, Illinois
In or near city or town

Adams County
Name of Local Governing Community

Adams
County

Illinois
State

Zip Code

9. Date activity is proposed to commence November 2000 Estimated Time of Construction 3 years (to Sep 2003)

10. Is any portion of the activity for which authorization is sought now complete? ____ Yes X No If answer is "Yes" give reasons in Item 6.

Month and Year the activity was completed ____ Indicate the existing work on drawings.

11. List all approvals or certifications required by other federal, interstate, state, or local agencies for any structures, construction, discharges, deposits, or other activities described in this application. If this form is being used for concurrent application to the Corps of Engineers, Illinois Department of Natural Resources, and Illinois Environmental Protection Agency, these agencies need not be listed.

Issuing Agency	Type Approval	Identification No.	Date of Application	Date of Approval
No additional requests				

12. Has any agency denied approval for the activity described herein or for any activity directly related to the activity described herein? ____ Yes X No (If "Yes", explain in Item 6.)

13. Application is hereby made for authorizations of the activities described herein. I certify that I am familiar with information contained in the application, and that to the best of my knowledge and belief, such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities.

Signature of Applicant or Authorized Agent

Joseph Raoul, Jr., P.E.
Typed or Printed Name of Applicant or Authorized Agent

CR FORM 426
JAUG 95

ILLINOIS
DEPARTMENT OF
NATURAL RESOURCES

524 South Second Street, Springfield 62701-1787

~~Jim Edgar~~, Governor ● Brent Manning, Director

May 11, 2000

Department of the Army
Rock Island District Corps of Engineers
Clock Tower Building - P. O. Box 2004
Rock Island, Illinois 61204-2004
Attn: Planning, Programs, and Project Management Division (Darron Niles)

Dear Mr. Niles:

My staff and I have reviewed the Gardner Division Habitat Rehabilitation and Enhancement Report dated March, 2000. Brad Poulter, the District 20 Wildlife Habitat Biologist for Illinois Department of Natural Resources, has been actively involved with the planning process, and we have no further comment.

We appreciate the opportunity to respond.

Sincerely yours,

Deck Major, Regional
Wildlife Biologist
IL. Dept. Of Natural Resources

The purpose of this public notice is to solicit comments on the proposed project.

NO OBJECTION
U.S. Fish & Wildlife Service
Rock Island, Illinois
J. Miller 6/7/2000
Supervisor Date

PUBLIC NOTICE

US Army Corps of Engineers
Rock Island District

Applicant: U.S. Army Corps of Engineers

Date: May 25, 2000
Expires: June 14, 2000

CEMVR-OD-390600

Section 404

Joint Public Notice
U.S. Army Corps of Engineers
Illinois Environmental Protection Agency
Illinois Department of Natural Resources/Office of Water Resources

1. **Applicant.** U.S. Army Corps of Engineers, Clock Tower Building, Rock Island, Illinois 61204-2004.

2. **Project Location.** The Gardner Division Habitat Rehabilitation and Enhancement Project (HREP) is located 5 miles upstream of Quincy, Illinois, near the midpoint of Pool 21. The project area lies in various sections in Townships 1 South and 1 North, Range 9 West, Adams County, Illinois, between Upper Mississippi River miles 332.5 and 340.2. Gardner Division is made up of several islands, of which Long, Shandrew, and Flannigan are the largest. The project area also contains a major backwater lake and several important side chutes – Canton, O'Dell, Smoots, and Shandrew. All project lands are in Federal ownership and are managed by the U.S. Fish and Wildlife Service as part of the Mark Twain National Wildlife Refuge.

3. **Project Description.**

a. **Purpose.** The primary goals for the Gardner Division HREP are to enhance aquatic and floodplain terrestrial habitat. Project objectives are to protect and restore side channel aquatic habitat for the benefit of fisheries and other aquatic life, to protect existing floodplain terrestrial habitat from shoreline erosion, and to restore diversity of woody vegetation on floodplain terrestrial habitat for the benefit of resident and migratory wildlife. Management measures selected to meet these objectives include dredging in O'Dell Chute and constructing a closure structure, placing riprap bank protection on selected islands within the Gardner Division complex, and planting mast-producing trees on Long Island's eastern agricultural field.

b. **Proposed Project.** The project plan includes: dredging 8400 feet of O'Dell Chute and constructing an emergent closure structure upstream of the dredged channel; protecting the shorelines and head ends of selected islands; and planting 67 acres of mast-producing trees on the dredged material placement site located on Long Island's eastern agricultural field.

(1) **Side Channel Restoration and Protection: O'Dell Chute Dredging.** Approximately 77,500 cubic yards of sandy material Chute will be hydraulically dredged in an upstream direction from approximately 6,400 linear feet of the downstream end of O'Dell. The width of the dredge cut will be 50 feet, with proposed vertical sides. A dredge cut depth of 7.5 feet (elevat462.5) is required to ensure a 6-foot depth below flat pool at the end of the project life (50 years) to maintain fisheries benefits. It is presumed that the sides of the dredged area will slump to their natural angle of repose as the material is being dredged. The natural angle of repose of the sandy material is expected to be a 2:1 (horizontal:vertical) slope. The appearance of the dredge cut immediately following the dredging activities will exhibit dredge cut sides with approximately 2:1 slopes and a 50-foot bottom width. The material will be placed (using booster pumps as appropriate) on the eastern agricultural field of Long Island that runs adjacent to this chute.

(2) **Side Channel Restoration and Protection: O'Dell Chute Closure Structure.** A closure structure to stop sand from migrating downstream to be constructed will be emergent approximately 90 percent of the year and will be submergent the rest of the time. The structure will be placed at the upstream end of O'Dell Chute Dredge Cut. Dredging activities will have to be performed prior to constructing the closure structure to ensure access to this location. The maximum chute width is around 300 feet, with an average width closer to 150 feet. The closure structure will run the entire width of the channel at the proposed location. The structure will be keyed into the current chute flood to ensure that the rock will remain in place during high water conditions. The structure's side slopes will be 2 horizontal to 1 vertical. The top of the structure will be approximately 5 feet in depth due to using a stone size of 400-pound stone. Approximately 4,400 tons of rock will be required for construction.

MAY 27 2000

Illinois
Department of
Natural Resources

http://dnr.state.il.us

524 South Second Street • Springfield, Illinois 62701-1787

George H. Ryan, Governor • Brent Manning, Director

June 12, 2000

Colonel James V. Mudd
District Engineer
Department of the Army
Rock Island District, Corps of Engineers
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Attn: OD-S

Dear Colonel Mudd:

The Illinois Department of Natural Resources, Office of Realty and Environmental Planning, has reviewed the project(s) listed below and has no objections to permit issuance:

Permit No.	Applicant
390600	U.S. Army Corps of Engineers

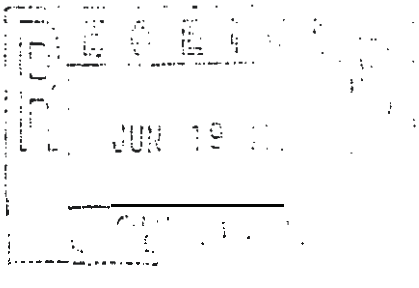
Please contact me if we can be of further assistance.

Sincerely,

Robert W. Schanzle
Permit Program Manager

RWS:rs 5-18(00)

cc: IDNR/OWR (Dalton)
IEPA (Yurdin)
USFWS (Fisher)
USEPA (Pierard)



This recommendation regarding the issuance/denial of the U.S. Army Corps of Engineers permit by the IDNR, Office of Realty and Environmental Planning does not supersede permit decisions made by the IDNR, Office of Water Resources under the Illinois Rivers, Lakes and Streams Act.

Illinois Department of Agriculture
George H. Ryan, Governor • Joe Hampton, Director
Bureau of Land and Water Resources
State Fairgrounds • P.O. Box 19281 • Springfield, IL 62794-9281 • 217/782-6297 • TDD 217/524-6858 • Fax 217/557-0993

June 19, 2000

Mr. Darron Niles
U.S. Army Engineer District, Rock Island
ATTN: Planning, Programs and Project Management Division
Clock Tower Building - P.O. Box 2004
Rock Island, Illinois 61204-2004

Re: Upper Mississippi River System
Environmental Management Program
Definite Project Report with Integrated EA (R-15PR)
Gardner Division Habitat Rehabilitation and Enhancement
Pool 21, Mississippi River Miles 332.5 - 340.2
Adams County, Illinois

Dear Mr. Niles:

The Illinois Department of Agriculture (IDA) has examined the above referenced project for its potential impact to agricultural land in order to determine its compliance with the federal Farmland Protection Policy Act (7 USC 4201 et seq.) and, hence, the Illinois Farmland Preservation Act (505 ILCS 75/1 et seq.).

The recommended plan includes constructing an emergent closure structure and dredging in O'Dell Chute; protecting the shorelines and head ends of selected islands; and planting 67 acres of mast-producing trees on a dredged material placement site located on Long Island's eastern agricultural field. Because all Gardner Division project features will be located on federally owned lands managed, through cooperative agreement, by the USFWS, the IDA does not object to the project's implementation.

We have determined the project meets the intent of the Illinois Farmland Preservation Act.

Sincerely,

James R. Hartwig
Office of Farmland Protection and Mined Land Reclamation

JRH:drs

cc: Director Joe Hampton, IDA
Joan Messina, IDA
Mike Williams, IDA
Jim Lippson, IDA
John Herath, IDA
Warren Goetsch, IDA
Steve Frank, IDA

ILLINOIS
DEPARTMENT OF
NATURAL RESOURCES
Office of Water Resources

524 South Second Street, Springfield 62701-1787 George H. Ryan, Governor ● Brent Manning, Director

June 29, 2000

SUBJECT: Gardner Division Habitat Rehabilitation
and Enhancement Project
Mississippi River, Adams County

Mr. Joseph Raoul, Jr., P.E.
Chief, Engineering Division
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

ATTENTION: Ms. Kara Mitvalsky, Environmental Engineering Section

Dear Mr. Raoul:

Thank you for the April 20, 2000 transmittal of your application for an Illinois Department of Natural Resources, Office of Water Resources permit for the subject project. The public notice comment period for the project expired on June 14, and neither we nor your Regulatory Branch have received any letters of objection. However, to help us determine whether the proposed work complies with our public waters and floodway construction requirements, the following additional information should be submitted:

1. An assessment of the impact the proposed O'Dell Chute closure structure would have on sedimentation in the upstream portion of the chute;

2. An evaluation of the impacts the closure structure would have on the public's interests in, and uses of, the upstream portion of the chute; and

3. An assessment of the impacts the proposed closure structure and Long Island dredged material placement would have on normal and flood flows of the river. This assessment should consider the potential for and affects of similar floodway construction on Federal and other properties in the project reach.

Please feel free to contact Mike Diedrichsen of my staff at 217/782-3863 if you have any questions or comments.

Sincerely,

Dennis L. Kennedy, P.E.
Senior Water Resources Engineer

DLK:MLD:crw
cc: U.S. Army Corps of Engineers, Rock Island District (CEMVR-OD-390600)

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Custom House, Room 244
200 Chestnut Street
Philadelphia, Pennsylvania 19106-2904

IN REPLY REFER TO:

July 11, 2000

ER 00/349

Colonel James V. Mudd
District Engineer
Rock Island District, U.S. Army Corps of Engineers
Clock Tower Building
Rock Island, Illinois 61204-2004

Dear Colonel Mudd:

As requested, the Department of the Interior (Department) has reviewed the draft Definite Project Report with Integrated Environmental Assessment for the Gardner Division Habitat Rehabilitation and Enhancement Project, Pool 21 of the Upper Mississippi River (miles 332.5 through 340.2), Adams County, Illinois. The U.S. Fish and Wildlife Service (Service), as the Federal project sponsor, has worked closely with the U.S. Army Corps of Engineers (Corps) and the Illinois Department of Natural Resources (ILDNR) (non-Federal project partner) throughout the planning process to develop a project that will restore and protect the fish and wildlife resources of the project area. The Service will continue to work with the Corps and the ILDNR in the final design and evaluation of the project's enhancement measures. The subject document adequately addresses the environmental concerns of the Department.

We appreciate the opportunity to review the document and provide these comments.

Sincerely,

Michael T. Chezik

Michael T. Chezik
Regional Environmental Officer

Mark Twain National Wildlife Refuge

1704 N. 24th Street
Quincy, IL 62301
Phone: (217) 224-8580 Fax: (217) 224-8583

Memorandum

To: Darron Niles, Corps of Engineers, Rock Island District

From: Karen Westphall, USFWS, Mark Twain National Wildlife Refuge

Subject: Comments on Gardner Division Public Review Draft DPR

Date: August 8, 2000

Enclosed are comments from Mark Twain NWR on the draft Definite Project Report for the Gardner Division HREP. If you have any comments, please let me know. Thanks

Karen Westphall

cc: Heidi Woeber, RIFO
Dave Ellis, Annada District

Gardner Division HREP

Comments on Public Draft DPR
USFWS - Mark Twain National Wildlife Refuge
August 8, 2000

1. Side_Channel_and_Backwater_Restoration/Protection

   An on-site meeting with the Illinois DNR and a local angler has confirmed existing deep-water fisheries habitat in the upper part of O 'Dell Chute. In order to protect this habitat from sedimentation, the Refuge recommends moving the closing structure up to the head of Flannigan Island. A 5000-foot dredge cut would still be constructed at the downstream end of O'Dell Chute to ensure fish access to the chute and to provide additional overwintering habitat. This option is described on page 12, paragraph a.2 of the DPR.

   At the open house on June 22, the public expressed concern about the potential for increased sedimentation in Canton Chute if a closing structure is built in O'Dell Chute. In order to address this concern, post-project monitoring should be expanded include transects in Canton Chute.

2. Shoreline protection

   Construct as recommended in draft DPR with shoreline protection on all identified islands. (Note: Plate 2 should include stabilization at the head of Shandrew Island.)
   The Refuge recognizes and appreciates the use of Corps O&M funds for some of the shoreline protection sites. It is hoped that these sites can be scheduled for protection within the same time frame as the HREP sites in order to minimize further resource damage.

3. Reforestation

   Construct as recommended in draft DPR. Includes dredge material placement and tree planting only on the highest elevations of the field (67 acres total).

4. Long Island Lake

   Many public comments expressed concern about sedimentation at the lower end of Long Island Lake. The Corps should evaluate the feasibility of dredging the lower end of the lake to improve water exchange and fish access. In order to minimize project construction delays, this feature (if feasible) could be constructed as part of a future habitat enhancement project.

5. Other

   The Refuge also recommends evaluating the effects of removing ditch plugs from the upper end of Long Island. Natural channels on the island were blocked years ago to facilitate access to agricultural fields. If removed, would water flow to Long Island Lake increase? How would any increased flow affect the habitat quality and sedimentation rate in the lake?

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276

217/782-3362

THOMAS V. SKINNER, DIRECTOR

August 22, 2000

Rock Island District
Corps of Engineers
Clock Tower Building
Rock Island, Illinois 61204

RE: U.S. Army Corps of Engineers (Adams County)
Gardner Division HREP – Mississippi River
Log # C-0527-00 [CoE appl. # 390600]

This Agency received a request on April 24, 2000 from U.S. Army Corps of Engineers requesting necessary comments concerning the dredging of 77,500 cubic yards of material and other activities associated with the Gardner Division HREP. We offer the following comments.

Based on the information included in this submittal, it is our engineering judgment that the proposed project may be completed without causing water pollution as defined in the Illinois Environmental Protection Act, provided the project is carefully planned and supervised.

These comments are directed at the effect on water quality of the construction procedures involved in the above described project and are not an approval of any discharge resulting from the completed facility, nor an approval of the design of the facility. These comments do not supplant any permit responsibilities of the applicant toward the Agency.

This Agency hereby issues certification under Section 401 of the Clean Water Act (PL 95-217), subject to the applicant's compliance with the following conditions:

1. The applicant shall not cause:

   a. violation of applicable water quality standards of the Illinois Pollution Control Board, Title 35, Subtitle C: Water Pollution Rules and Regulation;

   b. water pollution defined and prohibited by the Illinois Environmental Protection Act; or

   c. interference with water use practices near public recreation areas or water supply intakes.

2. The applicant shall provide adequate planning and supervision during the project construction period for implementing construction methods, processes and cleanup procedures necessary to prevent water pollution and control erosion.

3. Any spoil material excavated, dredged or otherwise produced must not be returned to the waterway but must be deposited in a self-contained area in compliance with all state statutes, regulations and permit requirements with no discharge to waters of the State unless a permit has been issued by this Agency. Any backfilling must be done with clean material and placed in a manner to prevent violation of applicable water quality standards.

4. All areas affected by construction shall be mulched and seeded as soon after construction as possible. The applicant shall undertake necessary measures and procedures to reduce erosion during construction. Interim measures to prevent erosion during construction shall be taken and may include the installation of staked straw bales, sedimentation basins and temporary mulching. All construction within the waterway shall be conducted during zero or low flow conditions. The applicant shall be responsible for obtaining an NPDES Storm Water Permit *prior to initiating construction if the construction activity associated with the project will result in the* disturbance of 5 (five) or more acres, total land area. An NPDES Storm Water Permit may be obtained by submitting a properly completed Notice of Intent (NOI) form by certified mail to the Agency's Division of Water Pollution Control, Permit Section

5. The applicant shall implement erosion control measures consistent with the "Illinois Urban Manual" *(IEPA/USDA, NRCS; 1995).*

6. The proposed work shall be constructed with adequate erosion control measures (i.e., silt fences, straw bales, etc.) to prevent transport of sediment and materials to the adjoining wetlands.

This certification becomes effective when the Department of the Army, Corps of Engineers, includes the above condition # 1 through # 6 as conditions of the requested permit issued pursuant to Section 404 of PL 95-217.

This certification does not grant immunity from any enforcement action found necessary by this Agency to meet its responsibilities in prevention, abatement, and control of water pollution.

Sincerely,

Bruce J. Yurdin, Manager
Watershed Management Section
Bureau of Water

cc: IEPA, Records Unit
IEPA, DWPC, FOS, Springfield
IDNR, OWR, Springfield
USEPA, Region 5
U.S. Army Corps of Engineers

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

REPLY TO
ATTENTION OF

http://www.mvr.usace.army.mil

August 31, 2000

Ms. Mitvalsky/ab/5623

Engineering Division
Environmental Engineering Section

Subject: Gardner Division Habitat Rehabilitation and Enhancement Project, Mississippi River, Adams County

Mr. Mike Diedrichsen
Illinois Department of Natural Resources
Office of Water Resources
524 South Second Street
Springfield, Illinois 62701-1787

Dear Mr. Diedrichsen:

This letter is in response to your letter dated June 29, 2000, requesting more information prior to issuing an Illinois Department of Natural Resources, Office of Water Resources permit for the subject project. In this letter, you requested additional information on three items. These items and their responses are enclosed with this letter.

Please feel free to contact Kara Mitvalsky of my staff at telephone number 309/794-5623, or via electronic mail at Kara.N.Mitvalsky@mvr02 .usace.army.mil, if you have additional questions or comments.

Sincerely,

ORIGINAL SIGNED BY

John J. Copeland
For Joseph Raoul, Jr., P.E.
Chief, Engineering Division

Enclosures

Mr. Mike Diedrichsen
Illinois Department of Natural Resources
Office of Water Resources
524 South Second Street
Springfield, IL 62701-1787

Mike; August 31, 2000

This is a follow up to our telephone conversation on August 29th and your e-mail of August 30th both concerning the Gardner Division Habitat Rehabilitation and Enhancement Project. Specifically an accumulated effect of the cutoff wall and the dredge disposal on the water surface profiles needed to be studied. To answer that question the HEC-RAS model developed to study the possible impacts to flood heights of the cutoff wall was modified to include the dredge disposal area. The proposed dredge disposal is from approximately river mile 335 to 336 and runs between 500 and 1000 foot wide and 8 inches deep. I modeled a dredge disposal fill site that is 1,000 foot wide and 0.67 feet deep from river mile 334.9 to 336.6. The area modeled is larger than the proposed disposal area to fully account for any extra dredging that may occur. Enclosures one and two show the most downstream cross-section (334.9) under current conditions and with the dredge disposal placed in the agriculture field respectively. The 1% frequency flow (371,000 cfs), the flow resulting in a river water surface at the top of the cutoff wall under natural conditions (66,000 cfs) and the flow resulting in a water surface elevation at the top of the dredge disposal fill under natural conditions (110,400 cfs) were modeled for this study.

The 1% flow under natural conditions (defined here as without the cutoff wall or the dredge disposal fill) used flows from the *Upper Mississippi River Water Surface Profiles: River Mile 0.0 to River Mile 847.5*, Technical Flood Plain Management Task Force, November 1979, and used the 1% flood profile as the downstream boundary condition. The model was calibrated to match the profile in the study. Flat pool was used for the downstream boundary condition for both the 66,000 cfs and the 110,000 cfs flows.

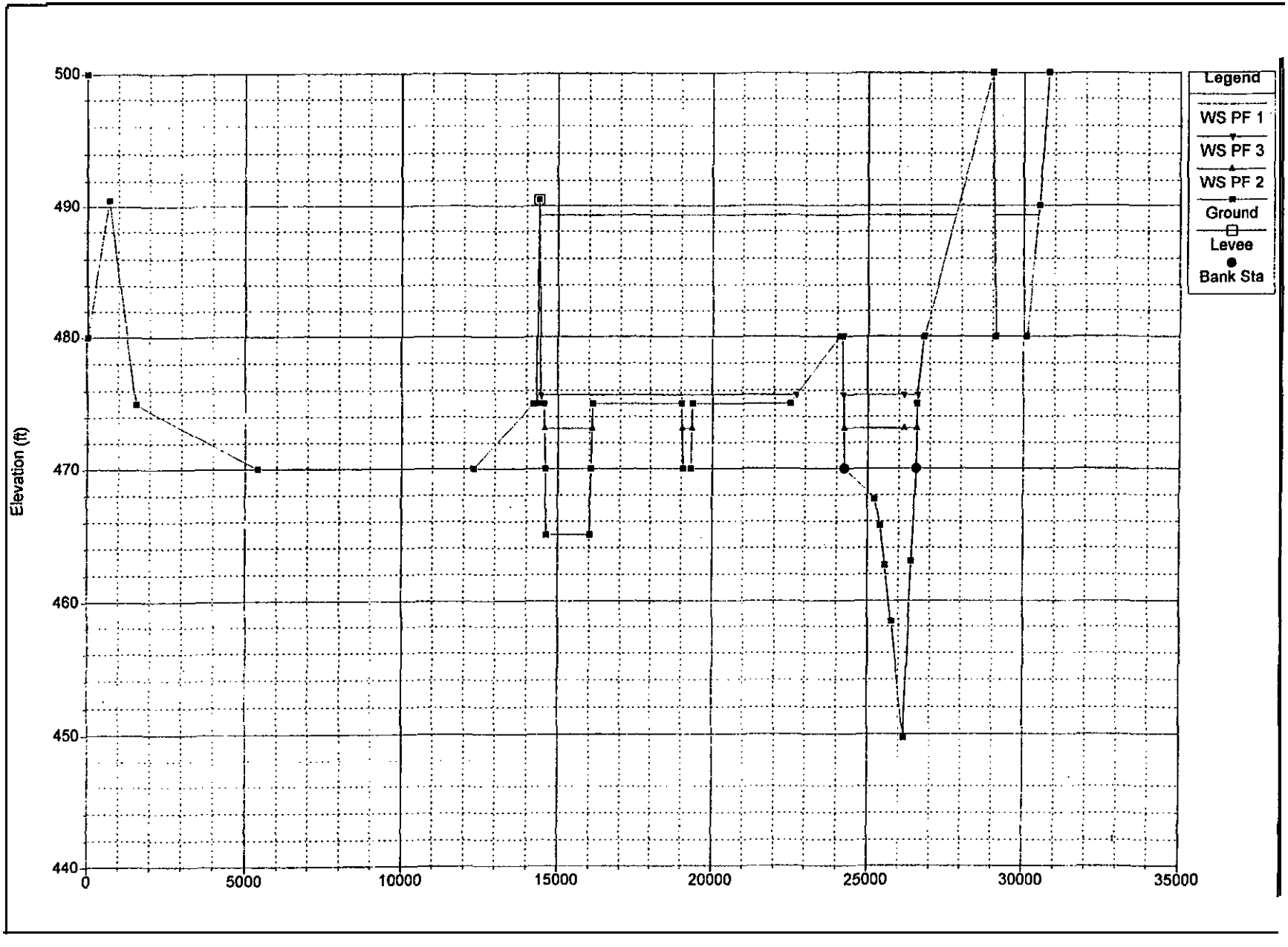
The water surface profile did not change for any of the flow conditions for either the with or without condition of the stone cutoff wall at the upper end of O'Dell Chute and the dredge disposal fill in the agriculture field. Enclosures three and four show the water surface profiles in tabular and graphic forms for the 1% flood, the cutoff wall overtopping event and the dredge disposal fill overtopping event.

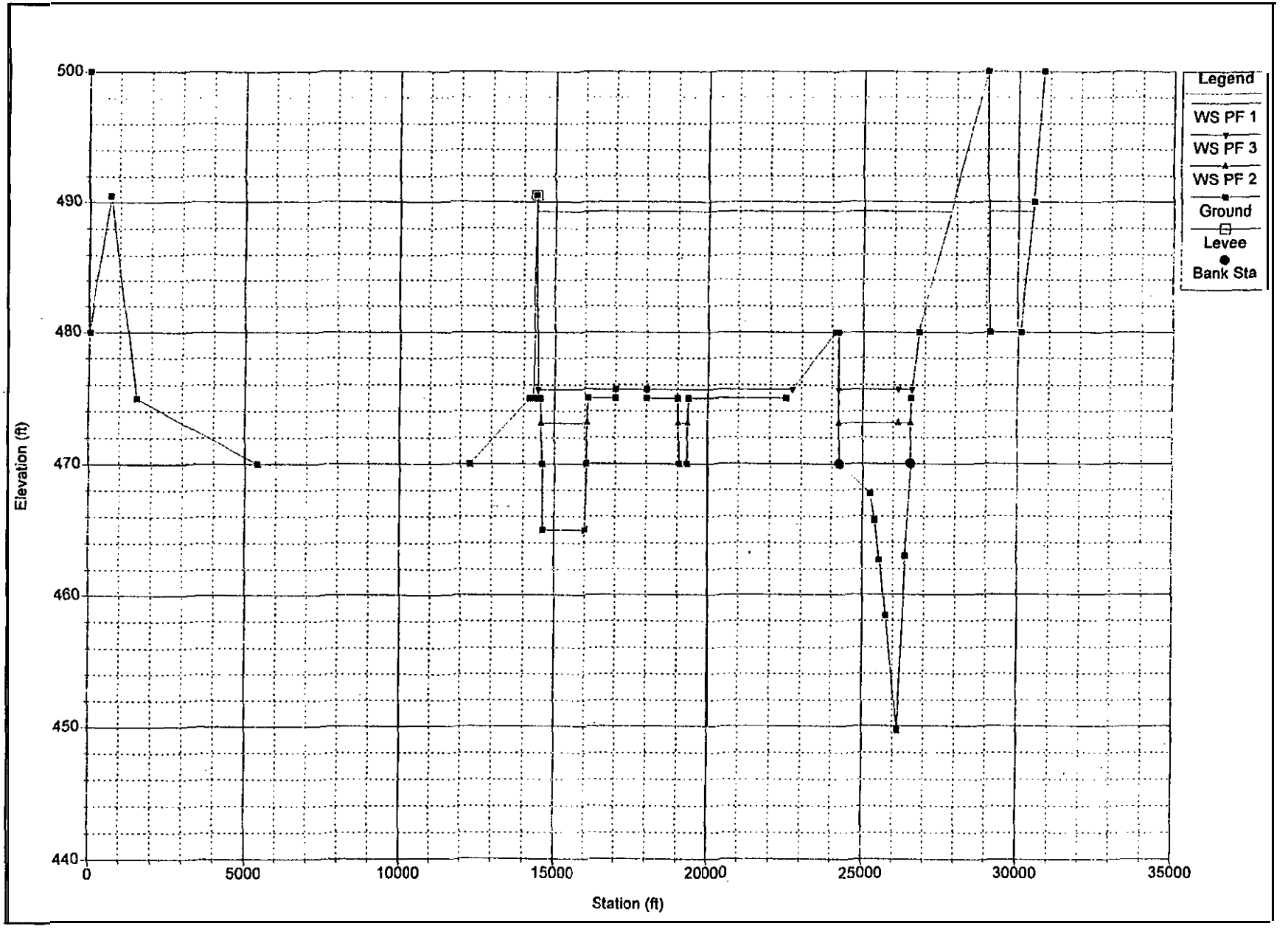
There is no similar work anticipated in this area in the future. Dredging in other backwater areas of Gardner Division was looked at, at various times in this study but was rejected by the U.S. Fish and Wildlife Service as unsustainable for habitat improvement. No other cutoff wall is feasible in this reach of the river. The plan includes the possibility of re-dredging the chute in 25 years. If the project is a success the extra fill area modeled

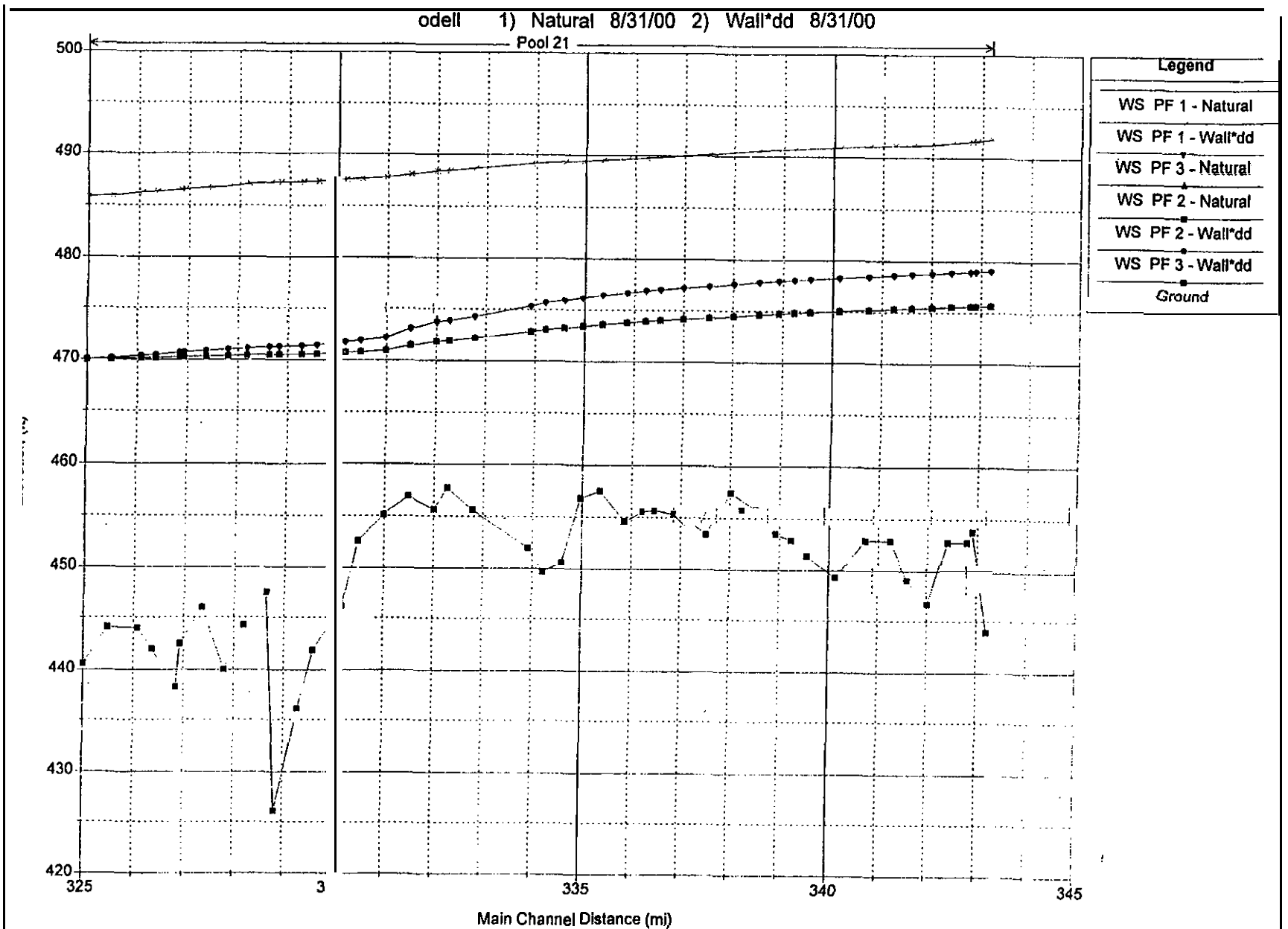
will be enough to contain the new dredge material and if the project is not successful then the dredging will not be done in 25 years.

If you need additional information from our office please contact David Martin at 309-794-5361 or david.l.martin@MVR02.usace.army.mil.

David L. Martin
Hydraulics Section


Legend
WS PF 1
WS PF 3
WS PF 2
Ground
Levee
Bank Sta
Elevation (ft)
500
490
480
470
460
450
440
0
5000
10000
15000
20000
25000
30000
35000


Legend
WS PF 1
WS PF 3
WS PF 2
Ground
Levee
Bank Sta
Elevation (ft)
500
490
480
470
460
450
440
0
5000
10000
15000
20000
25000
30000
35000
Station (ft)


odell 1) Natural 8/31/00 2) Wall*dd 8/31/00
Pool 21
500
490
480
470
460
450
440
430
420
325
3
335
340
345
Main Channel Distance (mi)
Legend
WS PF 1 - Natural
WS PF 1 - Wall*dd
WS PF 3 - Natural
WS PF 2 - Natural
WS PF 2 - Wall*dd
WS PF 3 - Wall*dd
Ground

HEC-RAS River: Illinois Reach: Pool 21

Reach	River Sta	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)
Pool 21	343.1	Natural	371000	444.0	491.87
Pool 21	343.1	Wall*dd	371000	444.0	491.87
Pool 21	343.1	Natural	66000	444.0	475.63
Pool 21	343.1	Wall*dd	66000	444.0	475.63
Pool 21	343.1	Natural	110400	444.0	479.08
Pool 21	343.1	Wall *dd	110400	444.0	479.08
Pool 21	342.8	Natural	371000	453.8	491.66
Pool 21	342.8	Wall*dd	371000	453.8	491.67
Pool 21	342.8	Natural	66000	453.8	475.58
Pool 21	342.8	Wall *dd	66000	453.8	475.58
Pool 21	342.8	Natural	110400	453.8	478.99
Pool 21	342.8	Wall* dd	110400	453.8	478.99
Pool 21	342.7	Natural	371000	452.8	491.63
Pool 21	342.7	Wall*dd	371000	452.8	491.63
Pool 21	342.7	Natural	66000	452.8	475.57
Pool 21	342.7	Wall*dd	66000	452.8	475.57
Pool 21	342.7	Natural	110400	452.8	478.97
Pool 21	342.7	Wall* dd	110400	452.8	478.97
Pool 21	342.69	Wall*dd	371000	452.8	491.47
Pool 21	342.69	Wall*dd	66000	452.8	475.52
Pool 21	342.69	Wall*dd	110400	452.8	478.89
Pool 21	342.65	Natural	371000	452.8	491.47
Pool 21	342.65	Natural	66000	452.8	475.51
Pool 21	342.65	Natural	110400	452.8	478.89
Pool 21	342.3	Natural	371000	446.7	491.29
Pool 21	342.3	Wall*dd	371000	446.7	491.30
Pool 21	342.3	Natural	66000	446.7	475.44
Pool 21	342.3	Wall *dd	66000	446.7	475.44
Pool 21	342.3	Natural	110400	446.7	478.79
Pool 21	342.3	Wall* dd	110400	446.7	478.79
Pool 21	341.9	Natural	371000	449.1	491.20
Pool 21	341.9	Wall*dd	371000	449.1	491.21
Pool 21	341.9	Natural	66000	449.1	475.37
Pool 21	341.9	Wall*dd	66000	449.1	475.37
Pool 21	341.9	Natural	110400	449.1	478.70
Pool 21	341.9	Wall * dd	110400	449.1	478.70
Pool 21	341.5	Natural	371000	452.9	491.20
Pool 21	341.5	Wall*dd	371000	452.9	491.20
Pool 21	341.5	Natural	66000	452.9	475.30
Pool 21	341.5	Wal l* dd	66000	452.9	475.30
Pool 21	341.5	Natural	110400	452.9	478.62
Pool 21	341.5	Wall*dd	110400	452.9	478.62
Pool 21	341	Natural	371000	452.9	491.09
Pool 21	341	Wall* dd	371000	452.9	491.09
Pool 21	341	Natural	66000	452.9	475.18
Pool 21	341	Wall*dd	66000	452.9	475.19
Pool 21	341	Natural	110400	452.9	478.48
Pool 21	341	Wall*dd	110400	452.9	478.49
Pool 21	340.9	Natural	371000	449.3	490.94
Pool 21	340.9	Wall* dd	371000	449.3	490.94
Pool 21	340.9	Natural	66000	449.3	475.03
Pool 21	340.9	Wall* dd	66000	449.3	475.03
Pool 21	340.9	Natural	110400	449.3	478.29
Pool 21	340.9	Wall*dd	110400	449.3	478.29
Pool 21	340.3	Natural	371000	451.4	490.81
Pool 21	340.3	Wall*dd	371000	451.4	490.81

Pool 21	340.3	Natural	66000	451.4	474.92
Pool 21	340.3	Wall*dd	66000	451.4	474.92
Pool 21	340.3	Natural	110400	451.4	478.15
Pool 21	340.3	Wall* dd	110400	451.4	478.15
Pool 21	340.0	Natural	371000	452.9	490.73
Pool 21	340.0	Wall *dd	371000	452.9	490.74
Pool 21	340.0	Natural	66000	452.9	474.84
Pool 21	340.0	Wall*dd	66000	452.9	474.84
Pool 21	340.0	Natural	110400	452.9	478.05
Pool 21	340.0	Wall*dd	110400	452.9	478.06
Pool 21	339.7	Natural	371000	453.5	490.66
Pool 21	339.7	Wall*dd	371000	453.5	490.67
Pool 21	339.7	Natural	66000	453.5	474.76
Pool 21	339.7	Wall*dd	66000	453.5	474.76
Pool 21	339.7	Natural	110400	453.5	477.95
Pool 21	339.7	Wall* dd	110400	453.5	477.96
Pool 21	339.3	Natural	371000	455.8	490.59
Pool 21	339.3	Wal l * dd	371000	455.8	490.59
Pool 21	339.3	Natural	66000	455.8	474.66
Pool 21	339.3	Wall*dd	66000	455.8	474.66
Pool 21	339.3	Natural	110400	455.8	477.85
Pool 21	339.3	Wall* dd	110400	455.8	477.85
Pool 21	338.8	Natural	371000	457.4	490.39
Pool 21	338.8	Wall*dd	371000	457.4	490.40
Pool 21	338.8	Natural	66000	457.4	474.50
Pool 21	338.8	Wall*dd	66000	457.4	474.50
Pool 21	338.8	Natural	110400	457.4	477.65
Pool 21	338.8	Wall*dd	110400	457.4	477.65
Pool 21	338.3	Natural	371000	453.4	490.16
Pool 21	338.3	Wall*dd	371000	453.4	490.17
Pool 21	338.3	Natural	66000	453.4	474.32
Pool 21	338.3	Wall*dd	66000	453.4	474.33
Pool 21	338.3	Natural	110400	453.4	477.42
Pool 21	338.3	Wall*dd	110400	453.4	477.42
Pool 21	337.8	Natural	371000	455.3	489.99
Pool 21	337.8	Wall*dd	371000	455.3	490.00
Pool 21	337.8	Natural	66000	455.3	474.17
Pool 21	337.8	Wall *dd	66000	455.3	474.18
Pool 21	337.8	Natural	110400	455.3	477.21
Pool 21	337.8	Wall*dd	110400	455.3	477.21
Pool 21	337.3	Natural	371000	455.6	489.85
Pool 21	337.3	Wall*dd	371000	455.6	489.85
Pool 21	337.3	Natural	66000	455.6	474.06
Pool 21	337.3	Wall*dd	66000	455.6	474.06
Pool 21	337.3	Natural	110400	455.6	477.04
Pool 21	337.3	Wall*dd	110400	455.6	477.05
Pool 21	337	Natural	371000	455.5	489.76
Pool 21	337	Wall*dd	371000	455.5	489.77
Pool 21	337	Natural	66000	455.5	473.97
Pool 21	337	Wall* dd	66000	455.5	473.97
Pool 21	337	Natural	110400	455.5	476.92
Pool 21	337	Wall*dd	110400	455.5	476.92
Pool 21	336.6	Natural	371000	454.6	489.66
Pool 21	336.6	Wall*dd	371000	454.6	489.66
Pool 21	336.6	Natural	66000	454.6	473.81
Pool 21	336.6	Wall*dd	66000	454.6	473.81
Pool 21	336.6	Natural	110400	454.6	476.69
Pool 21	336.6	Wal l* dd	110400	454.6	476.69
Pool 21	336.1	Natural	374000	457.5	489.55
Pool 21	336.1	Wal l *dd	374000	457.5	489.55
Pool 21	336.1	Natural	66000	457.5	473.64

Pool 21	336.1	Wall *dd	66000	457.5	473.64
Pool 21	336.1	Natural	110400	457.5	476.45
Pool 21	336.1	Wall*dd	110400	457.5	476.45
Pool 21	335.7	Natural	374000	456.8	489.44
Pool 21	335.7	Wall*dd	374000	456.8	489.44
Pool 21	335.7	Natural	66000	456.8	473.45
Pool 21	335.7	Wall*dd	66000	456.8	473.45
Pool 21	335.7	Natural	110400	456.8	476.18
Pool 21	335.7	Wall * dd	110400	456.8	476.16
Pool 21	335.3	Natural	374000	450.6	489.36
Pool 21	335.3	Wal l*dd	374000	450.6	489.36
Pool 21	335.3	Natural	66000	450.6	473.27
Pool 21	335.3	Wall* dd	66000	450.6	473.27
Pool 21	335.3	Natural	110400	450.6	475.93
Pool 21	335.3	Wall*dd	110400	450.6	475.90
Pool 21	334.9	Natural	374000	449.7	489.27
Pool 21	334.9	Wall*dd	374000	449.7	489.27
Pool 21	334.9	Natural	66000	449.7	473.10
Pool 21	334.9	Wall*dd	66000	449.7	473.10
Pool 21	334.9	Natural	110400	449.7	475.66
Pool 21	334.9	Wall*dd	110400	449.7	475.67
Pool 21	334.6	Natural	374000	452.0	489.16
Pool 21	334.6	Wall* dd	374000	452.0	489.16
Pool 21	334.6	Natural	66000	452.0	472.88
Pool 21	334.6	Wall*dd	66000	452.0	472.88
Pool 21	334.6	Natural	110400	452.0	475.30
Pool 21	334.6	Wal l* dd	110400	452.0	475.30
Pool 21	333.5	Nat ural	374000	455.6	488.71
Pool 21	333.5	Wall*dd	374000	455.6	488.71
Pool 21	333.5	Natural	66000	455.6	472.23
Pool 21	333.5	Wall*dd	66000	455.6	472.23
Pool 21	333.5	Natural	110400	455.6	474.32
Pool 21	333.5	Wall*dd	110400	455.6	474.32
Pool 21	333	Natural	374000	457.7	488.48
Pool 21	333	Wall*dd	374000	457.7	488.48
Pool 21	333	Natural	66000	457.7	471.95
Pool 21	333	Wall*dd	66000	457.7	471.95
Pool 21	333	Natural	110400	457.7	473.91
Pool 21	333	Wall*dd	110400	457.7	473.91
Pool 21	332.7	Natural	374000	455.6	488.41
Pool 21	332.7	Wall*dd	374000	455.6	488.41
Pool 21	332.7	Natural	66000	455.6	471.85
Pool 21	332.7	Wal l* dd	66000	455.6	471.85
Pool 21	332.7	Natural	110400	455.6	473.76
Pool 21	332.7	Wall*dd	110400	455.6	473.76
Pool 21	332.2	Natural	374000	456.9	488.07
Pool 21	332.2	Wall*dd	374000	456.9	488.07
Pool 21	332.2	Natural	66000	456.9	471.45
Pool 21	332.2	Wall*dd	66000	456.9	471.45
Pool 21	332.2	Natural	110400	456.9	473.13
Pool 21	332.2	Wal l* dd	110400	456.9	473.13
Pool 21	331.7	Natural	374000	455.1	487.70
Pool 21	331.7	Wall*dd	374000	455.1	487.70
Pool 21	331.7	Natural	66000	455.1	470.95
Pool 21	331.7	Wall*dd	66000	455.1	470.95
Pool 21	331.7	Natural	110400	455.1	472.23
Pool 21	331.7	Wall*dd	110400	455.1	472.23
Pool 21	331.2	Natural	374000	452.6	487.57
Pool 21	331.2	Wall*dd	374000	452.6	487.57
Pool 21	331.2	Natural	66000	452.6	470.78
Pool 21	331.2	Wal l *dd	66000	452.6	470.78

Pool 21	331.2	Natural	110400	452.6	471.92
Pool 21	331.2	Wall *dd	110400	452.6	471.92
Pool 21	330.9	Natural	374000	446.2	487.50
Pool 21	330.9	Wall *dd	374000	446.2	487.50
Pool 21	330.9	Natural	66000	446.2	470.71
Pool 21	330.9	Wall* dd	66000	446.2	470.71
Pool 21	330.9	Natural	110400	446.2	471.76
Pool 21	330.9	Wall*dd	110400	446.2	471.76
Pool 21	330.3	Natural	374000	441.9	487.33
Pool 21	330.3	Wal l* dd	374000	441.9	487.33
Pool 21	330.3	Natural	66000	441.9	470.56
Pool 21	330.3	Wall *dd	66000	441.9	470.56
Pool 21	330.3	Natural	110400	441.9	471.42
Pool 21	330.3	Wal l* dd	110400	441. 9	471.42
Pool 21	330	Natural	374000	436.1	487.27
Pool 21	330	Wall*dd	374000	436.1	487.27
Pool 21	330	Natural	66000	436.1	470.52
Pool 21	330	Wall*dd	66000	436.1	470.52
Pool 21	330	Natural	110400	436.1	471.34
Pool 21	330	Wall* dd	110400	436.1	471.34
Pool 21	329.5	Natural	374000	426.1	487.24
Pool 21	329.5	Wal l* dd	374000	426.1	487.24
Pool 21	329.5	Natural	66000	426.1	470.49
Pool 21	329.5	Wal l* dd	66000	426.1	470.49
Pool 21	329.5	Natural	110400	426.1	471.28
Pool 21	329.5	Wal l * dd	110400	426.1	471.28
Pool 21	328.9	Natural	374000	447.5	487.20
Pool 21	328.9	Wal l* dd	374000	447.5	487.20
Pool 21	328.9	Natural	66000	447.5	470.48
Pool 21	328.9	Wall*dd	66000	447.5	470.48
Pool 21	328.9	Natural	110400	447.5	471.24
Pool 21	328.9	Wall*dd	110400	447.5	471.24
Pool 21	328.4	Natural	374000	444.3	487.09
Pool 21	328.4	Wal l* dd	374000	444.3	487.09
Pool 21	328.4	Natural	66000	444.3	470.42
Pool 21	328.4	Wal l *dd	66000	444.3	470.42
Pool 21	328.4	Natural	110400	444.3	471.09
Pool 21	328.4	Wall*dd	110400	444.3	471.09
Pool 21	328	Natural	374000	440.0	486.81
Pool 21	328	Wal l* dd	374000	440.0	486.81
Pool 21	328	Natural	66000	440.0	470.38
Pool 21	328	Wal l* dd	66000	440.0	470.38
Pool 21	328	Natural	110400	440.0	470.99
Pool 21	328	Wall*dd	110400	440.0	470.99
Pool 21	327.5	Natural	374000	446.0	486.68
Pool 21	327.5	Wall*dd	374000	446.0	486.68
Pool 21	327.5	Natural	66000	446.0	470.32
Pool 21	327.5	Wall*dd	66000	446.0	470.32
Pool 21	327.5	Natural	110400	446.0	470.85
Pool 21	327.5	Wall*dd	110400	446.0	470.85
Pool 21	327	Natural	374000	442.5	486.55
Pool 21	327	Wall* dd	374000	442.5	486.55
Pool 21	327	Natural	66000	442.5	470.27
Pool 21	327	Wal l*dd	66000	442.5	470.27
Pool 21	327	Natural	110400	442.5	470.74
Pool 21	327	Wal l* dd	110400	442.5	470.74
Pool 21	326.9	Natural	374000	438.3	486.50
Pool 21	326.9	Wall*dd	374000	438.3	486.50
Pool 21	326.9	Natural	66000	438.3	470.26
Pool 21	326.9	Wall *dd	66000	438.3	470.26
Pool 21	326.9	Natural	110400	438.3	470.69

Pool 21	326.9	Wall*dd	110400	438.3	470.69
Pool 21	326.4	Natural	374000	442.0	486.29
Pool 21	326.4	Wall*dd	374000	442.0	486.29
Pool 21	326.4	Natural	66000	442.0	470.17
Pool 21	326.4	Wall* dd	66000	442.0	470.17
Pool 21	326.4	Natural	110400	442.0	470.45
Pool 21	326.4	Wall*dd	110400	442.0	470.45
Pool 21	326.1	Natural	374000	444.0	486.25
Pool 21	326.1	Wall*dd	374000	444.0	486.25
Pool 21	326.1	Natural	66000	444.0	470.14
Pool 21	326.1	Wall*dd	66000	444.0	470.14
Pool 21	326.1	Natural	110400	444.0	470.39
Pool 21	326.1	Wall *dd	110400	444.0	470.39
Pool 21	325.5	Natural	374000	444.1	485.92
Pool 21	325.5	Wall*dd	374000	444.1	485.92
Pool 21	325.5	Natural	66000	444.1	470.05
Pool 21	325.5	Wall*dd	66000	444.1	470.05
Pool 21	325.5	Natural	110400	444.1	470.13
Pool 21	325.5	Wall*dd	110400	444.1	470.13
Pool 21	325	Natural	374000	440.6	485.80
Pool 21	325	Wall*dd	374000	440.6	485.80
Pool 21	325	Natural	66000	440.6	470.00
Pool 21	325	Wall*dd	66000	440.6	470.00
Pool 21	325	Natural	110400	440.6	470.00
Pool 21	325	Wall*dd	110400	440.6	470.00

APPENDIX B

CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

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

REPLY TO
ATTENTION OF:

CEMVR-PM-AR

CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 21, MISSISSIPPI RIVER MILES 332.5 THROUGH 340.2
ADAMS COUNTY, ILLINOIS

SEPTEMBER 2000

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-15F)

GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 21, MISSISSIPPI RIVER MILES 332.5 THROUGH 340.2
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SECTION 1 - PROJECT DESCRIPTION

LOCATION

The proposed project is located on the left descending bank of the Mississippi River (River Miles 332.5-340.2) in Adams County, Illinois. The Gardner Division complex is just north of Quincy, Illinois.

The lands comprising the Gardner Division complex are owned by the U.S. Army Corps of Engineers (Corps) but are managed by the U.S. Fish and Wildlife Service and the Illinois Department of Natural Resources for the benefit of both game and nongame wildlife species. The project area consists of approximately 6,300 acres of bottomland hardwood wetlands, cultivated croplands, and aquatic habitats. See Figure ES-1 of the DPR (Definite Project Report).

GENERAL DESCRIPTION

By definition and Federal regulatory jurisdiction, much of the site is classified as wetland or "waters of the United States" and is therefore subject to evaluation and regulation under Section 404 of the Clean Water Act.

The Gardner Division Habitat Rehabilitation and Enhancement Project includes dredging and construction of a closure dam in the O'Dell Chute side channel, placing rock shoreline protection on several of the islands in the complex, and planting of mast-producing trees on a portion of the historically cultivated cropland. These improvements would benefit both game and nongame fish and wildlife and would enhance overall habitat diversity. A more detailed description of project features and expected benefits is provided in the main text of the DPR, of which this Evaluation is an appendix.

AUTHORITY AND PURPOSE

Authority for the proposed project is provided by the 1985 Supplemental Appropriations Act (Public Law 99-88) and Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-62), as amended (see Section 1.f. of the DPR).

The purpose of this project, under Section 1103, is "to ensure the coordinated development and enhancement of the Upper Mississippi River (UMR)." The project is the result of planning efforts by the State of Illinois, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.

GENERAL DESCRIPTION OF DREDGED AND FILL MATERIAL

Fill material for shoreline protection would consist of approximately 16,600 tons of riprap and 9,700 tons of bedding stone. Rock material for construction of the closure structure at the head of O'Dell Chute would consist of approximately 4,400 tons of riprap stone. All riprap and bedding stone would be inert and uncontaminated rock obtained from an approved source. Rock up to 450 pounds in size would be used for all structures. In addition to the rock placed for shoreline protection as part of the EMP project, approximately 23,650 tons of riprap and 13,750 tons of bedding stone would be placed as shoreline protection for channel maintenance purposes.

Material to be dredged from O'Dell Chute and from the closure structure's access channel will be placed on an adjacent agricultural field. Approximately 83,000 cubic yards of fine to medium sand will be dredged. Placing this material would require using approximately 60 to 80 acres of this agricultural field.

Other materials being placed on Long Island include 3,551 mast-producing trees planted on 67 acres of the dredged material placement site (on the agricultural field). This vegetative material can be considered exempt from this evaluation.

DESCRIPTION OF PROPOSED PLACEMENT SITES

The proposed rock placement sites are adjacent to the main channel border and side channel habitats. The sites are open water, unconfined, and along the bankline. Rock would be placed along 7,700 linear feet of bankline (3,200 feet for the EMP project; 4,500 feet for channel maintenance purposes).

The proposed action would require the clearing of existing shoreline vegetation along a zone approximately 20 feet landward of and adjacent to rock placement sites. The total area to be cleared is approximately 4 acres.

Placement of dredged material from O'Dell Chute would be on the easternmost agricultural field on Long Island. Material would be placed on the field in locations currently at higher elevations and graded to a depth of approximately 8 inches. Approximately 60-80 acres of the 184-acre field would be used for dredged material placement.

DESCRIPTION OF PLACEMENT METHOD

Placement of rock material for bankline protection typically involves the use of deck-mounted cranes and/or derricks, deck barges, endloaders, quarter boats, and tender craft. Materials are dumped to alignment and spread to profile. Large-grade stone is placed by crane or derrick. Shoreline work may potentially involve clearing of flood debris or young cottonwood and silver maple by endloaders and/or bulldozers.

Placement of dredged material from O'Dell Chute on the eastern agricultural field would be by hydraulic dredging, with bulldozers or other earth-moving equipment used to grade and shape the material to the desired depth. Shoreline disturbance at the dredging and closure dam construction sites is expected to be minimal.

SECTION 2 - FACTUAL DETERMINATIONS

PHYSICAL SUBSTRATE DETERMINATIONS

The elevation and slope of all rock placement sites would change as indicated on DPR plate 6. The actual increase varies across the river bottom cross section, depending on depth. The existing bottom elevations adjacent to the structures also may vary. Undercutting of the bank often causes tons of sediment and toppled trees to enter the river. Placement of bankline protection along the shore should prevent degradation and ensure integrity of the shoreline.

Material placed for shoreline protection would be quarried limestone, up to 450 pounds in size, for all structures. Movement of material off site would be negligible due to the large-sized rock used for construction.

Material placement should not significantly affect benthic inhabitants. Existing benthos populations along the shoreline are expected to be minimal due to the degraded and unstable condition of the banks. The newly deposited rock would provide a stable, permanent substrate that should increase benthos populations following construction.

Actions Taken to Minimize Impacts

Minimal vegetation impacts are expected to result from the proposed action. Faunal impacts would be limited to short-term disruption of the aquatic and terrestrial shoreline community. Construction would be scheduled to avoid impacting threatened and endangered species. The proposed action would provide a more diverse aquatic substrate than presently exists at the construction site.

WATER CIRCULATION, FLUCTUATION, AND SALINITY DETERMINATIONS

Water

Typically, analysis of sand and rock substrates, such as those found in the immediate project area, reveals little evidence of pollutants due to the limited surface area of sand-size particles and the lack of strong chemical bonding of contaminants to sand grains.

Any contaminants in sandy materials would be those typically contained or transported by normal fluvial processes and as such would be common constituents of the Upper Mississippi River System. Any activity that would disturb the existing substrate would therefore not be anticipated to alter water chemistry in the water column.

Clarity and turbidity of the river varies with seasonal flow. Placement sites and methods have been selected to minimize impacts to clarity, color, odor, taste, dissolved gas levels, nutrients, and biochemical oxygen demand in the riverine environment. Discharge of rock would stabilize finer substrate materials; terrestrial placement of rock shoreline protection would minimize water quality impacts.

Nonriverine originated components such as rock fill, capstone, concrete, and steel that may be placed temporarily or permanently during construction would be physically stable and chemically noncontaminating.

Current Patterns and Circulation

Placement of rock shoreline protection at identified sites on the islands would not significantly affect currents and flow. There would not be any noticeable alteration in current patterns upstream or downstream of the project. Changes in aquatic resources are difficult to predict, but there may be a trend toward a less erosive type of aquatic environment. Main channel velocities would not be affected by the proposed action.

Current velocity would decrease in O'Dell Chute following construction of the closure structure.

Limnological stratification is not applicable to this action

Normal Water Level Fluctuations

No effects on normal seasonal river stages are anticipated to result from any of the proposed placements.

Salinity Gradients

The proposed action would take place in a freshwater river system. Therefore, no consideration of salinity gradients is warranted for these actions.

Actions Taken to Minimize Impacts

The use of chemically stable materials and physical stabilization of materials by design are actions intended to reduce impacts to the riverine system.

SUSPENDED PARTICULATE/TURBIDITY DETERMINATIONS

Rock placement along the bankline would decrease the suspended particulates now originating from the shoreline erosion. All other completed structures would have negligible effects on turbidity and suspended particulates.

Effects on Chemical and Physical Properties of Water Column

The proposed action is not expected to affect light penetration, dissolved oxygen levels, toxic metals and organics, pathogens, or aesthetics.

Effects on Biota

Adverse effects to biota, including primary producers (e.g., zooplankton and phytoplankton), suspension/filter feeders, and sight feeders, are expected to be short-term. Invertebrate populations of may flies, caddisflies, stoneflies, and other aquatic insects would increase on the additional rock substrate provided.

Actions Taken to Minimize Impacts

Impacts are expected to be minimized by placement site selection, placement methods, and the use of chemically noncontaminating and physically stable materials for project construction.

CONTAMINANT DETERMINATIONS

Rock fill material would be clean, uncontaminated stone from an approved source.

AQUATIC ECOSYSTEM AND ORGANISM DETERMINATIONS

Because the likelihood of contamination by pollutants is generally low for projects involving rock placement, impacts to the aquatic ecosystem are anticipated to be negligible.

Effects on plankton are anticipated to be minimal. Negative effects on benthos would be limited to elimination of those organisms currently inhabiting the immediate placement sites. The placement of rock fill should provide interstitial spaces for invertebrate production and limited vertebrate spawning potential. The benthic community present in O 'Dell Chute may show an increase in species preferring quiet waters, since flows would be diminished.

Effects on nekton would be limited to displacement and temporary disruption of foraging patterns. Because the proposed activities are generally conducted in low-flow (hence nonspawning seasons), impacts to spawning species should be negligible. Fish populations would benefit from shoreline protection and closure structure construction. Riprap, through invertebrate colonization, would provide an excellent food source and possible spawning sites.

Effects on the aquatic food web are expected to be beneficial overall by increasing production at the lower trophic levels.

Effects on special aquatic sites should be negligible in the project area; no sanctuaries or refuges would be adversely affected by the proposed action. No wetlands or mudflats, vegetated shallows, coral reefs, or riffle and pool complexes would be adversely affected by the proposed action.

Threatened and endangered species use of, or existence in, the project area is discussed in the Environmental Assessment. No significant impacts or effects to endangered species are anticipated to result from this action.

Other wildlife, such as the river otter, muskrat, and beaver that may move through and around the project area, should only be affected to the extent of temporary travel disruption. No food chain or critical habitat requirements would be affected by the proposed actions.

PROPOSED PLACEMENT SITE DETERMINATIONS

The fill material is inert and would not mix with the water. The lack of fine particulates typically contained in rock fill and main channel sand indicates negligible chemical or turbidity effects resulting from this action.

Due to the nature of the fill material, all discharges are anticipated to be in compliance with Illinois State water quality standards.

The proposed action should have no effect on municipal or private water supplies. Recreational or commercial fisheries may experience a slight benefit from the proposed action. Water-related recreation would not be affected. Aesthetics are generally negatively affected by this type of construction activity; however, the exposed rock would eventually weather and blend in with the adjacent shoreline.

DETERMINATION OF CUMULATIVE EFFECTS ON THE AQUATIC ECOSYSTEM

Placement of rock would benefit aquatic resources by adding diversity to the substrate in this reach of the river. This diversity should provide crevices and interstices in which certain aquatic organisms can feed and reproduce. Temporary turbidity impacts may occur on and off site but would be short-term in duration. No cumulative negative impacts are expected to result from this action. Beneficial impacts are anticipated for wetlands, wildlife, and fish. Long-term productivity would be enhanced by the proposed action. For these reasons, shoreline protection and placement of dredged material at the mast tree planting site would have a cumulative positive effect on the aquatic ecosystem.

DETERMINATION OF SECONDARY EFFECTS ON THE AQUATIC ECOSYSTEM

Any negative impacts resulting from the proposed placement are expected to remain localized and short-term in nature. Resuspension of existing substrate material during project construction would not contribute to any significant impacts to the aquatic ecosystem.

SECTION 3 - FINDINGS OF COMPLIANCE OR NONCOMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT POOL 21, MISSISSIPPI RIVER MILES 332.5 THROUGH 340.2 ADAMS COUNTY, ILLINOIS

1. No significant adaptations of the 404(b)(1) guidelines were made relative to this evaluation.

2. Alternatives that were considered for the proposed action were as follows:

No Federal Action. No Federal action in this instance means no change in land cover or current management practices.

Preferred Alternative. Dredge O'Dell Chute side channel and construct a closure structure; place rock protection on shorelines of selected islands in the Gardner Division complex; plant mast-producing trees on approximately 67 acres of the eastern agricultural field on Long Island.

Management Measures Considered but Not Selected.

Several management measures were considered for construction but not selected based on engineering feasibility, environmental impacts, cost, and/or inability to meet the goals and objectives of the Corps of Engineers, the U.S. Fish and Wildlife Service, and the State of Illinois. These measures included construction of a sediment deflection levee, dredging additional side channels, notching of existing wing dams, construction of low berms or potholes for passive management ponds, establishing water control capability on Long Island Lake, planting all historical agricultural fields to mast-producing trees, and implementing sedimentation control measures on Bear Creek.

3. Permits, certification, or waiver of certification under Section 404 of the Clean Water Act would be obtained before construction begins. The project would be in compliance with water quality standards of the State of Illinois as applicable.

4. The project is not anticipated to introduce toxic substances into nearby waters or result in appreciable increases in existing levels of toxic materials.

5. No significant impact to Federal or state listed threatened or endangered species would result from the proposed action.

6. The project is situated along an inland freshwater river system. No marine sanctuaries are involved or would be affected by the proposed action.

7. No municipal or private water supplies would be affected by the proposed action, and no degradation of waters of the United States is anticipated to result from the proposed action. While Gardner Division can be classified as a special aquatic site, environmental improvements resulting from the proposed action would outweigh short-term construction impacts and offset some of the habitat degradation caused by siltation and shoreline erosion. No long-term adverse effects to the river ecosystem are expected to result from this action.

8. The materials used for construction would be chemically and physically stable and noncontaminating.

9. No other practical alternatives have been identified. The proposed action is in compliance with Section 404(b)(1) of the Clean Water Act, as amended. The proposed action would not significantly impact water quality and would improve the integrity of an authorized navigation system.

25 September 2000
Date

William J. Bayles
Colonel, U.S. Army
District Engineer

APPENDIX C

DRAFT MEMORANDUM OF AGREEMENT

MEMORANDUM OF AGREEMENT
BETWEEN
THE UNITED STATES FISH AND WILDLIFE SERVICE
AND
THE DEPARTMENT OF THE ARMY
FOR
GARDNER DIVISION HABITAT
REHABILITATION AND ENHANCEMENT
OF THE
UPPER MISSISSIPPI RIVER SYSTEM
AT
MISSISSIPPI RIVER POOL 21, ADAMS COUNTY, ILLINOIS

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 (USFWS) and the Department of the Army (DOA) will operate in constructing, operating, maintaining, repairing, and rehabilitating the Gardner Division Refuge Area, Illinois, separable element of the Upper Mississippi River System - Environmental Management Program (UMRS-EMP).

II. BACKGROUND

Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662, authorizes construction of measures for the purpose of enhancing fish and wildlife resources in the Upper Mississippi River System. The project area is managed by the USFWS and is on land managed as a national wildlife refuge. Under conditions of Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, 100 percent of the construction costs of those fish and wildlife features for the Gardner Division Refuge area are the responsibility of the DOA, and pursuant to Section 107 (b) of the Water Resources Development Act of 1992, Public Law 102-580, 100 percent of the cost of operation and maintenance for the Gardner Division Refuge Area are the responsibility of USFWS.

III. GENERAL SCOPE

The project to be accomplished pursuant to this MOA shall consist of the following: a. Dredging 5,000 feet of O'Dell Chute and constructing an emergent closure structure at the upstream end of the chute. b. Protecting the shorelines and head ends of

selected islands. and c. Planting 67 acres of mast-producing trees on the dredged material placement site located on Long Island's eastern agricultural field.

IV. RESPONSIBILITIES

A. DOA is responsible for:

1. Construction. Construction of the project consists of Mast Tree Planting, Shoreline Rock Protection, and Emergent Closure Structure and O'Dell Chute Dredging Enhancements.

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

3. Construction Management. Subject to and using funds appropriated by the Congress of the United States, and in accordance with Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, DOA will construct the Gardner Division, Illinois, Habitat Rehabilitation and Enhancement Project as described in the "Upper Mississippi River System Environmental Management Program Definite Project Report with Integrated Environmental Assessment (R-15F)," dated _____ applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The USFWS will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. If DOA encounters potential delays related to construction of the project, DOA will promptly notify USFWS of such delays.

4. Maintenance of Records. The DOA will keep books, records, documents, and other evidence pertaining to costs and expenses incurred in connection with construction of the project to the extent and in such detail as will properly reflect total costs. The DOA shall maintain such books, records, documents, and other evidence for a minimum of three years after completion of construction of the project and resolution of all relevant claims arising therefrom, and shall make available at its offices, at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the USFWS.

B. The USFWS is responsible for Operation, Maintenance and Repair:

Upon completion of constructionas determined by the District Engineer, Rock Island, the USFWS shall accept the Project and shall operate, maintain, and repair the project as defined in the definite project report entitled " Upper Mississippi River System Environmental Management Program Definite Project Report with Integrated Environmental Assessment (R-15F)," dated _____, in accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580.

V. MODIFICATION AND TERMINATION

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

VI. REPRESENTATIVES

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

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

DOA: District Engineer
U.S. Army Engineer District, Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

VII. EFFECTIVE DATE OF MOA

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

THE DEPARTMENT OF THE ARMY THE U.S. FISH AND WILDLIFE SERVICE

BY: _____
WILLIAM J. BAYLES
Colonel, U.S. Army
District Engineer

BY: _____
WILLIAM F. HARTWIG
Regional Director
U.S. Fish and Wildlife Service

DATE : _____

DATE : _____

APPENDIX D

HABITAT EVALUATION AND QUANTIFICATION AND INCREMENTAL COST ANALYSIS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-15F)

GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT

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APPENDIX D
HABITAT EVALUATION AND QUANTIFICATION AND INCREMENTAL COST ANALYSIS

1. INTRODUCTION

A habitat analysis was conducted to evaluate the potential benefits of alternative habitat improvement features at Gardner Division. Active participants included biologists from the Rock Island District of the U.S. Army Corps of Engineers; the U.S. Fish and Wildlife Service, Rock Island Ecological Service Office; and the Illinois Department of Natural Resources.

The need for quantification of HREP (Habitat Rehabilitation and Enhancement Project) outputs as a project performance evaluation tool, a project ranking tool, and a project planning tool has been discussed by various agencies associated with the UMRS-EMP. This application involves quantification solely for the purpose of project planning.

Quantification of outputs is expressed in Habitat Units (HUs). HUs are a measure of habitat quality (habitat suitability indices, or HSI) and quantity (acres). Annualization of HUs can then be used to determine changes brought about by project features/alternatives over time. This annualization computes average annual habitat units (AAHUs). Once construction begins and as a project matures, habitat changes occur, and therefore habitat benefits may change. Many features, such as tree planting, would not begin to show benefits until well into the project life. The particular dynamics of the ecosystem under study then determine the target years chosen for analysis. With or without a project, habitat conditions change over time; therefore, the overall value of a proposed project depends upon the comparison of with-project benefits and without-project benefits.

Comparison of alternative designs and combinations of features is accomplished through cost-effectiveness evaluation and incremental cost analysis. Cost-effectiveness evaluation is used to identify the least costly solution to achieve a range of project benefits. Incremental cost analysis is a tool that can be used to scale the size of the project or of individual features by determining changes in costs associated with increasing levels of benefits.

2. HABITAT EVALUATION METHODOLOGY

The methodology used in this evaluation was the Wildlife Habitat Appraisal Guide (WHAG).[1] The WHAG was developed by the Missouri Department of Conservation and the U.S. Department of Agriculture, Soil Conservation Service (now NRCS). It is a field evaluation procedure designed to

[1] D. L. Urich and others, "Habitat Appraisal of Private Land in Missouri," *Wildlife Society Bulletin* 12 (1984): 350-356.

estimate habitat quality and account for changes due to land management practices. Checklist-type appraisal guides are used for upland, wetland, and aquatic habitats, and computer programs are used to analyze field data in terms of habitat suitability for various evaluation species. This analysis employed a multi-agency team approach with representatives from the Corps of Engineers, the U.S. Fish and Wildlife Service, and the Illinois Department of Natural Resources.

The WHAG analysis is a numerical system for evaluating the quality and quantity of particular habitats for species selected by WHAG team members. The qualitative component of the analysis is known as the habitat suitability index (HSI) and is rated on a 0.1 to 1.0 scale. The suitability of a given habitat type for a set of evaluation species is determined by the qualitative characteristics of the habitat type. The WHAG procedures include the use of limiting factors, which is a habitat requirement for an individual species during a critical time of year. Absence of that habitat characteristic makes the habitat unsuitable and results in the lowest HSI value of 0.1. Habitat quality ratings can be improved by: (1) increasing acreages for particular habitat types that may be limited or lacking; (2) altering a limiting factor, such as unpredictable water levels; (3) altering a management strategy, such as cropping practice or cover crop composition; or (4) a combination of the preceding, depending on management goals, target species requirements, or available funds.

The quantitative component of the WHAG analysis is the measure of acres of habitat that are available for the selected species. From the qualitative and quantitative determinations, the standard unit of measure, the habitat unit (HU), is calculated using the formula (HSI x Acres = HUs). For project planning and impact analysis, project life was established as 50 years. To facilitate comparison, target years were established at 0 (existing conditions), 1, 25, and 50 years. HSIs and average annual habitat units (AAHUs) for each evaluation species were calculated to reflect expected habitat conditions over the life of the project.

Prior to field evaluation, the study team reviewed aerial photography, topographic maps, and preliminary design drawings. During field evaluation, assumptions were developed regarding existing conditions and projected post-project conditions relative to limiting factors and management practices.

3. EVALUATION SPECIES SELECTION

Table D-1 lists the evaluation species used in this analysis. These species are an established set in the WHAG model. Although a set list of species has been used, each species represents a guild of other similar species that utilize the habitat in similar ways. In essence, each species represents an array of habitat variables for the species being evaluated. These species represent key management goals and objectives of the Gardner Division HREP.

TABLE D-1. Evaluation Species Selected for Habitat Analysis

Species	Scientific Name	Habitat Evaluated
Channel catfish	*Ictalurus punctatus*	aquatic
Sauger	*Stizostedion canadense*	aquatic
Largemouth bass	*Micropterus salmoides*	aquatic
Gizzard shad	*Dorosoma cepedianum*	aquatic
Carp	*Cyprinus carpio*	aquatic
Bluegill	*Lepomis macrochirus*	aquatic
Black bullhead	*Ictalurus melas*	aquatic
Mallard	*Anas platyrhynchos*	non forested wetland
Canada goose	*Branta canadensis*	non forested wetland
Green-backed heron	*Butorides striatus*	non forested wetland
Wood duck	*Aix sponsa*	forested wetland
Beaver	*Castor canadensis*	forested wetland
Northern parula	*Parula americana*	forested wetland
Prothonotary warbler	*Protonotaria citrea*	forested wetland

Seven fish species were used to evaluate restoration and protection of side channel habitat and the aquatic component of protection of island shorelines. Channel catfish, sauger, and gizzard shad are fish that commonly inhabit main channel and channel border habitats. Largemouth bass and bluegill are centrarchids that inhabit side channels and backwaters, and are important sport fish species. Carp and black bullhead are common and abundant in backwater habitats. All seven species utilize backwater areas as spawning habitat.

Seven wildlife species were used to evaluate the reforestation of agricultural fields on Long Island. Mallard and Canada goose are migratory waterfowl that utilize early successional wetland habitat and have socioeconomic importance as game species. The green-backed heron is a wading bird found in midsuccessional herbaceous and shrub dominated wetland habitat. The beaver is a resident furbearing mammal that utilizes early successional forest habitat. The wood duck is a waterfowl species that favors mature forested wetland habitat with abundant snags and cavity trees. The parula and prothonotary warbler are neotropical migrant songbirds that utilize mature forested wetland habitat during the breeding season.

4. ASSUMPTIONS

Several assumptions have been made in regards to model performance, changes in habitat conditions over time, and future management practices.

a. Model Performance. The WHAG was designed to be applied to many different types of habitat. In order to evaluate the benefits of restoration and protection of O' Dell Chute, a field data sheet was prepared using the aquatic (MOFISH) matrix for side channel habitat.

WHAG team members completed field data sheets for the Cropfield-Wetland matrix and the Bottomland Hardwoods-Wetland matrix in order to evaluate without-project and with-project conditions for the reforestation feature. The Cropfield matrix was used to represent baseline conditions for agricultural fields. Two field data sheets were prepared for the Bottomland Hardwoods matrix. One field sheet represented natural succession of cropfields to a silver maple-cottonwood dominated forest community. The second field sheet represented future with-project

conditions assuming successful planting of mast-producing tree species (pin oak, bur oak, swamp white oak, northern pecan, and sycamore).

The Bottomland Hardwoods-Wetland matrix prepared by the WHAG team assuming succession to silver maple-cottonwood dominant forest also was used to evaluate the terrestrial benefits of the shoreline protection feature. To evaluate the benefits of shoreline protection on aquatic habitat, a field data sheet was prepared using the MOFISH matrix for main channel habitat.

b. Changes in Habitat Conditions Over Time. Habitat conditions are not static. Either through natural processes or human activity, habitat evolves and may change in quality and/or quantity. Imbedded in each cover type evaluation, change has been added to the model. To assess the change over the period of analysis, target years have been defined. At each target year, a change in the habitat variables may be noticed. Noticeable changes can be characterized by a change in habitat benefit output.

Target years of 0 (baseline condition), 1, 25, and 50 (future without- and future with-project conditions) are sufficient to analyze HUs and characterize habitat changes over the estimated project life.

Evaluation of the side channel restoration/protection feature assumed that under without-project conditions, aquatic habitat, particularly deep water areas (6 feet or greater) in the chute would be essentially eliminated by target year 50. Under with-project conditions, the evaluation assumed that surface acreage would remain relatively stable and that the dredging component of the feature would slightly increase the amount of deep water habitat in the chute. Initially, the baseline acreage used to calculate changes in habitat for each alternative was limited to the surface acreage of the chute downstream of the closure structure (23 acres for A1, 45 acres for A2, and 39 acres for A3). However, public comments and agency input received during public review of the draft DPR prompted the Corps to reevaluate project outputs from a baseline of the entire 45 acres of O'Dell Chute for all three alternatives. This was done to ensure that quantification of outputs adequately reflected the assumption that portions of the chute located upstream of the closure would continue to silt in and their habitat value would be lost.

For the terrestrial component of the shoreline protection feature, the difference between with-project and without-project conditions is expressed by changing the acreage figures used in the analysis. Under future without-project conditions, a loss of bottomland hardwood forest habitat is assumed to occur over the 50-year period used in the analysis. Estimated acreage losses without shoreline protection are summarized in Table D-2 below. Under future with-project conditions, an initial loss of approximately 4.0 acres of shoreline vegetation is assumed to occur as a result of clearing for construction. Following completion of construction, the acreage of forested habitat is assumed to remain stable. Smaller islands were assumed to have a higher rate of acreage loss from erosion than larger islands.

TABLE D-2. Island Loss Assumptions

Island	Current Acreage (TY0 & TY1)	TY25	TY50
Long Island	3646	3605	3560
La Grange and Shandrew Islands	251	246	239
Small Island	23	17	11
E Island	12	9	6
A Island	2	1	0
B Island	4	2	0
C Island	3	2	0
D Island	6	3	0
TOTAL ISLAND LOSS (rounded to nearest acre)	3947	3885	3816

Evaluation of the aquatic component of the shoreline protection feature assumed affected acreage to be limited to areas in close proximity to the protected sites, estimated to be a zone approximately 100 feet wide and five times the linear length of shoreline protection placement. Habitat conditions and affected acreage were assumed to remain stable over the 50-year project life, with the only change in habitat quality between future without-project and future with-project attributed to the addition of riprap. Analysis of both terrestrial and aquatic benefits assumed that, in addition to the 3,200 linear feet of shoreline protection proposed as part of the HREP, an additional 4,500 feet of shoreline protection would be placed on identified islands as part of ongoing channel maintenance in this reach of the river.

Evaluation of the reforestation feature assumes that under future without-project conditions, row crop cultivation would continue on historic agricultural fields throughout the 50-year project life. Initially, all three historic agricultural fields on Long Island, totaling 687 acres, were included in the analysis. However, cultivation of the two western fields (503 acres total) had already been discontinued prior to initiation of the WHAG analysis, and a portion of this acreage had previously been planted with acorns and bare root seedling mast trees as part of the Mississippi River Mast Tree Section 1135 project between 1995 and 1998. For these reasons, the western cropfields were eliminated from further analysis.

c. Future Management Use. Evaluation of all feasible project features and alternatives assumed that current operation would continue essentially unchanged through the 50-year project life and that the current management objectives would remain in effect.

5. RESULTS OF HABITAT ANALYSIS

This section describes the benefits in AAHUs for each feature discussed in the Definite Project Report. These features are the protection and restoration of side channel habitat by constructing a closure structure and dredging in O'Dell Chute, protection and enhancement of floodplain terrestrial and aquatic habitat by placement of rock erosion protection on shorelines of selected islands, and restoration of floodplain terrestrial habitat by reforestation of historic cropfields by discontinuing cultivation and planting mast-producing trees to restore diversity.

Results of the habitat analysis, expressed in total AAHUs, are provided in Tables D-3 through D-6 for the preferred alternative for each of the project's three features (side channel restoration, shoreline protection, and reforestation).

a. Side Channel Restoration/Protection. Protection of side channel habitat within O'Dell Chute is dependent on the ability to drastically reduce the amount of sediment entering the chute at the upper end. The closure structure is designed to block an estimated 90 percent of bedload sediment from entering the chute. Restoration of aquatic habitat is based on the presumption that dredging would increase the amount of deep water area (6 feet or greater) in O'Dell Chute. Results of the analysis are summarized in Table D-3 below. While restoration and protection of side channel habitat is expected to benefit fisheries beyond the boundaries of O'Dell Chute, evaluation of benefits was limited to the area directly affected by dredging and closure structure construction. Consequently, the quantifiable benefits that could potentially be realized are constrained by the relatively small size of the chute.

(1) O'Dell Chute Improvement with Closure at Upper End of 5,000-Foot Dredge Cut (A1). This option consists of dredging a channel from the downstream entrance of O'Dell Chute approximately 5,000 feet upstream to connect existing deep water locations, which would ensure sufficient fish ingress and egress capabilities to Canton Chute during winter conditions. Dredged material from O 'Dell Chute would be placed on Long Island's eastern agricultural field to enhance elevation for mast tree plantings. An emergent closure structure would be constructed at the upstream end of the dredge cut to decrease sediment transfer into the chute. Approximately 23 acres (surface area) of aquatic habitat downstream of the closure structure would be protected with this option. About 22 acres of the chute upstream of the closure structure were assumed to be lost to siltation. Total benefits were calculated to be 42.0 AAHUs.

(2) O'Dell Chute Improvement with Closure at Head of Chute (A2). This option involves dredging the 5,000-foot length of channel and placing material on the agricultural field as described in paragraph (1) above, and placing an emergent closure structure at the upriver end of O'Dell Chute. Construction of the closure structure at this location would require dredging in the lower end of Shandrew Chute to provide access to the site for construction equipment. The effects of access dredging were not credited as a gain in deep water habitat in the evaluation of habitat benefits because this area is located upstream of the closure structure and would not be protected from future siltation. Approximately 45 surface acres of aquatic habitat would be protected downstream of the closure structure. Total benefits were calculated to be 61.4 AAHUs. Table D-3 displays the projected benefits identified for this option.

TABLE D-3. Side Channel Protection/Restoration—Projected Habitat Benefits (AAHUs)

Species	Base HUs	Without Project	With Project	Net HUs
CHANNEL CATFISH	7.4	3.6	16.0	12.4
LARGEMOUTH BASS	6.2	2.9	13.4	10.5
GIZZARD SHAD	5.7	2.7	11.8	9.1
CARP	4.7	2.2	10.7	8.5
BLUEGILL	5.8	2.7	13.6	10.9
BLACK BULLHEAD	5.1	2.4	12.4	10.0
TOTAL BENEFITS SIDE CHANNEL RESTORE/PROTECT (AAHUs - 45 acres protected with gain in deep water habitat)				61.4

(3) O'Dell Chute Improvement with Closure at Upper End of 8,400-Foot Dredge Cut (A3). This option consists of dredging a channel from the downstream entrance of O'Dell Chute approximately 8,400 feet upstream with placement of material on Long Island as described in paragraph (1) above, and construction of the emergent closure structure at the upstream end of the 8,400-foot dredge cut. Approximately 39 surface acres of aquatic habitat

would be protected downstream of the closure structure. About 6 acres of the chute upstream of the closure structure were assumed to be lost to siltation. While the surface acreage protected by the closure structure is less than for Alternative A2 described above, the percentage of deep (>6 feet) water in the protected area is expected to be higher immediately after construction and taper off later in the project life. This improves habitat quality and results in calculated benefits comparable to the A2 alternative (60.0 AAHUs).

b. Shoreline Protection. Because protection of selected island shorelines with riprap has the potential to provide benefits to both terrestrial and aquatic habitat, separate evaluations were conducted and then combined to determine total projected habitat benefits associated with this feature. Protection of all identified islands with riprap is expected to prevent the loss of 127 acres of bottomland hardwood forest due to erosion. Placement of riprap on all identified island shorelines also is expected to benefit approximately 85 acres of aquatic habitat. Table D-4 summarizes the results of the terrestrial habitat analysis, and Table D-5 shows the results of the aquatic habitat analysis.

Despite the size of the area assumed to be affected by this feature, the total aquatic habitat benefits are relatively small. This is primarily due to the presumption that the only change between future without-project and future with-project conditions would be the addition of riprap as substrate on the submerged portion of protected shorelines.

(1) Protect Small Islands Only (Small Island and Islands A, B, C, D, and E) (B1). This option would involve placing approximately 4,300 linear feet of rock protection on only six of the small islands identified as vulnerable to erosion. Approximately 41 acres of terrestrial habitat would be protected from erosion under future with-project conditions (54.1 AAHUs), and the addition of rock substrate would benefit approximately 49 acres of aquatic habitat (8.1 AAHUs). Total benefits for this option were calculated to be 62.2 AAHUs.

(2) Protect Large Islands Only (Long and La Grange Islands) (B2). This option would involve placing approximately 3,400 linear feet of rock protection on the three larger islands (Long, Shandrew, and La Grange) identified as vulnerable to erosion. Approximately 86 acres of terrestrial habitat would be protected from erosion under future with-project conditions (146.6 AAHUs), and the addition of rock substrate would benefit approximately 36 acres of aquatic habitat (5.9 AAHUs). Total benefits for this option were calculated to be 152.5 AAHUs.

(3) Protect All Identified Islands (Options 1 and 2 Combined) (B3). Tables D-4 and D-5 represent the projected benefits identified for this option. Total benefits for this option were calculated to be 206.8 AAHUs.

TABLE D-4. Shoreline Protection—Projected Terrestrial Habitat Benefits (AAHUs)

Species	Base HUs	Without Project	With Project	Net HUs
GRN-BCKD HERON	2,210.3	2,175.0	2,208.1	33.1
WOOD DUCK	2,870.5	2,824.6	2,867.7	43.1
BEAVER	2,409.7	2,371.2	2,407.3	36.1
NORTHERN PARULA	2,368.2	2,330.3	2,365.8	35.5
PROTH. WARBLER	2,999.7	2,951.7	2,996.7	45.0
TOTAL BENEFITS TERRESTRIAL BANK PROTECTION (AAHUs - prevent loss of 127 acres)				192.8

TABLE D-5. Shoreline Protection—Projected Aquatic Habitat Benefits (AAHUs)

Species	Base HUs	Without Project	With Project	Net HUs
CHANNEL CATFISH	55.2	55.2	59.5	4.3
SAUGER	55.7	55.7	61.4	5.7
L. MOUTH BASS	35.4	35.4	38.2	2.8
GIZZARD SHAD	44.9	44.9	46.1	1.2
CARP	44.0	44.0	44.0	0.0
BLUEGILL	36.9	36.9	36.9	0.0
BLACK BULLHEAD	48.2	48.2	48.2	0.0
TOTAL BENEFITS AQUATIC BANK PROTECTION (AAHUs - 85 acres)				14.0

Total benefits of providing shoreline protection at all identified sites:

Terrestrial Benefits (192.8) + Aquatic Benefits (14.0) = Total Benefits (206.8).

c. Reforestation (Mast Tree Planting). Restoration of historic bottomland hardwood forest on Long Island's eastern agricultural field would involve the cessation of row crop cultivation and planting of mast-producing tree species. A total of 184 acres would be directly converted from cropfield to forest habitat by implementation of this feature. While the loss of cropfield habitat would reduce habitat for some game species such as mallard and Canada goose, numerous other bird and mammal species, represented by the five evaluation species listed in Table D-6 below, would derive substantial benefits from reduced forest fragmentation, increased cover, and improvements to the available food base provided by the increased presence of mast-producing trees.

(1) Plant Eastern Agricultural Field at Higher Elevations Only (67 Acres Planted, 117 Acres Natural Succession) (C1). Table D-6 above summarizes the results of analyzing habitat changes resulting from planting mast trees on areas of higher elevation within the eastern field (approximately 67 acres) and allowing the remaining 117 acres to revegetate naturally. This option was estimated to provide total benefits of 35 8.3 AAHUs. Planting large stock container-grown mast trees at the highest elevations is expected to enhance the survival rate of plantings and, in the long term, provide a seed base to promote future natural regeneration of these species.

TABLE D-6. Reforestation—Projected Habitat Benefits (AAHUs)

Species	Base HUs	Without Project	With Project	Net HUs
MALLARD	107.7	107.7	19.3	-88.4
CANADA GOOSE	37.7	37.7	0.3	-37.4
GRN-BCKD HERON			110.2	110.2
WOOD DUCK			84.0	84.0
BEAVER			127.2	127.2
NORTHERN PARULA			68.2	68.2
PROTH. WARBLER			94.5	94.5
TOTAL BENEFITS MAST TREE PLANTING (AAHUs)	(67 acres mast tree planting, 117 acres natural succession)			**358.3**

(2) Plant Entire Eastern Agricultural Field (184 Acres) (C2). This option would involve planting mast-producing trees over the entire 184-acre eastern field. Analysis of this option resulted in calculated benefits of 366.0 AAHUs. This represents an increase of less than 8 AAHUs over Option 1 above. The introduction of mast-producing tree species in an area already in the process of succeeding to forest habitat is a relatively subtle change in habitat quality. Existing habitat evaluation methodologies, WHAG included, are generally less sensitive to such qualitative changes within habitat types than to more drastic changes from one habitat type to another (e.g., cropfield converted to forest). In these circumstances, the results of the analysis may not reflect real life expectations. However, physical conditions at the site (low elevations, vulnerable to frequent flooding) could also affect the survival of plantings and for this reason the results of the analysis may not underrepresent the relative value of this option.

6. INCREMENTAL ANALYSIS OF ALTERNATIVES

The environmental benefits (outputs) and costs of each feature are summarized in Table 5-1 in the Definite Project Report. A total of 48 potential combinations may be formulated with the identified increments of feasible project features. Table D-7 displays these combinations in ascending order based on output. Alternative increments of each feature were then analyzed to identify the most cost-effective increments of each feature included in the selected plan. The results are summarized below.

TABLE D-7. Potential Combination of Features Ranked by Output

	Plan	Output (AAHUs)	Construction Cost ($1,000)	Annualized Cost ($1,000)
1.	A0+B0+C0=	0	0	0
2.	A1+B0+C0=	42.0	1065	76
3.	A3+B0+C0=	60.0	1254	89
4.	A2+B0+C0=	61.4	1315	93
5.	A0+B1+C0=	62.2	542	39
6.	A1+B1+C0=	104.2	1606	115
7.	A3+B1+C0=	122.2	1796	128
8.	A2+B1+C0=	123.6	1857	132
9.	A0+B2+C0=	152.5	759	54
10.	A1+B2+C0=	194.5	1823	130
11.	A0+B3+C0=	206.8	1262	90
12.	A2+B2+C0=	213.9	2074	147
13.	A3+B2+C0=	212.5	2013	143
14.	A1+B3+C0=	248.8	2326	166
15.	A3+B3_C0=	266.8	2516	179
16.	A2+B3+C0=	268.2	2577	183
17.	A0+B0+C1=	358.3	234	17
18.	A0+B0+C2=	366.0	647	46
19.	A1+B0+C1=	400.3	1298	93
20.	A1+B0+C2=	408.0	1711	122
21.	A3+B0+C1=	418.3	1488	106
22.	A2+B0+C1=	419.7	1549	110
23.	A0+B1+C1=	420.5	776	56
24.	A3+B0+C2=	426.0	1901	135
25.	A2+B0+C2=	427.4	1962	139
26.	A0+B1+C2=	428.2	1189	85
27.	A1+B1+C1=	462.5	1840	132
28.	A1+B1+C2=	470.2	2253	161
29.	A3+B1+C1=	480.5	2030	145
30.	A2+B1+C1=	481.9	2091	149
31.	A3+B1+C2=	488.2	2443	174
32.	A2+B1+C2=	489.6	2504	178
33.	A0+B2+C1=	510.8	993	71
34.	A0+B2+C2=	518.5	1406	100
35.	A1+B2+C1=	552.8	2057	147
36.	A1+B2+C2=	560.5	2470	176
37.	A0+B3+C1=	565.1	1496	107
38.	A3+B2+C1=	570.8	2247	160
39.	A2+B2+C1=	572.2	2308	164
40.	A0+B3+C2=	572.8	1909	136
41	A3+B2+C2=	578.5	2660	189
42.	A2+B2+C2=	579.9	2721	193
43.	A1+B3+C1=	607.1	2560	183
44.	A1+B3+C2=	614.8	2973	212
45.	A3+B3+C1=	625.1	2750	196
46.	A2+B3+C1=	626.5	2811	200
47.	A3+B3+C2=	632.8	3163	225
48.	A2+B3+C2=	634.2	3224	229

a. Side Channel Restoration/Protection. During early project planning and design, only one feasible alternative (A2) was initially identified and evaluated with the no action alternative. Following review of an earlier draft version of this report, the interagency team identified two additional alternatives for this feature (A1 and A3). Both of the new alternatives involved the same components (construction of an emergent closure structure and dredging in the lower end of O'Dell Chute) as the A2 alternative; however, neither A1 nor A3 require dredging in Shandrew Chute to gain access to the construction site for the closure structure. Results of the incremental cost analysis are shown in Table D-8 below.

TABLE D-8. Side Channel Restoration/Protection—Incremental Cost Analysis

Feature Alternative	Symbol	Annual Cost**	Output AAHUs*	Avg. Cost	Inc. Cost	Inc. Output	Inc. $/AAHU
No Action	A0	0	0	0	0	0	0
Dredge 5,000' with closure at head of cut	A1	76	42.0	1.810	69	42.0	1.810
Dredge 8,400' with closure at head of cut	A3	89	60.0	1.483	13	18.0	0.722
Dredge 5,000' with closure at head of chute	A2	93	61.4	1.515	4	1.4	2.857

* Outputs are calculated as Average Annual Habitat Units (AAHUs).
** All costs are listed in $1,000s. Represents initial construction costs only.
* Not cost-effective in comparison to other alternatives. Not included in incremental analysis.

b. Shoreline Protection. In addition to the No Action alternative, three increments of shoreline protection (riprap placement) were analyzed: protecting the small islands only (B1), protecting the large islands only (B2), or protecting all islands identified as vulnerable to erosion (B3). The outputs, costs, and average cost per AAHU are presented in Table D-9 below.

TABLE D-9. Shoreline Protection—Output, Cost, and Average Cost for Each Alternative

Feature	Symbol	Annual Cost**	Output AAHUs*	Avg. Cost $/AAHU
No Action	B0	0	0	0
Small Islands Only	B1	39	62.2	0.627
Large Islands Only	B2	54	152.5	0.354
All Islands	B3	90	206.8	0.435

* Outputs are calculated as Average Annual Habitat Units (AAHUs).
** All costs are listed in $1,000s. Represents initial construction costs only.

B1 and B2 could be implemented independently of each other, but are both components of B3. For purposes of the incremental analysis, we had to choose either B0, B1, and B3 or B0, B2, and B3 as increments to analyze. B0, B1, B3 was chosen since the protection of small islands was considered to be critical to maintaining complex diversity. Table D-10 summarizes the results of this analysis.

TABLE D-10. Shoreline Protection—Small Islands Protection with Incremental Cost Per Unit

	Symbol	Ann. Cost	Output	Avg. Cost	Inc. Cost	Inc. Output	Inc. Cost $/AAHU
No Action	B0	0	0	0	0	0	0
Small Islands Only	B1	39	62.2	0.627	39	62.2	0.627
All Islands	B3	90	206.8	0.435	51	144.6	0.353

c. Reforestation. Two increments of reforestation were analyzed in addition to the alternative of no action: planting the dredged material placement portion of the Eastern Agricultural Field (C1), a total of 67 acres, and planting the entire Eastern Agricultural Field (C2), a total of 184 acres. These alternatives were incrementally analyzed to identify the most cost-effective plan. The results are presented in Table D-11.

TABLE D-11. Reforestation—Feature Alternatives with Incremental Cost Per Unit

Feature Alternative	Symbol	Annualized Cost ($1000s)	Output (AAHUs)	Average Cost ($/AAHU)	Incremental Cost ($1000s)	Incremental Output (AAHUs)	Incremental Cost per Unit ($/AAHU)
No Action	C0	0	0	0	0	0	0
Placement Site (67 ac.)	C1	17	358.3	0.047	17	358.3	0.047
East Ag Field (184 ac.)	C2	46	366.0	0.126	29	7.7	3.766

d. Best Buy Plan. Based on the results of the analyses presented above, the most cost-effective or "Best Buy" plan that would meet all project objectives would be Closure Structure at End of 8,400-Foot Dredge Cut in O'Dell Chute (A3) + Shoreline Protection All Islands (B3) + Reforestation of 67-Acre Dredge Placement Site (C1). Based on comments and input received during public review of the DPR, the Corps and the interagency team instead selected the combination A2 + B3 + C1 as the recommended plan. While the A2 alternative (Closure Structure at Head of O'Dell Chute with 5,000-Foot Dredge Cut at Lower End) has a higher incremental cost than the A3 alternative, this alternative is cost-effective and would meet all project objectives, and would also protect the entire 45 acres of O'Dell Chute against future loss due to sedimentation.

7. DISCUSSION

The results of the WHAG analysis suggest that Gardner Division can be enhanced with the features proposed for this project. Results of the WHAG application were compared as increments to costs where applicable.

The proposed project for Gardner Division involves three primary enhancement features: constructing an emergent closure structure at the head of O'Dell chute and dredging a 5,000-foot channel at the lower end of the chute; protecting the shorelines and head ends of selected islands; and planting 67 acres of mast-producing trees on higher elevations of the eastern agricultural field on Long Island.

In conclusion, the WHAG analysis indicates that closure of the head end of the side channel and dredging 5,000 feet in the lower end, shoreline protection of all identified islands, and mast tree planting on 67 acres of the eastern agricultural field would provide the greatest outputs in a cost-effective manner. This combination would meet HREP goals and objectives, would add to habitat diversity as well as quality, and would best meet the overall management objectives for the site.

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE DOCUMENTATION REPORT

APPENDIX E

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-15F)

GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT
POOL 21, MISSISSIPPI RIVER MILES 332.5 AND 340.2
ADAMS COUNTY, ILLINOIS

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)
DOCUMENTATION REPORT (HDR)

1. PURPOSE

The specific and relevant purposes of a hazardous, toxic, and radioactive waste documentation report (HDR) are to adequately document an appropriate inquiry into hazardous, toxic, and radioactive waste (HTRW) activities on potential project lands. This report documents the inquiry for the Gardner Division Habitat Rehabilitation and Enhancement Project in order to minimize and prevent Federal liability under the Comprehensive Environmental Response, Compensation and Liability Act and to reduce any threats to site workers and avoid costly delays associated with environmental abatement activities. HTRW Attachment 1 contains a list of acronyms used in this report.

2. BACKGROUND

The policies and authorities outlined in ER 1165-2-132, *Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects*, were developed to facilitate the early identification and the appropriate consideration of HTRW problems in all of the various phases of a water resources study or project. Construction of civil works projects in HTRW contaminated areas should be avoided where practicable.

ASTM Standards E1527-97 and E1528-96 provide a comprehensive guide to conducting Phase I HTRW Environmental Site Assessments. Not every property warrants the same level of assessment. Consistent with good commercial or customary practice, the appropriate level of environmental site assessment will be guided by the type of property subject to assessment, the expertise and risk tolerance of the user, and the information developed in the course of the inquiry. The screening methods and tools used to prepare the Phase I HTRW Environmental Site Assessments have been selected based on the location, physical setting, surrounding land uses, and particular nature of the dredged material placement site.

The Gardner Division Habitat Rehabilitation and Enhancement Project involves work on Federal Land which has historically been a refuge area, with some sections used for agricultural purposes and recreational purposes, and not for industrial purposes. Therefore, the techniques used to assess the potential for HTRW contamination along the project alignment consisted of only a site visit, a review of maps, and a search of Federal and State environmental databases.

3. RECORDS REVIEW

A list of documents and records reviewed or referenced is contained in HTRW Attachment 2.

4. SITE SAFETY

A Site Specific Safety and Health Plan has been developed and is contained in HTRW Attachment 3. Assessment methods did not involve intrusive techniques such as the taking and analyzing of soil samples.

5. SITE DESCRIPTION AND BACKGROUND/SITE VISIT

a. **Site Locations.** The Gardner Division Habitat Rehabilitation and Enhancement Project (HREP) lies on the left descending bank of the Mississippi River between River Miles (RM) 332.5 and 340.2, approximately 3 miles downstream of Lock and Dam 20 in Adams County, Illinois. The project area encompasses Long Island, Shandrew Island, Flannigan Island, La Grange Island, and small unnamed islands. All project lands are in Federal ownership. Gardner Division has been managed by the U.S. Fish and Wildlife Service (USFWS). The project is located in three USGS 7.5 minute Quadrangles: the Long Island Quadrangle; the La Grange Quadrangle; and the Quincy West Quadrangle. Ranges and Townships include R9W, R10W, T1N, and T1S.

b. **Land Cover/Vegetation/Stresses to Topography.** Since two of the fields on Long Island were related to agricultural production activities, it is assumed that herbicides have been applied to the fields in order to control weeds in a manner consistent with normal agricultural needs. Pesticides and herbicides applied to lands during the course of normal agricultural activities are exempt from Comprehensive Environmental Response, Compensation and Liability Act or Resource Conservation and Recovery Act and Amendments regulations.

c. **Utilities/Transportation Features.** Access to the area was limited to boat or water access. Barge and recreational traffic navigate through the river. No utilities were identified in the area.

d. **Estimated Quantities of Contaminants and Potential Hazards.** The only potential environmentally impacted project area appears to be within the proposed dredge cuts in the side chutes where toxic constituents could possibly have collected. Since the material to be dredged consists primarily of sandy material, these contaminants would be highly diluted. It is unlikely that any significant amount of contaminants would significantly build up. Since the potential for contamination in the dredged material is very low, it is unlikely that any area within the dredge cut would ever be included in a hazardous waste disposal site investigation, and the potential for hazard to humans or the environment from sediment is extremely minimal.

6. PERMITS, CLEANUP ACTIONS, CONTAMINATION, AND OTHER ENVIRONMENTAL ISSUES REVIEW

a. **Facility Index System (FINDS).** The FINDS system supports a cross media analysis as well as regulatory and enforcement actions by pointing to other United States Environmental Protection Agency databases that regulate or track a facility. The FINDS program reviews the following databases: Comprehensive Environmental Response, Compensation, and Liability Information System; Resource Conservation and Recovery Information

System (RCRIS); Toxic Release Inventory; Permit Compliance System; Aerometric Information Retrieval System (AIRS)/AIRS Facility Subsystem (AFS) Program System Database; and the Biennial Reporting System Database. Queries were performed on the following Zip Codes: 62376 (Marcelline, IL and Ursa, IL); 62338 (Fowler, IL); 62301, 62305, 62306 (Quincy, IL). The query revealed that two PCS sites, eleven TRIS sites, twenty-one RCRIS sites, one CERCLIS, and fifteen AIRS are located in the area. HTRW Attachment 4 displays the results of these database queries.

b. **State of Illinois Environmental Protection Agency Site Environmental Information Data System (SEIDS) List.** The Illinois SEIDS list was reviewed for sites in Adams County via an Illinois Environmental Protection Agency Internet search. The SIEDS database lists Leaking Underground Storage Tanks, Department of Defense sites, Site Remediation Programs, Resource Conservation and Recovery Act. The query revealed that three RCRA sites, eleven SRP sites, and one LUST site were located in Adams County. HTRW Attachment 5 displays the results of these database queries.

c. **Summary.** A review of the data for the dredge cut and placement site indicates that there is a very slight potential for HTRW contamination within the project area. Very low concentrations of contaminants could be bound up in a few and isolated spots in the dredge cut areas where there is a high concentration of fines and clay sediments. Effluent from the dredged placement area could contain low concentrations of pesticides, herbicides, and constituents of fertilizer such as nitrates. However, these contaminants are expected to be well within the regulatory limits and would be addressed by complying with the water quality standards required for all dredging operations. All HTRW sites identified through database research were not within the immediate vicinity of the project and are not expected to have an adverse effect on the project site.

8. SUMMARY OF POTENTIAL HTRW SOURCES

Based on this review, there were no apparent direct sources of HTRW located within the limits of construction of the proposed habitat rehabilitation and enhancement site at the time of this report investigation. The area of the dredge cut is located in a waterway that has some upstream industrial activity. Releases of unknown quantities and constituents have possibly contributed to sediment contamination. However, since the proposed dredged areas consist primarily of sandy materials, the accumulation of contaminants, if present, would be less than expected in a sediment area that has a higher percentage of clay and fines.

9. RECOMMENDATIONS

Since there is only a slight potential of encountering contaminants in the sediments, it is not recommended that any further HTRW Environmental Assessments be conducted. The dredged material placement site is located in agricultural areas where current environmental regulations allow for the controlled application of herbicides and pesticides. Sampling of dredge cut sediments is not recommended since the material consists of sandy sediments, and since any hazardous substances, which had been released to the river, would have been diluted by the large volume of water present.

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ATTACHMENT 1
ACRONYMS

AIRS/AFS	Aerometric Information Retrieval System Facility Subsystem
ASTM	American Society for Testing and Materials
CERCLIS	Comprehensive, Environmental Response, Compensation, and Liability Information System
DOD	Department of Defense
FINDS	Facility Index System
HDR	HTRW Documentation Report
HTRW	Hazardous, Toxic, and Radioactive Waste
LUST	Leaking Underground Storage Tanks
PCS	Permit Compliance System
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
SEIDS	Site Environmental Information Data System List
SRP	Site Remediation Program
SSHP	Site Specific Safety and Health Plan
TRIS	Toxic Release Inventory System
USGS	United States Geological Service

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ATTACHMENT 2
REFERENCES AND ABSTRACTS

U. S. Army Corps of Engineers, Rock Island District, ER 1165-2-1, Hazardous, Toxic, and Radioactive Wastes Guidance for Civil Works Projects, 26 June 1992.

U. S. Army Corps of Engineers, Policy Guidance Letter No. 34, CECW-PA, Non-CERCLA Regulated Contaminated Materials at Civil Works Projects, 5 May 1992.

U. S. Army Corps of Engineers, ER 385-1-92, Safety and Occupational Health Document Requirements for Hazardous, Toxic, and Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OEW) Activities, 18 March 1994.

U. S. Army Corps of Engineers, ER 405-1-12, Real Estate Handbook, Chapter 8.

U. S. Army Corps of Engineers, ER 500-1-1, Natural Disaster Procedures.

ASTM E 1527-97, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.

ASTM E 1528-98, Standard Practice for Environmental Site Assessments: Transaction Screen Process.

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ATTACHMENT 3
SITE SPECIFIC SAFETY AND HEALTH (SSHP) PLAN

SITE SPECIFIC SAFETY AND HEALTH PLAN TITLE PAGE Rock Island District Corps of Engineers	This SSHP is a part of the Rock Island District HTRW Program, which includes EM 385-1-1 and ER 385-1-92.
PROJECT NAME: **Gardner Division Habitat Rehabilitation and Enhancement Project, Mississippi River Miles 332.5-340.2**	REQUEST FOR SERVICES NO.:
JOBSITE ADDRESS: Adams County, Illinois.	COST CODE:
PROJECT MANAGER: Darron Niles	PHONE NO.: (309) 794-5400
SITE CONTACT: Richard Nickel	PHONE NO.: (309) 794-5886
( ) AMENDMENT NO. _____ TO EXISTING APPROVED SSHP. DATE EXISTING APPROVED SSHP:	

OBJECTIVES OF FIELD WORK:
Environmental Site Assessment for the project site. A site walk of the project area and adjacent shoreline will be made. Environmental concerns will be documented. No intrusive investigations (soil samples, etc.) will be conducted.

SITE TYPE: Check as many as applicable:

( ) Active	( ) Landfill	(X) Natural
(X) Inactive	(X) Uncontrolled	( ) Military
( ) Secure	( ) Industrial	(X) Other specify: Existing farmland. Wildlife Refuge.
( ) Unsecure	( ) Residential	
( ) Enclosed space	( ) Well Field	

DESCRIPTION AND FEATURES: Summarize below. Include principal operations and unusual features (containers, buildings, dikes, power lines, hills, slopes, and river). The site is a rural area near the Illinois River, which is used primarily for agricultural purposes (farming and grazing). The only utilities located near the area were overhead electrical lines be tween the field and the road.

SURROUNDING POPULATION: ( ) Residential ( ) Industrial (X) Rural ( ) Urban ( ) Commercial: ( ) Other:

SITE SPECIFIC SAFETY AND HEALTH PLAN
EMERGENCY CONTACTS & APPROVAL PAGE
Rock Island District Corps of Engineers

This SSHP is a part of the Rock Island District HTRW Program, which includes EM 385-1-1 and ER 385-1-92.

EMERGENCY CONTACTS		
Water Supply	n/a	
Site Telephone	n/a	
EPA Release Report No.	800-424-8802	

EMERGENCY CONTACTS	**NAME**	**PHONE**
Project Manager	Darron Niles	(309) 794-5400
Safety and Health Manager	Jeff Cochran	(309) 794-5280
Industrial Hygienist		
Environmental Agency	Illinois EPA	(217) 782-3637
State Spill Number	Illinois Emergency Services and Disaster Agency	(217) 782-7860
Fire Department		911
Police Department		911
Poison Control Center		
Occupational Health Unit		

CONTINGENCY PLANS Read and Refer to **DM 385-1-2, Appendix H**. Enter any additional Site Specific Information and clarifications below:

1. Evacuation routes will be to the roads that lead away from the site and perpendicular to the alignment.
2. Personnel will evacuate if there appear to be any conditions that could expose any of the site visitors to an environmental or safety hazard.
3. All accidents will be reported in accordance with **DM 385-1-1, Appendix B**, including preparing an accident report form ENG 3394 as required by the appendix.
4. The overall plan is to evacuate the site in case of an emergency. In case of a medical emergency, the local EMS will be contacted from the nearest available telephone (resident or business).

MEDICAL EMERGENCY

Hospital Name:	
Hospital Address:	
Name of Contact at Hospital:	
Name of 24-Hour Ambulance:	

HEALTH AND SAFETY PLAN APPROVALS

Prepared by: Kara N. Mitvalsky	Date: 8 December 1998
Reviewed by: Kenneth Barnes	Date: 9 December 1998

Route to Hospital (Provide description below and attach map with route to hospital on the following page). A route map was not prepared since the emergency plan is to call 911 from the nearest telephone should there be an emergency.

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ATTACHMENT 4
USEPA DATABASE

EPA Geographic Information Query System, April 9, 1999.
EPA Envirofacts Facility Databases Information.
Databases accessed via http://www.epa. gov/r10earth/gisapps/zipsearch.html and http://www.epa.gov/r10earth/gisapps/mapseries.html.

Search Description:

Title: Zip Code Search.
Requested Databases: Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS); Resource Conservation and Recovery Information System (RCRIS); Toxic Release Inventory (TRIS); Permit Compliance System (PCS); Aerometric Information Retrieval System (AIRS)/AIRS Facility Subsystem (AFS) Program System Database.

The following zip codes were searched:
62376
62338
62301
62305
62306

Results for Ursa and Marcelline, IL 62376 include the following:

Facility Name Address	EPA Facility ID Number	Permit to Discharge Water?	Toxic Release Report?	Hazardous Waste Handler?	Active or Archived Superfund Report?	Air Releases Reported?	BRS 1995 Reporter?
Adams FS Inc., IL Route 61, Ursa, IL 62376	ILT180010555	No	Yes	No	No	No	No
Marcelline Farm Supply, IL Route 96, Marcelline, IL 62376	ILD025885757	No	No	No	Yes	No	No
Ursa Farmers Cooperative Company, 202 Maple Street, Ursa, IL 62376	ILDO07983869	No	No	No	No	Yes	No
Ursa Self Service, Route 96, Ursa, IL 62376	ILD984842039	No	No	Yes	No	No	No
TOTAL		0	1	1	1	1	0

Results for Fowler and Coatsburg, IL 62325 include the following:

Facility Name Address	EPA Facility ID Number	Permit to Discharge Water?	Toxic Release Report?	Hazardous Waste Handler?	Active or Archived Superfund Report?	Air Releases Reported?	BRS 1995 Reporter?
Adams FS Inc., US NO24, Coatsburg, IL 62325	ILT180010563	No	No	Yes	No	Yes	No
Ill Bell Telephone Company, Fowler CDO, HWY 24 1Mile W of Fowler, Fowler, IL, 62338	ILD980793129	No	No	Yes	No	No	No
Moorman Manufacturing Company, Route 1, Ellington Township, Fowler, IL 62338	ILD984874891	No	No	No	No	Yes	No
Old Fowler School, Washington and Frisable Street, Fowler, IL 62338	IL0000019075	No	No	Yes	No	No	No
Shaffer and Sons, RR 1 Box 94A, Fowler, IL 62338	ILD051716983	No	No	Yes	No	Yes	No
Total		**0**	**0**	**4**	**0**	**3**	**0**

Results from Quincy, IL 62306 are as follows:

Facility Name Address	EPA Facility ID Number	Permit to Discharge Water?	Toxic Release Report?	Hazardous Waste Handler?	Active or Archived Superfund Report?	Air Releases Reported?	BRS 1995 Reporter?
ADM Quincy Plant, 1900 Gardner Expressway	ILD006295109	**Yes**	**Yes**	**Yes**	No	**Yes**	No
Air Products and Chemicals Incorporated, 2800 Refinery Road	IL0002348761	No	No	No	No	**Yes**	No
C& Y/Quincy Foods, 2800 Refinery Road	IL0001332881	No	**Yes**	No	No	No	No
Illinois Ayers Oil Co, Box 772	ILD984880799	No	No	No	No	**Yes**	No
Westmin Corp, 1131 Bayview Drive	ILD984811752	No	No	No	No	**Yes**	No
Westmin Corp., 616 S. 5th Street	IL0001308691	No	**Yes**	No	No	No	No
Total		**1**	**3**	**1**	**0**	**4**	**0**

Results from Quincy, IL 62305 include the following:

Facility Name Address	EPA Facility ID Number	Permit to Discharge Water?	Toxic Release Report?	Hazardous Waste Handler?	Active or Archived Superfund Report?	Air Releases Reported?	BRS 1995 Reporter?
Blessing Hospital, Broadway at 11th Street	ILD984891424	No	No	Yes	No	Yes	No
Broadcast Electronics, Inc, 4100 N. 24th	ILD003242112	No	No	Yes	No	No	No
Comstock Castle Stove Company, 119 W Washington	ILD006263065	No	No	Yes	No	No	No
Doyle Equipment MFG Company Inc., 3900 Broadway	ILD006294839	No	Yes	Yes	No	No	No
Gardner Denver, Inc., 1800 Gardner Expressway	ILD006306856	No	Yes	Yes	No	Yes	No
Hollister Whitney Elevator, 2603 N 24th St	ILD006282214	No	No	Yes	No	No	No
Huck Store Fixture Company, 1100 N 28th Street	ILD006263057	No	Yes	Yes	No	Yes	No
Hulls Autobody, 1815 N 30th St	ILD982619512	No	No	Yes	No	No	No
JM Huber Corp Engineering Minerals Division, 3806 Gardner Expressway	IL0001912054	No	Yes	No	No	No	No
JM Huber Corp, 3150 Gardner Expressway	ILD096720966	Yes	No	Yes	No	Yes	No
Knapheide Mfg. Company, 1848 Westphalia Strasse	000007574032	No	Yes	No	No	No	No
Kuester Tool and Die Inc., 3321 Cannonball Rd	ILD982425506	No	No	Yes	No	No	No
Martin and Kroencke Imp Co, Hwy 104E	IL0001332873	No	No	Yes	No	No	No
Moorman's Inc., 1000 N 30th St.	ILD006297832	No	Yes	Yes	No	Yes	No
Pepsi Cola Bottling Company	ILD984804211	No	Yes	Yes	No	No	No
Quincy Wilbert Vault Company, 4128 Wismann Lane	IL0002198075	No	No	No	No	Yes	No
S and D Developers Inc. WHSE, 3803 Dye Rd.	ILD061043741	No	No	Yes	No	No	No
St Marys Hospital, Broadway at 14th St.	ILD071979868	No	No	Yes	No	Yes	No
Total		**1**	**7**	**15**	**0**	**7**	**0**

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ATTACHMENT 5
ILLINOIS EPA DATABASE

Illinois Environmental Protection Agency.
Site Environmental Information Data System (SEIDS),
Database Accessed via http://www.epa.state.il.us/land/seids.

Selection Type: Select the County that contains the site.
Selected: Adams County.
Requested Databases: Site Remediation Program (SRP), Department of Defense (DOD), Leaking Underground Storage Tanks (LUST), Resource Conservation and Recovery Act (RCRA), and Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) sites.

The query revealed that three RCRA sites, eleven SRP sites, and one LUST site were located in Cass County, Illinois.

Results for Adams County include the following:

Site Name Address	Site ID Number	LUST	CERCLIS	DOD	SRP	RCRA
Lima Lake Burn Site, 300 ft S. of Highway 8, Meyer, Illinois	0010700003	No	No	No	Yes	No
Electric Wheel Landfill, 1120 North 28th Street, Quincy, Illinois	0018060013	No	No	No	Yes	Yes
Moorman Manufacturing, 2901 Chestnut, Quincy, Illinois	0010655002	No	No	No	Yes	Yes
Harris Broadcast, 3200 Wisman Lane, Quincy, Illinois	0018060012	Yes	No	No	Yes	Yes
Former Coca Cola Bottling Co., 616 North 24th St., Quincy, Illinois	0010655181	No	No	No	Yes	No
CIPS Town Gas, 818 Jersey, Quincy, Illinois	0010650017	No	No	No	Yes	No
Quincy Municipal Landfills #2 & #3, CR 1153 North, Quincy, Illinois	0018150006	No	No	No	Yes	No
Sand Ridge Burn Site, 1.25 miles west of Highway 7, Ursa, Illinois	0010700004	No	No	No	Yes	No
Rock Creek Burn Site, 200 ft east of Highway 7, Ursa, Illinois	0010700005	No	No	No	Yes	No
Miller, 304 Warsaw, Ursa, Illinois	0010700002	No	No	No	Yes	No
Ursa Highway 7 Burn Site, West & adjacent to Highway 7, Ursa, Illinois	0010700006	No	No	No	Yes	No
Total		**1**	**0**	**0**	**11**	**3**

APPENDIX F

WATER QUALITY

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GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT

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APPENDIX F
WATER QUALITY

1. PURPOSE

The purpose of this appendix is to discuss the results of water quality related baseline monitoring performed in the vicinity of the Gardner Division Environmental Management Program project. Water quality monitoring was performed in an effort to define present water quality conditions and to identify potential problem areas. Grain size and elutriate analyses were performed in order to assess the potential water quality impacts of dredging related activities.

2. INTRODUCTION

The original fact sheet for the Gardner Division project called for the dredging of several backwater chutes and a large portion of Long Island Lake. Many of the proposed dredging sites were located near the lower end of Long Island; therefore, most of the initial water quality monitoring sites were established in this area. Baseline water quality monitoring was performed for varying lengths of time at the five sites shown in Definite Project Report (DPR) plate 12. As the project evolved, much of the proposed dredging near the lower end of Long Island was eliminated from consideration; consequently, water quality monitoring at sites W-M332.7M, W-M333.0N, W-M333.3K, and W-M333.8Q was discontinued. Site W-M336.6S is the only water quality monitoring site that may be impacted by alternatives currently being considered; therefore, the results from monitoring performed at this site will be discussed.

Samples for elutriate analysis were collected in 1993 at three Long Island Lake sites (E-M336.1M, E-M334.2N, and E-M333.4M) as shown in DPR plate 12. Since Long Island Lake dredging is no longer under consideration, the results from these analyses will not be discussed. Design alternatives considered in this analysis include dredging portions of Shandrew Island Side Channel and O'Dell Chute. Grain size analyses performed on samples collected from these areas by Corps of Engineers Geotechnical Branch personnel on September 19, 1996, indicate the bed material is predominantly sand, having a maximum of 10.6 percent passage through a #230 sieve. The sandy nature of the material precludes the need for an elutriate analysis.

3. METHODS

Baseline water quality monitoring data were collected by Corps Water Quality and Sedimentation Section personnel and by engineering firms under contract to the Corps. Barrientos and

Associates, Inc., Iowa City, Iowa, collected the 1990 water quality monitoring data, while Donohue and Associates, Waterloo, Iowa, collected the 1991 data. Corps Water Quality and Sedimentation Section personnel performed the remaining water quality monitoring. In general, sampling date, time, water depth, Secchi disk depth, water velocity, wave height, air temperature, percent cloud cover, wind speed and direction, pH, water temperature, dissolved oxygen (D.O.) and conductivity were recorded in the field. Water samples for laboratory analysis were collected just below the surface. Samples collected by Barrientos or Donohue personnel were placed on ice and delivered to labs in Iowa City or Des Moines, Iowa, or Sheboygan, Wisconsin, respectively. Samples collected by Corps personnel for chlorophyll and suspended solids analyses were shipped to ARDL, Inc., Mount Vernon, Illinois, during 1992 and 1993 and to EIS Analytical Services, Inc., South Bend, Indiana, in 1994. Turbidity and alkalinity samples collected by Corps personnel were analyzed in-house. Sample collection/preservation and field/laboratory analytical procedures were performed according to U.S. Environmental Protection Agency (1983) or American Public Health Association *et al.* (1989 or 1992) methods.

4. RESULTS AND DISCUSSION

The results from baseline water quality monitoring at site W-M336.6S are given in Table F-1. Sampling commenced at this site, which is located within O'Dell Chute, on April 14, 1990. Upon review of the data set, water quality problems were not evident; therefore, sampling was discontinued on May 24, 1994. During the 4 years that the site was sampled, all D.O. values were above the instantaneous Illinois General Use Water Quality Standard of 5.0 mg/l (see Figure F-1). D.O. concentrations ranged from 6.13 mg/l to 17.33 mg/l, and averaged 10.57 mg/l. The relatively high velocities measured in O'Dell Chute (average of 1.066 ft/sec) were probably a major factor contributing to the high D.O. concentrations observed. On only one occasion (September 30, 1991) was zero velocity measured (see Figure F-2), and this coincided with the lowest water depth observation (2.40 ft). Two pH values were outside of the Illinois General Use Water Quality Standard range of 6.5 to 9.0. On November 10, 1993, the pH was 9.33 and on April 19, 1994, the pH was 9.18. Relatively high D.O. and chlorophyll concentrations on both of these sampling dates suggest the high pH values were due to plant photosynthetic activity. Suspended solids and turbidity values averaged 83.6 mg/l and 46 NTUs, respectively.

5. CONCLUSIONS

The water quality of the Mississippi River in the Gardner Division project area was rated as "good" according to the Illinois Environmental Protection Agency (1998) in their most recent 305b report to Congress. The report stated the primary river contaminants in the project area are nutrients and sediment resulting from agricultural runoff.

No water quality problems were observed during a 4-year baseline monitoring study performed at site W-M336.6S. The relatively high velocities measured in O'Dell Chute resulted in sufficient D.O. concentrations to support aquatic life. Construction of a closure structure in O'Dell Chute is one of the potential features of the Gardner Division project. If this feature is constructed, it is recommended that monitoring continue at site W-M336.6S in order to determine its impact on water quality. It is likely there will be little impact on D.O. concentrations if the proposed closure structure is submerged; however, if the structure is built to an elevation that significantly reduces flow into O'Dell Chute, low D.O. concentrations may occur.

6. LITERATURE CITED

American Public Health Association, American Water Works Association and Water Environment Federation. 1992. *Standard Methods for the Examination of Water and Wastewater.* 18th Edition. APHA, Washington, DC.

American Public Health Association, American Water Works Association and Water Environment Federation. 1989. *Standard Methods for the Examination of Water and Wastewater.* 17th Edition. APHA, Washington, DC.

Illinois Environmental Protection Agency. 1998. *The Condition of Illinois Water Resources 1998.* IEPA/BOW/98-006. 8 pp.

U.S. Environmental Protection Agency. 1983. *Methods for Chemical Analysis of Water and Wastes.* U.S. Environmental Protection Agency, Cincinnati, Ohio.

Table F-1. Water quality monitoring results from samples collected at site W-M336.6S

DATE	WATER DEPTH (FT)	VELOCITY (FT/SEC)	WAVE HEIGHT (FT)	AIR TEMP. (°C)	CLOUD COVER (%)	WIND SPEED (MPH)
4/14/90	2.60		0.0	11		
5/9/90	4.60	1.930	0.0	18		
5/26/90	4.60	1.930	0.0	18		
6/9/90	6.45	0.649	0.0	29		
8/5/90	10.10	2.440	0.1	27		
8/19/90	6.25	1.660	0.1	31		
9/16/90	5.05	0.968	0.0	22		
9/30/90	3.00	0.129	0.1	15		
7/18/91	8.00			28	0	0
7/23/91	7.00	0.550	0.5	34	0	10
8/6/91	6.50	0.900	0.0	29	10	0
8/20/91	5.00	0.200	0.0	27	5	
9/11/91	4.30	0.100	0.0	26	100	0
9/17/91	4.50	0.200	0.3	24	90	<5
9/30/91	2.40	0.000	0.0	20	0	0
10/18/91	3.50	0.010	0.8	13	100	10
10/22/91	4.60	0.020	0.6	26	0	10
11/15/91	5.00	0.600	0.2	8	100	10
12/4/91	5.50	0.500	0.0	-7	0	0
4/7/92	6.00	*	0.0	14	95	0
5/5/92	10.30	1.530	0.1	14	20	8
5/19/92	3.25	1.150	0.0	27	20	0
7/23/92	6.10	1.813	0.0	26	100	0
8/13/92	4.30	1.137	0.0	18	70	2
8/27/92	3.00	0.107	0.0	21	100	0
9/17/92	5.20	1.727	0.0	23	90	0
10/8/92	2.45	0.424	0.1	9	95	20
10/27/92	3.20	0.863	0.0	12	0	3
11/24/92	10.70	2.332	0.0	4	100	0
1/25/93	5.45	1.572	0.0	1	10	0
10/27/93	3.50	1.534	0.0	12	85	0
11/10/93	4.55	0.782	0.0	5	10	0
3/23/94	6.50	1.792	0.1	17	20	15
4/19/94	4.30	1.557	0.1	21	15	1
5/10/94	9.60	2.392	0.0	24	0	5
5/24/94	5.60	1.693	0.0	28	70	3
MIN	2.40	0.000	0.0	-7	0	0
MAX	10.70	2.440	0.8	34	100	20
AVG.	5.36	1.066	0.1	19	47	4

* Meter Malfunction

Table F-1 (Cont.). Water quality monitoring results from samples collected at site W-M336.6S

DATE	WIND DIRECTION	WATER TEMP (°C)	DISSOLVED OXYGEN (MG/L)	pH (SU)	TOTAL ALKALINITY (MG/L as CaCO3)
4/14/90		9.0	15.10	8.80	144
5/9/90		17.0	8.60	7.40	120
5/26/90		17.0	8.60	7.40	120
6/9/90		21.0	7.70	7.80	140
8/5/90		25.0	7.70	8.30	152
8/19/90		27.0	9.00	8.60	174
9/16/90		23.0	8.90	8.10	162
9/30/90		19.0	8.90	8.00	160
7/18/91		29.5	12.10	8.13	164
7/23/91	NW	30.0	13.00	8.22	164
8/6/91		25.5	10.98	7.96	154
8/20/91	NW	25.2	9.93	7.50	158
9/11/91		26.5	7.35	7.35	158
9/17/91	SE	25.0	9.35	7.43	168
9/30/91		18.0	9.83	7.07	160
10/18/91	NW	13.0	11.00	7.22	154
10/22/91	SW	14.9	11.89	7.40	159
11/15/91	NW	4.0	11.20	*	
12/4/91		-0.5	12.33	*	*
4/7/92		8.1	12.86	8.24	163
5/5/92	NW	16.0	*	8.32	129
5/19/92		22.7	11.63	8.64	159
7/23/92		24.8	7.08	7.65	168
8/13/92	NW	24.8	6.43	8.09	179
8/27/92		23.6	7.91	8.30	187
9/17/92		21.8	6.13	*	140
10/8/92	SW	16.1	7.91	8.08	155
10/27/92	SE	11.9	12.65	8.59	166
11/24/92		5.3	*	8.08	164
1/25/93		0.2	13.62	8.45	200
10/27/93		11.7	13.60	8.90	189
11/10/93		7.9	17.33	9.33	175
3/23/94	S	7.4	12.32	8.33	174
4/19/94	NW	14.6	15.04	9.18	139
5/10/94	S	15.9	10.29	8.02	129
5/24/94	S	23.8	11.09	8.77	164
MIN		-0.5	6.13	7.07	120
MAX		30.0	17.33	9.33	200
AVG.		17.4	10.57		159

* Meter Malfunction

Table F-1 (Cont.). Water quality monitoring results from samples collected at site W-M336.6S

DATE	SPECIFIC CONDUCTANCE (µMHOS/CM @ 25°C)	SECCHI DISK DEPTH (FT)	TURBIDITY (NTU)	SUSPENDED SOLIDS (MG/L)
4/14/90	391	1.20	26	44.0
5/9/90	364	0.50	100	150.0
5/26/90	364	0.50		
6/9/90	413	0.60	100	140.0
8/5/90	421	0.75	83	140.0
8/19/90	454	1.35	40	87.0
9/16/90	444	0.90	35	60.0
9/30/90	439	0.85	32	53.0
7/18/91	441	1.60	35	53.0
7/23/91	445	1.10	32	51.0
8/6/91	436	0.90	34	43.0
8/20/91	446	1.00	46	62.0
9/11/91	452	1.00	24	28.0
9/17/91	453	0.90	64	60.0
9/30/91	444	1.00	68	49.0
10/18/91	439	0.80	58	96.0
10/22/91	430	1.00	36	53.0
11/15/91	414	0.60	84	87.0
12/4/91	126	1.30	99	142.0
4/7/92	394	0.60	23	68.0
5/5/92	314	1.30	47	170.0
5/19/92	415	1.15	17	44.0
7/23/92	480	0.80	37	102.0
8/13/92	484	1.40	17	37.8
8/27/92	475	1.50	16	34.1
9/17/92	367	0.25	170	307.0
10/8/92	395	1.35	17	29.3
10/27/92	377	1.30	15	31.6
11/24/92	375	0.45	108	309.0
1/25/93	431	1.05	15	28.8
10/27/93	427	1.30	17	6.2
11/10/93	368		12	22.0
3/23/94	395	1.15	18	62.0
4/19/94	362	1.00	31	86.0
5/10/94	326	0.70	31	130.0
5/24/94	396	1.20	19	60.0

MIN	126	0.25	12	6.2
MAX	484	1.60	170	309.0
AVG.	405	0.98	46	83.6

Table F-1 (Cont.). Water quality monitoring results from samples collected at site W-M336.6S

DATE	CHLOROPHYLL a (MG/M3)	CHLOROPHYLL b (MG/M3)	CHLOROPHYLL c (MG/M3)	PHEOPHYTIN a (MG/M3)
4/14/90	74.0	<1	15.0	72.0
5/9/90	14.0	<1	11.0	95.0
5/26/90				
6/9/90	30.0	6.0	8.0	33.0
8/5/90	102.0	3.0	12.0	11.0
8/19/90	111.0	<1	10.0	14.0
9/16/90	38.0	5.0	8.0	21.0
9/30/90	32.0	<1	11.0	35.0
7/18/91	11.6	<.2	1.6	5.1
7/23/91	47.5	3.8	5.5	34.3
8/6/91	57.2	4.2	6.0	33.4
8/20/91	38.5	2.9	1.7	2.9
9/11/91	27.7	2.6	2.7	5.6
9/17/91	65.2	7.0	8.5	7.8
9/30/91	16.9	2.3	4.8	13.7
10/18/91	21.9	11.4	<.2	8.3
10/22/91	38.3	1.4	7.3	3.2
11/15/91	7.4	<.2	1.2	5.2
12/4/91	14.2	2.0	3.2	<.2
4/7/92	55.0	<1.3	4.8	17.0
5/5/92	33.0	<1.1	3.2	2.1
5/19/92	54.0	12.0	<1.5	26.0
7/23/92	16.0	<6.9	29.0	26.0
8/13/92	11.6	<6.5	<7.7	<9.4
8/27/92	28.4	<2.1	<2.4	155.0
9/17/92	211.0	<2.2	12.8	116.0
10/8/92	13.3	16.6	22.3	78.8
10/27/92	114.0	<1.3	46.3	96.1
11/24/92	43.3	23.7	40.5	43.0
1/25/93	22.0	6.2	25.8	37.4
10/27/93	166.0	13.0	14.3	<2.7
11/10/93	108.0	6.8	12.3	<2.7
3/23/94	25.0	<1	<1	36.0
4/19/94	252.0	<1	30.0	6.8
5/10/94	50.0	<1	2.6	7.4
5/24/94	80.0	4.2	8.5	28.0

MIN	7.4	<.2	<.2	<.2
MAX	252.0	23.7	46.3	155.0
AVG.	58.0			

FIGURE F-1. PRE-PROJECT DISSOLVED OXYGEN CONCENTRATIONS AT SITE W-M336.6S

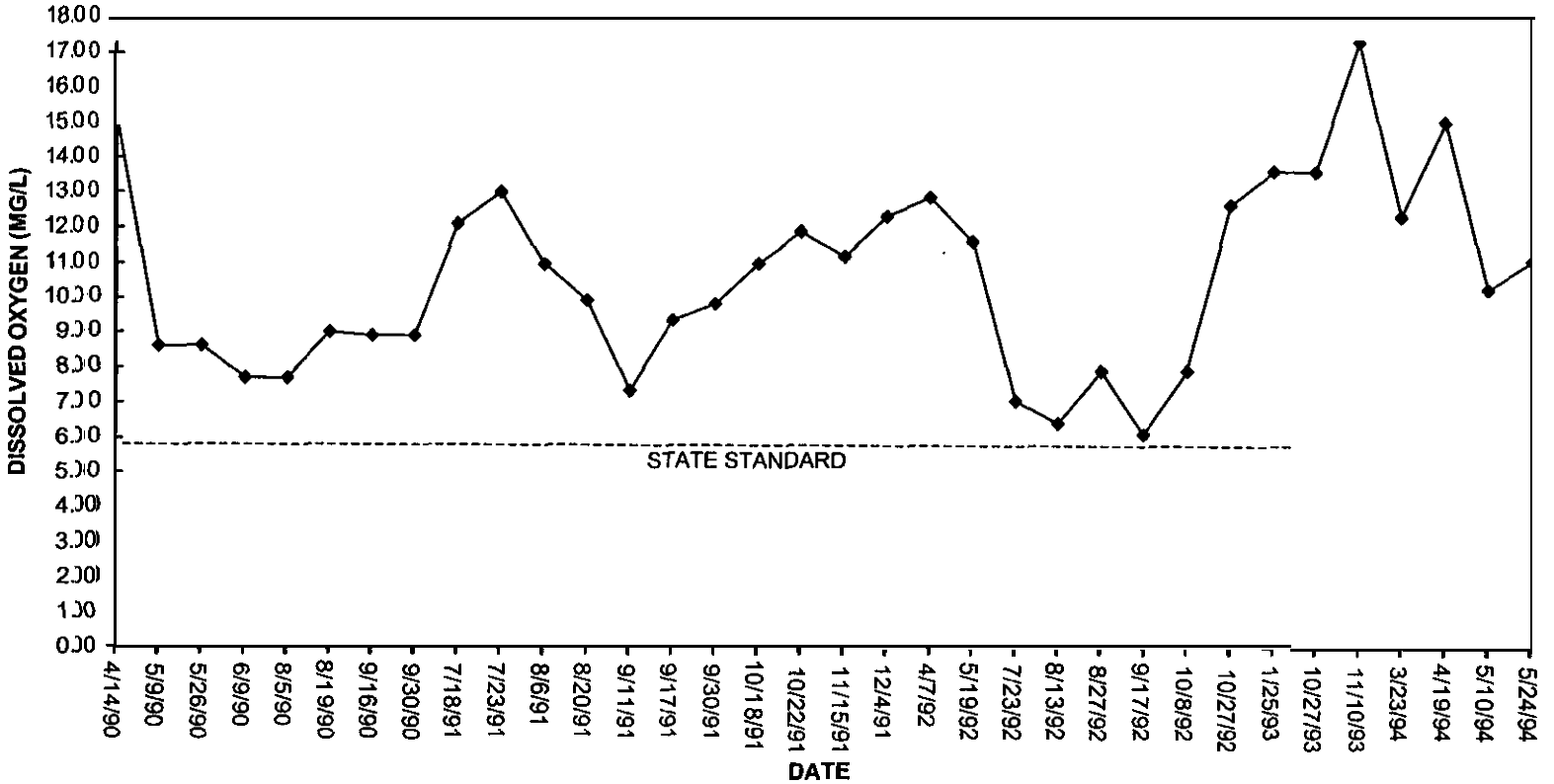
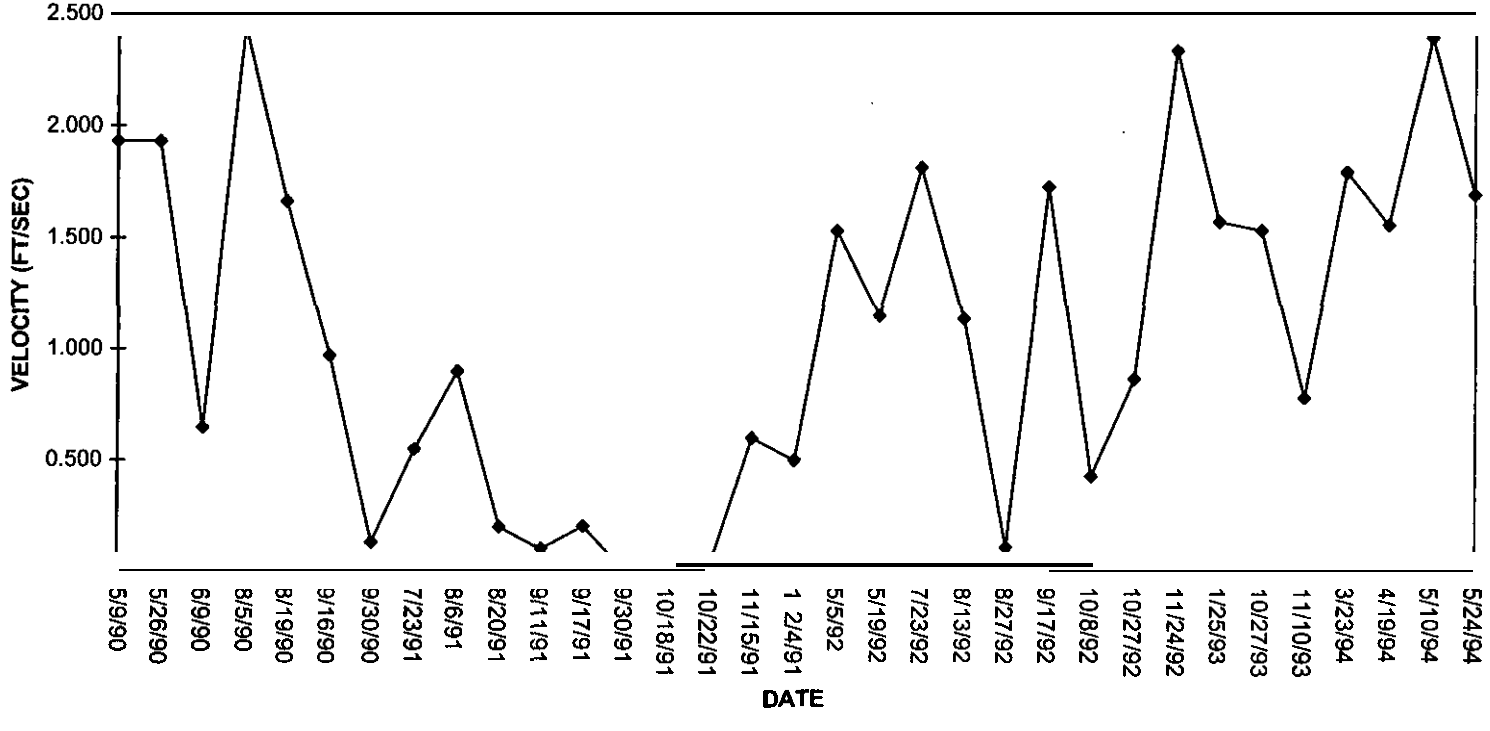


FIGURE F-2. PRE-PROJECT VELOCITIES AT SITE W-M336.6S



GEOTECHNICAL CONSIDERATIONS

APPENDIX G

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-15F)

GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 21, MISSISSIPPI RIVER MILES 332.5 THROUGH 340.2
ADAMS COUNTY, ILLINOIS

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UPPER MISSISSIPPI RIVER SYSTEM
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GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 21, MISSISSIPPI RIVER MILES 332.5 THROUGH 340.2
ADAMS COUNTY, ILLINOIS

APPENDIX G
GEOTECHNICAL CONSIDERATIONS

1. PURPOSE

This appendix presents the general geology (physiography) and specific geotechnical analyses relevant to the project. The Rock Island District's Geotechnical Branch personnel obtained soil borings, performed laboratory analysis and interpretation, and provided geotechnical analyses and recommendations.

2. PROJECT FEATURES

Key features of the project include island shoreline protection, side channel dredging with closure structure, and mast tree planting, as shown on plate 2 of the Definite Project Report (DPR). These features are designed to protect and/or enhance wetland and terrestrial habitat.

3. LOCATION

The project features are located between Mississippi River Miles (RM) 332.5 and 340.2, as shown on DPR plate 2. The island shoreline protection is proposed for various locations. The dredging will be done in O'Dell and Shandrew Chutes, and the closure structure will be placed at the head end of O'Dell Chute. The dredged material will be placed on Long Island's eastern agricultural field.

4. PHYSIOGRAPHY

The present Mississippi Valley was formed by glacial meltwaters eroding through older existing glacial sediments and down into bedrock. The majority of the bedrock is limestone and dolomite with an occasional shale unit. In many locations where the river impinges on the valley wall, massive vertical cliffs exist. In areas where the river flows more towards the center of the valley, as is the case here, the walls have become rounded and sloped, filling the valley edges with colluvium. As the last glacial meltwater volume decreased to allow deposition, most of the glacial valley filled with outwash sands and gravels in valley trains and alluvial terraces. At a few sites, the channel bottom remains bedrock controlled. Inter-tongued with this alluvium are coarser-grained upland sediments from tributary streams that create fans along the valley wall. The normal alluvial deposits generally become increasingly coarse-grained with depth, which in some areas

exceeds 100 feet. The sediments consist of a mix of igneous and metamorphic material from as far north as the Canadian Shield, and sedimentary carbonate rock material from the relative vicinity. These glacial valley train deposits are assigned to the Mackinaw Member of the Henry Formation.

The present Mississippi River is believed to erode as much as 50 feet below normal bottom in the active channels during high flood stages. This reworking of the upper portion of the glacial deposits, plus erosion of the upland till and loess, has left the upper layers of the modern valley filled with relatively fine-grained sands and gravels, overlain by silts and clays, all assigned to the Cahokia Alluvium. This unit of floodplain and channel deposits consists largely of silt, clay, and clayey sand, with wood and shell fragments. Lenses and old channel fills of sand and gravel are locally common but generally have a high silt content. The degree of sorting varies but is generally poor. Old cutoffs fill with clay plugs, which can become relatively compact and erosion resistant. This lateral variety of materials combined with human modification of flows makes prediction of future channel direction or rates of erosion extremely difficult.

The project area lies in the valley from near the confluence with Bear Creek, downstream approximately 9 miles. At this point, the valley is 6 miles wide, with the active river occupying up to 2- 1/2 miles in the western half. It is contained by a main stem levee system on the east. The main channel, roughly 1/3 mile wide, runs down the west-central portion of the active valley. Canton Chute, a smaller secondary channel, skirts the eastern edge. Between these two there are numerous braided backwaters and sloughs that create many small wooded islands, generally composed of the alluvial material discussed above. With the exception of an occasional small terrace or sand ridge, the eastern half of the valley floor is generally flat with numerous swales, ditches, and oxbows. This area is under continuous cultivation and has been extensively modified by agriculture.

5. SUBSURFACE EXPLORATION

The subsurface exploration was done in February 1994 and September 1996. Eleven offshore borings were taken by hand using a 2-inch-outer-diameter sampling tube. This sampling method was chosen because access using a drill rig barge was not possible and because it is effective for exploration of loose sand deposits. As exploration of the secondary channel bottoms near Shandrew and Flannigan Islands progressed, numerous field analyses of the adjoining island eroded channel bank soils were made. These soils were composed of sandy, clayey silts and silty, sandy clays. These alluvial soils composing the island range in thickness between 6 and 10 feet and are underlain by sand foundations. One hand auger was taken from the lake bottom on Long Island (GD-94-1). The boring locations and boring logs are shown on DPR plates 10 and 11, respectively.

6. LABORATORY TESTING

Due to the sampling method used, only soil classifications and representative gradation testing were done on the samples. The results of the laboratory classifications are listed with the boring logs (DPR plate 11). Laboratory gradation testing was done for representative samples taken from the borings. Gradation curves for these analyses are shown on plates G-1 through G-5.

7. STRATIGRAPHY

The foundation of the project area consists of brown and grey, medium to fine, poorly graded sands between approximate elevations 450.0 and 470.0 1929 NGVD (National Geodetic Vertical Datum). The islands in the project area consist of sandy, clayey silts and sandy, silty clays between approximate elevations 465.0 and 475.0 NGVD. Fat clays were found at the bottom of Long Island Lake.

8. SITE CHARACTERIZATION

In order to prepare geotechnical analyses for design of the proposed project features, it was necessary to assign engineering properties to the foundation and embankment materials. Soil shear strength parameters are major inputs to geotechnical analyses. The strength parameters are described as the angle of internal friction and cohesion, ϕ and c, respectively.

The following equation describes the shear strength:

$$S = c + \sigma \tan \phi$$

where:

S	= shear strength
c	= cohesion
σ	= normal stress
ϕ	= angle of internal friction

a. Foundations. The foundation for the entire project area is composed of sand. Since split spoon sampling methods were not used, foundation sand shear strengths were obtained by correlation with descriptive relative density (Reference A). The foundation sands encountered at the project location are considered to have, at the weakest, descriptive relative densities of "loose." This description indicates a 28 degree angle of internal friction. The project features will apply minimal loads to underlying soils, and the foundation strength is not considered to be the critical aspect of project feature stability. Therefore, efforts to further define foundation strengths are considered to be unwarranted.

b. Embankments.

(1) Semi-Compacted Earth. Construction of a semi-compacted earth embankment is an option at the agricultural field adjacent to O 'Dell Chute. This embankment will serve to contain dredged sands from O 'Dell Chute and control the associated water discharges in the event that applicable state dredging regulations require confined disposal for this type of material. The proposed embankment will be approximately 2 feet high and retain approximately 8 inches of dredged sand. The embankment slopes will be approximately 2.0 horizontal to1 vertical. The embankment will be built on a properly cleared, compacted, and scarified foundation, using the sandy, silty clays/sandy, clayey silts which compose the island. Assignment of shear strength to the semi-compacted embankment material is considered unnecessary due to its low height. The material will be placed in lifts not exceeding 8 inches and semi-compacted using roller or tracked equipment. Erosion protection for the semi-compacted embankment will be provided at specific locations where dredged water discharges are potentially problematic.

(2) Rock. Rock embankment shear strength parameters were estimated at c = 0 and ϕ = 37-45 degrees.

9. DREDGING DESIGN

a. General. Construction of project features will require the use of dredging to remove river bottom sand sediments in O 'Dell Chute. This feature is expected to improve fish habitat. A typical channel dredging section is shown on DPR plate 8.

b. Dredging Technique. Many choices of dredging techniques are available. The Geotechnical Factors in Dredgeability (DREDGABL version 1.0) program is a knowledge-based expert system whose objective is to provide guidance in the interpretation of geotechnical properties data for use in evaluating the dredgeability of sediments (Reference B). The DREDGABL program output provided recommendations for suitability of different dredging techniques, given type and density of material to be dredged (plates G-6 through G-9). Since the exact density of foundation sands is unknown and overhead clearance is limited by trees, the cutterhead pipeline dredge is recommended for use with this project.

c. Dredge Cut Stability. The O'Dell Chute foundation sand strength was characterized previously in this appendix. According to the most current hydrographic survey information, the dredge cuts throughout O'Dell Chute will range in depth between 0 and approximately 8 feet. The bottom width of the cuts will be approximately 50 feet. During dredging operations, the dredge cut side slopes are expected to reach a natural angle of repose of approximately 2.0 horizontal to 1 vertical. These slopes are expected to remain stable since current and wave erosional forces are expected to be minimal in this sheltered backwater location.

10. EROSION PROTECTION

a. General. The Automated Coastal Engineering System (ACES) design and analysis system was developed by the Coastal Engineering Research Center at the USACE Waterways Experiment Station (Reference E). Its wave growth and rubble-mound revetment design applications were used to select a rock gradation and embankment slope that will resist wave attack. The effects of river current on embankment stability and erosion susceptibility are not addressed here.

b. Design. Assumptions used in the ACES analysis included a maximum observed wind speed of 80 mph, fetch depth of 10 feet, and a measured fetch length of 1.98 miles. As shown on plate G-10, a wave height of 2.50 feet and a wave period of 2.9 seconds were calculated by the ACES Wind Adjustment and Wave Growth program. Using this wave height and period input, along with the most conservative damage acceptance level of 2, the ACES Rubble Mound Revetment Design program was applied for three different embankment slopes: 2.0, 2.5, and 3.0 horizontal to 1.0 vertical (see plates G-11 through G- 13). The preferred embankment slope is 3.0 horizontal to 1.0 vertical in order to maximize wave attack resistance. [A value engineering study was completed in March 2000, which determined that a 2:1 slope would be more cost effective for similar benefits (see Attachment 1). A final slope of 2:1 will be used for final design.] ACES calculated a 1.44-foot-thick erosion protection layer with a top size of approximately 245 pounds for the 3.0 horizontal to 1.0 vertical embankment slope. This, as well as the recommended 1.0-foot-thick bedding layer, is shown on plate G-11. Illinois Gradation No. 5 is the most commonly produced erosion protection stone with a gradation that approximates the ACES

output. The Illinois gradation No. 5 top size exceeds the top size of the ACES-recommended design by approximately 155 pounds. However, the equivalent of Illinois No. 5 is recommended for use as wave erosion protection for this project due to its successful application at numerous Rock Island District Mississippi River erosion protection projects. Due to the dimensions of Illinois gradation No. 5, at least a 2.0-foot-thick layer is recommended for use with this project. EM 1110-2-2300 (Reference F) suggests use of 9-inch-thick bedding (filter) layer for the protection stone. The 1.0-foot-thick bedding layer recommended by ACES should be used for this project. The gradation of the bedding layer should be the equivalent of Illinois Gradation CA-6.

11. ROCK EMBANKMENT

a. General. A closure structure is proposed for the upstream end of the dredge cut in O'Dell Chute. The purpose of the structure is to prevent the chute from refilling with sediment after dredging is completed. Rock will be used as the construction material for the closure structure. The structure will have 2H:1 V slopes and a 5-foot top width. It will be subjected to attack by wind-generated waves, as well as current. The ACES design (the equivalent of Illinois Gradation No. 5 erosion protection stone), which was proposed for the embankment erosion protection feature of this project, is considered adequate to protect against the smaller waves which will be generated in the closure structure's sheltered location. The effects of river current on rock embankment stability and erosion susceptibility are not addressed here. A typical rock closure structure section is shown on DPR plate 7.

b. Stability. The sand foundation beneath the rock embankment closure structure has a shear strength of at least 28 degrees angle of internal friction, as previously described. Although no analyses were used to determine the strength of the rockfill embankment, it is expected to range between 37 and 45 degrees angle of internal friction. Water levels are expected to remain approximately equal on either side of the embankment. These parameters, as well as embankment geometry, are shown on plate G-14. The rock embankment stability was modeled using UTEXAS3 (Reference C). The most critical failure surface was found using a circular search analysis, and the model's failure surface scenarios depicted on plate G-14 are considered relevant. Part of the section shown on plate G-14 was 'keyed' 3 feet into the underlying sands in order to decrease erosion susceptibility of the sand foundation beneath the closure structure. Its effect on the overall stability of the embankment was ignored. Safety factors for slope stability less than 1.3 are not recommended, as stated in EM 1110-2-1913 (Reference G). The minimum safety factor derived from the stability analysis was 2.5.

c. Bearing Capacity and Settlement. The rock embankment closure structure will bear on a sand foundation. The stability analysis previously described serves as an adequate representation of the resistance of the foundation against bearing capacity failure. Minimal immediate sand settlement is expected to occur as the rock embankment is placed.

12. RECOMMENDATIONS

a. Dredge Cuts

1. Allow the cut slopes to fall to natural angle of repose for sand (approximately 2H:1V).

b. Erosion Protection

1. Provide 2H: 1V slopes

2. Use the equivalent of a 2.0-foot-thick layer of Illinois gradation No. 5 erosion protection stone (400-pound top size) for the construction material.

3. Use the equivalent of 1.0-foot-thick layer of Illinois CA-6 for the erosion protection stone bedding.

c. Rock Embankment

1. Use the equivalent of Illinois gradation No. 5 erosion protection stone (400-pound top size) as the construction material.

2. Key part of the embankment 3 feet into the underlying sand foundation

13. REFERENCES

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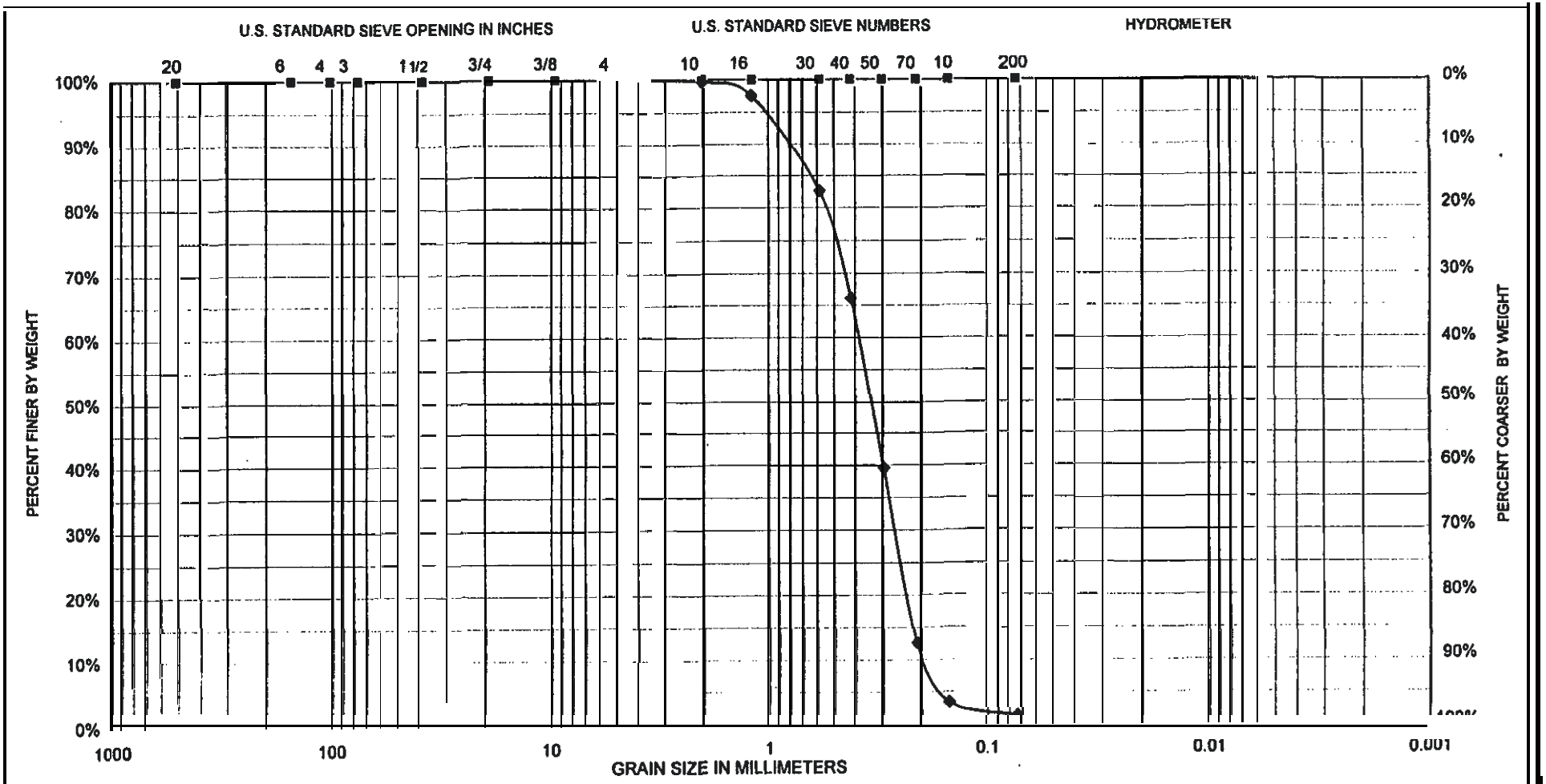
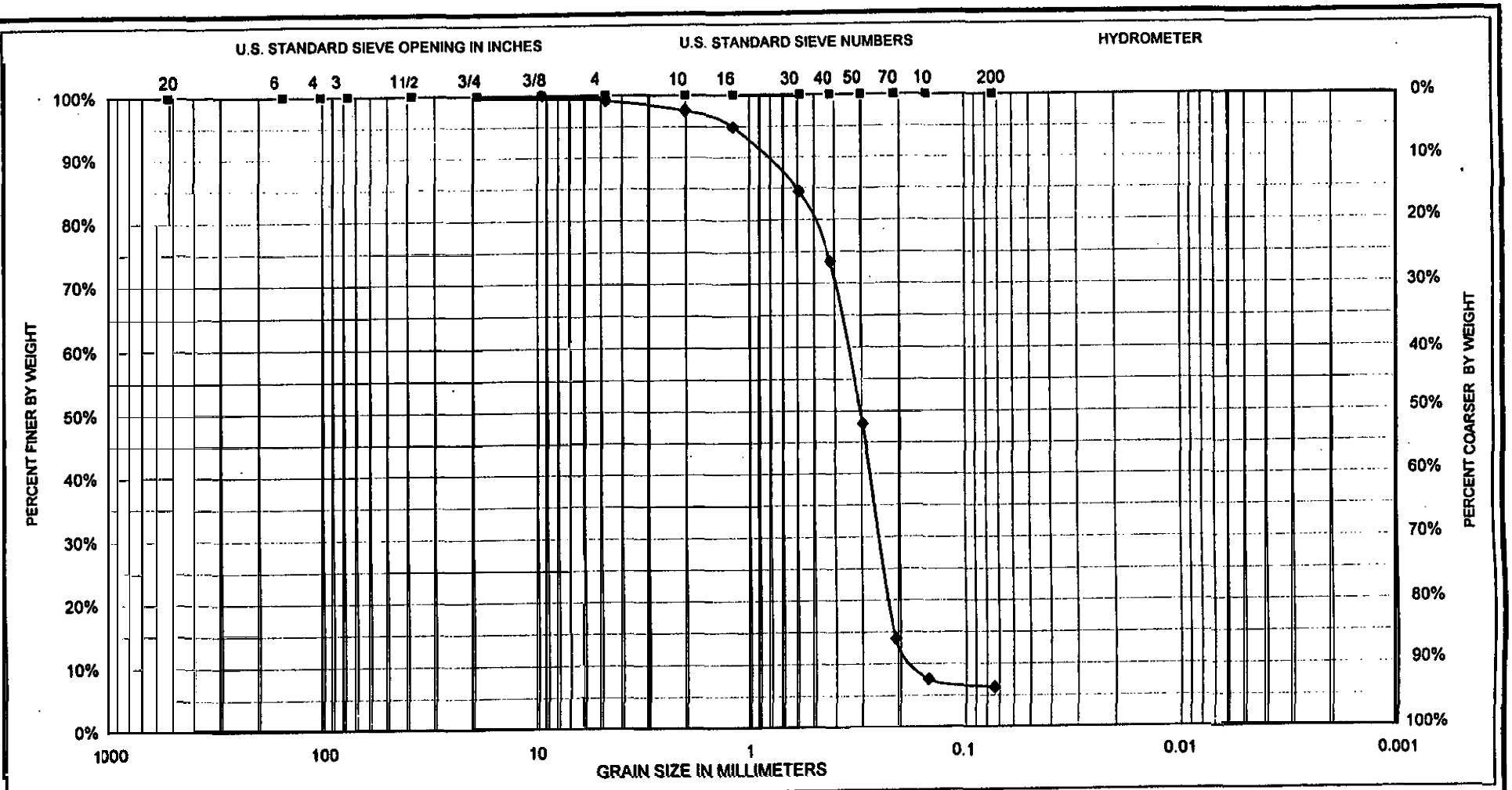


COBBLES	GRAVEL	SAND	SILT OR CLAY

Sample No.	Elev or Depth	Classification	Color	D_{10}	#200	Project:
1		SP, MEDIUM TO FINE SAND	BR	0.20	1.2%	

PLATE G-1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Color	D_{10}	-#200
1		SP-SC, CLAYEY MEDIUM TO FINE SAND	BR	0.19	6.3%

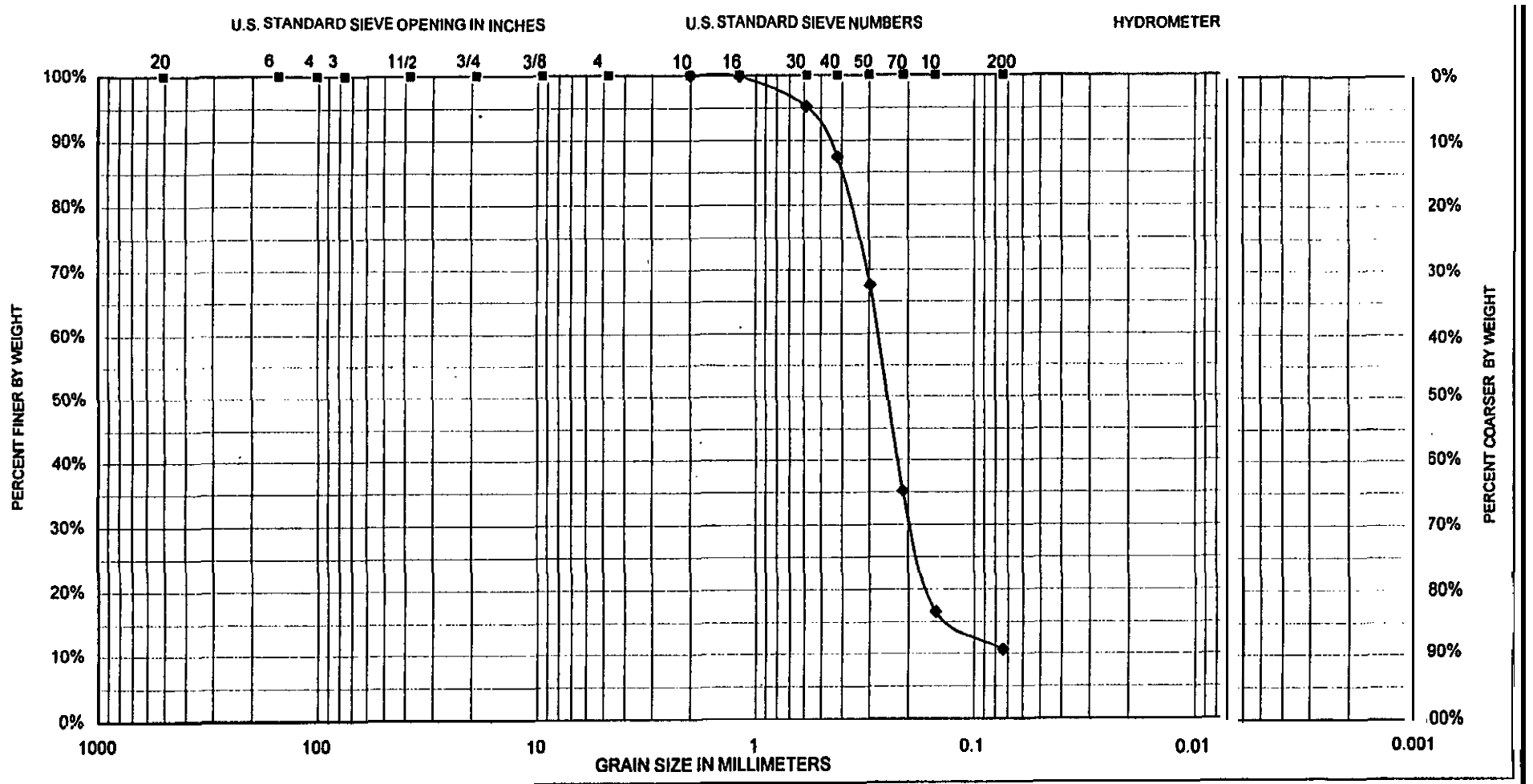
Project: GARDNER DIVISION

Area:

Boring No.: GD-96-4

Date: 19-Sep-96

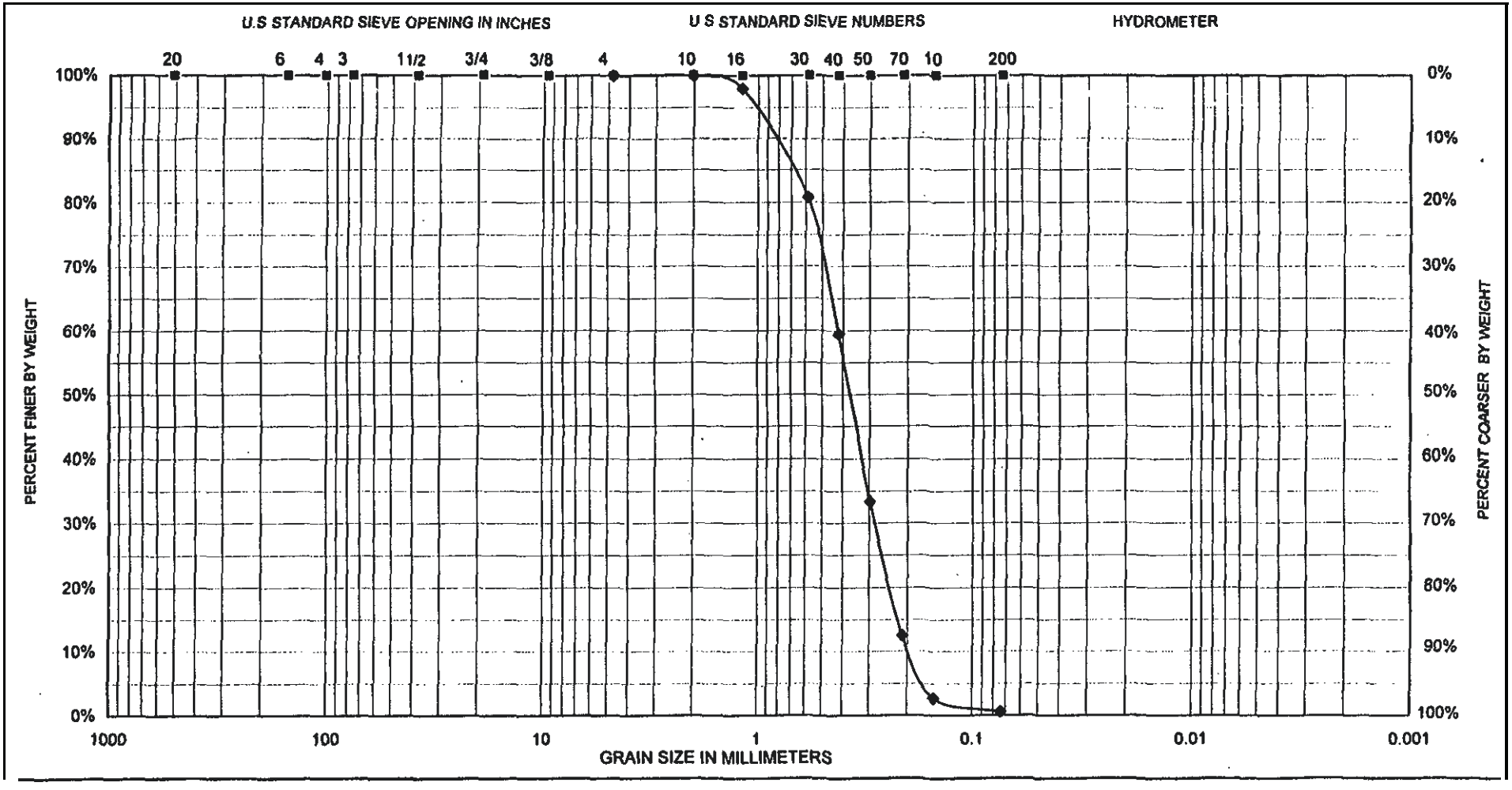
PLATE G-2



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Color	D_{10}	#200	Project: GARDNER DIVISION
1		SP-SC, CLAYEY MEDIUM TO FINE SAND	BR		10.6%	
						Area:
						Boring No.: GD-96-5
						Date: 19-Sep-96

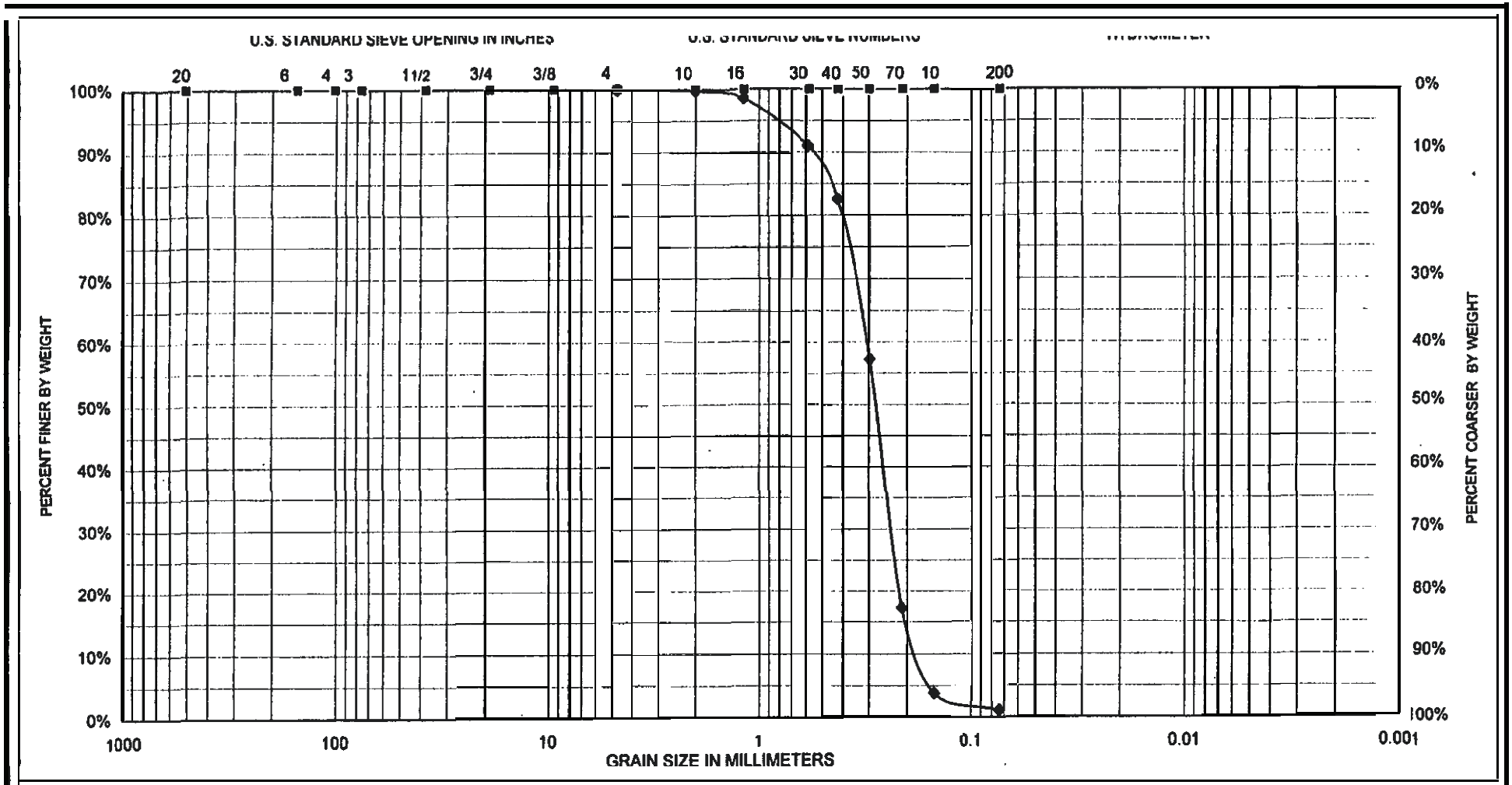
PLATE G-3



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Color	D_{10}	-#200	Project: GARDNER DIVISION
1		SP, MEDIUM TO FINE SAND	BR	0.20	0 5%	
						Area:
						Boring No.: GD-96-6
						Date: 19-Sep-96

PLATE G-4



Sample No.	Elev or Depth	Classification	Color	D_{10}	-#200	Project: GARDNER DIVISION
1		SP, MEDIUM TO FINE SAND	BR	0.18	1.0%	
						Area:
						Boring No.: GD-96-9
						Date: 19 Sep 96

PLATE G-5

DREDGEABILITY EVALUATION SUMMARY REPORT

USER NAME: RANDALL S. KINNEY **OF:** CENCR-ED-G

DATE: 12/13/96 **PROJECT:** GARDNER DIVISION EMP

FOR THE SEDIMENT DESCRIBED AS:

SEDIMENT:	Poorly Graded Sand			**USCS/ASTM:**	SP
FINENESS:	Medium	**COMPACTNESS:**	Very Dense	**ANGULARITY:**	Subrounded
CONSISTENCY:		**PLASTICITY INDEX:**		**LIQUIDITY INDEX:**	

THE SUITABILITY OF HOPPER DREDGES IS:

TRAILING ARM:	Good--fair excavation; almost no overflow of fines.
PLAIN SUCTION:	Not suitable--sand will not flow easily.
BUCKET HOPPER:	Good--easy digging; very little overflow of fines.

THE SUITABILITY OF MECHANICAL DREDGES IS:

BACKHOE:	Good--easy digging; very little overflow of fines.
BUCKET LADDER:	Good--easy digging; very little overflow of fines.
CLAMSHELL:	Hard digging; need heavy bucket; little fines overflow.
DRAGLINE:	Hard digging; need heavy bucket; little fines overflow.
POWER SHOVEL:	Good--easy digging; very little overflow of fines.

THE SUITABILITY OF PIPELINE DREDGES IS:

CUTTERHEAD:	Very good--easy cutting; fairly low pumping energy.
PLAIN SUCTION:	Not suitable--sand will not flow easily.
DUSTPAN:	Suitable only if sand is very loose, liquefies under shear.
BUCKETWHEEL:	Good--easy cutting; fairly low pumping energy.

BECAUSE THE EXCAVATION PROPERTIES ARE:

CUTTABILITY:	High	High strength; high permeability.
FLOWABILITY:	Low	High shear strength; little clayey binder.
SCOOPABILITY:	High	No cohesive strength; negligible suction.
SCOURABILITY:	High	Size slightly above optimum; no cohesion.
SUCTIONABILITY:	None	High shear strength; flow not likely.

AND THE REMOVAL AND TRANSPORT PROPERTIES ARE:

ABRASIVENESS:	Very low	About 4 times as severe as fine sand.
CLAY BALLING:	None	Insufficient cohesive fines.
HOPPER SETTLE:	Very high	Up to 5% fines will not settle quickly.
HOPPER BULKING:	Medium	About 1.25-1.35; fines wont settle.
PUMPABILITY:	High	compared to fine sand; avg. d50 = 0.92 mm.
STICKINESS:	None	Not enough wet, soft, plastic clay.
TURBIDITY:	Very Low	Zero to 5% fines will not settle quickly

AND THE DISPOSAL AREA PROPERTIES ARE:

SEDIMENT RATE:	Several	Up to 5% fines; settle slowly.
BULKING RATE:	Medium	About 1.25 to 1.35.
COMPACTABILITY:	Good	Vibratory roller; rubber-tired roller.

DREDGEABILITY EVALUATION SUMMARY REPORT

USER NAME: RANDALL S. KINNEY **OF:** CENCR-ED-G

DATE: 12/13/96 **PROJECT:** GARDNER DIVISION EMP

FOR THE SEDIMENT DESCRIBED AS:

SEDIMENT:	Poorly Graded Sand			**USCS/ASTM:**	SP
FINENESS:	Medium	**COMPACTNESS:**	Loose	**ANGULARITY:**	Subrounded
CONSISTENCY:		**PLASTICITY INDEX:**		**LIQUIDITY INDEX:**	

THE SUITABILITY OF HOPPER DREDGES IS:

TRAILING ARM:	Very good--easy excavation; almost no overflow of fines.
PLAIN SUCTION:	Suitable only if sand is very loose, liquefies under shear.
BUCKET HOPPER:	Good--easy digging; very little overflow of fines.

THE SUITABILITY OF MECHANICAL DREDGES IS:

BACKHOE:	Good--easy digging; very little overflow of fines.
BUCKET LADDER:	Good--easy digging; very little overflow of fines.
CLAMSHELL:	Easy digging; little fines overflow.
DRAGLINE:	Easy digging; little fines overflow.
POWER SHOVEL:	Good--easy digging; very little overflow of fines.

THE SUITABILITY OF PIPELINE DREDGES IS:

CUTTERHEAD:	Very good--easy cutting; fairly low pumping energy.
PLAIN SUCTION:	Suitable only if sand is very loose, liquefies under shear.
DUSTPAN:	Suitable if water jets used to loosen sand.
BUCKETWHEEL:	Good--easy cutting; fairly low pumping energy.

BECAUSE THE EXCAVATION PROPERTIES ARE:

CUTTABILITY:	Very high	Low strength; high permeability.
FLOWABILITY:	High	Low shear strength; little clayey binder.
SCOOPABILITY:	Very high	No cohesive strength; negligible suction.
SCOURABILITY:	Very high	Size slightly above optimum; no cohesion.
SUCTIONABILITY:	High	Only if loose sand liquefies under shear

AND THE REMOVAL AND TRANSPORT PROPERTIES ARE:

ABRASIVENESS:	Very low	About 4 times as severe as fine sand.
CLAY BALLING:	None	Insufficient cohesive fines.
HOPPER SETTLE:	Very high	Up to 5% fines will not settle quickly.
HOPPER BULKING:	Very low to	About 1.05-1.15; fines wont settle.
PUMPABILITY:	High	compared to fine sand; avg. d50 = 0.92 mm.
STICKINESS:	None	Not enough wet, soft, plastic clay.
TURBIDITY:	Very Low	Zero to 5% fines will not settle quickly

AND THE DISPOSAL AREA PROPERTIES ARE:

SEDIMENT RATE:	Several	Up to 5% fines; settle slowly.
BULKING RATE:	Very low to	About 1.05 to 1.15.
COMPACTABILITY:	Good	Vibratory roller; rubber-tired roller.

DREDGEABILITY EVALUATION SUMMARY REPORT

USER NAME: Randall S. Kinney **OF:** CENCR-ED-G

DATE: 12/13/96 **PROJECT:** GARDNER DIVISION EMP

FOR THE SEDIMENT DESCRIBED AS:

SEDIMENT:	Poorly Graded Sand			**USCS/ASTM:**	SP
FINENESS:	Fine	**COMPACTNESS:**	Loose	**ANGULARITY:**	Subrounded
CONSISTENCY:		**PLASTICITY INDEX:**		**LIQUIDITY INDEX:**	

THE SUITABILITY OF HOPPER DREDGES IS:

TRAILING ARM:	Very good--easy excavation; almost no overflow of fines.
PLAIN SUCTION:	Suitable only if sand is very loose, liquefies under shear.
BUCKET HOPPER:	Good--easy digging; very little overflow of fines.

THE SUITABILITY OF MECHANICAL DREDGES IS:

BACKHOE:	Good--easy digging; very little overflow of fines.
BUCKET LADDER:	Good--easy digging; very little overflow of fines.
CLAMSHELL:	Easy digging; little fines overflow.
DRAGLINE:	Easy digging; little fines overflow.
POWER SHOVEL:	Good--easy digging; very little overflow of fines.

THE SUITABILITY OF PIPELINE DREDGES IS:

CUTTERHEAD:	Very good--easy cutting; low pumping energy.
PLAIN SUCTION:	Suitable only if sand is very loose, liquefies under shear.
DUSTPAN:	Suitable if water jets used to loosen sand.
BUCKETWHEEL:	Good--easy cutting; low pumping energy.

BECAUSE THE EXCAVATION PROPERTIES ARE:

CUTTABILITY:	Very high	Low strength; high permeability.
FLOWABILITY:	Very high	Low shear strength; little clayey binder.
SCOOPABILITY:	Very high	No cohesive strength; negligible suction.
SCOURABILITY:	Very high	Optimum size is fine sand-coarse silt.
SUCTIONABILITY:	Very high	Only if loose sand liquefies under shear

AND THE REMOVAL AND TRANSPORT PROPERTIES ARE:

ABRASIVENESS:	Negligible	Fine grains cause almost no abrasion.
CLAY BALLING:	None	Insufficient cohesive fines.
HOPPER SETTLE:	Very high	Up to 5% fines will not settle quickly.
HOPPER BULKING:	Very low to	About 1.05-1.15; fines wont settle.
PUMPABILITY:	Very high	fine sand sizes are optimum; least energy.
STICKINESS:	None	Not enough wet, soft, plastic clay.
TURBIDITY:	Very Low	Zero to 5% fines will not settle quickly

AND THE DISPOSAL AREA PROPERTIES ARE:

SEDIMENT RATE:	Many minutes	Up to 5% fines; settle slowly.
BULKING RATE:	Very low to	About 1.05 to 1.15.
COMPACTABILITY:	Good	Vibratory roller; rubber-tired roller.

DREDGEABILITY EVALUATION SUMMARY REPORT

USER NAME: RANDALL S. KINNEY **OF:** CENCR-ED-G

DATE: 12/13/96 **PROJECT:** GARDNER DIVISION EMP

FOR THE SEDIMENT DESCRIBED AS:

SEDIMENT:	Poorly Graded Sand			**USCS/ASTM:**	SP
FINENESS:	Fine	**COMPACTNESS:**	Very Dense	**ANGULARITY:**	Subrounded
CONSISTENCY:		**PLASTICITY INDEX:**		**LIQUIDITY INDEX:**	

THE SUITABILITY OF HOPPER DREDGES IS:

TRAILING ARM:	Good--fair excavation; almost no overflow of fines.
PLAIN SUCTION:	Not suitable--sand will not flow easily.
BUCKET HOPPER:	Good--easy digging; very little overflow of fines.

THE SUITABILITY OF MECHANICAL DREDGES IS:

BACKHOE:	Good--easy digging; very little overflow of fines.
BUCKET LADDER:	Good--easy digging; very little overflow of fines.
CLAMSHELL:	Hard digging; need heavy bucket; little fines overflow.
DRAGLINE:	Hard digging; need heavy bucket; little fines overflow.
POWER SHOVEL:	Good--easy digging; very little overflow of fines.

THE SUITABILITY OF PIPELINE DREDGES IS:

CUTTERHEAD:	Very good--easy cutting; low pumping energy.
PLAIN SUCTION:	Not suitable--sand will not flow easily.
DUSTPAN:	Suitable if water jets used to loosen sand.
BUCKETWHEEL:	Good--easy cutting; low pumping energy.

BECAUSE THE EXCAVATION PROPERTIES ARE:

CUTTABILITY:	High	High strength; high permeability.
FLOWABILITY:	Medium	High shear strength; little clayey binder.
SCOOPABILITY:	High	No cohesive strength; negligible suction.
SCOURABILITY:	High	Optimum size is fine sand-coarse silt.
SUCTIONABILITY:	None	High shear strength; flow not likely.

AND THE REMOVAL AND TRANSPORT PROPERTIES ARE:

ABRASIVENESS:	Negligible	Fine grains cause almost no abrasion.
CLAY BALLING:	None	Insufficient cohesive fines.
HOPPER SETTLE:	Very high	Up to 5% fines will not settle quickly.
HOPPER BULKING:	Medium	About 1.25-1.35; fines wont settle.
PUMPABILITY:	Very high	fine sand sizes are optimum; least energy.
STICKINESS:	None	Not enough wet, soft, plastic clay.
TURBIDITY:	Very Low	Zero to 5% fines will not settle quickly

AND THE DISPOSAL AREA PROPERTIES ARE:

SEDIMENT RATE:	Many minutes	Up to 5% fines; settle slowly.
BULKING RATE:	Medium	About 1.25 to 1.35.
COMPACTABILITY:	Good	Vibratory roller; rubber-tired roller.

WIND ADJUSTMENT and WAVE GROWTH

Elevation of Observed Wind	Zobs:	33.00	ft	Wind Observation Type
Observed Wind Speed	Uobs:	80.00	mph	----------
Air-Sea Temp. Difference	delT:	0.00	deg C	Inland
Duration of Observed Wind	DurO:	45.00	sec	
Duration of Final Wind	DurF:	1.00	hr	
Latitude of Observation	LAT:	39.00	deg	
Average Depth of Fetch	d:	10.00	ft	
Length of Wind Fetch	F:	1.98	mi	Wave Growth Equations
Equiv. Neutral Wind Speed	Ue:	50.53	mph	----------
Adjusted Wind Speed	Ua:	76.02	mph	Restricted Fetch
Wave Height	Hm0:	2.50	ft	Shallow-water
Wave Period	Tp:	2.90	sec	Fetch-limited
Wind Direction	Wdir:	0.00	deg	
Mean Wave Direction	Theta:	360.00	deg	

RUBBLE MOUND REVETMENT DESIGN

Significant Wave Height	Hs:	2.50	ft
Significant Wave Period	Ts:	2.90	sec
Cotangent of Nearshore Slope	COT(phi):	50.00	
Water Depth at Toe of Revetment	ds:	10.00	ft
Cotangent of Structure Slope	COT(theta):	3.00	
Unit Weight of Rock	wr:	162.24	lbs/ft3
Permeability Coefficient	P:	0.10	
Damage Level	S:	2.00	

STONE SIZE GRADATION

ARMOR LAYER

Layer Thickness = 1.44 ft

PERCENT LESS THAN BY WEIGHT	WEIGHT (lbs)	DIMENSION (ft)
0.00	7.63	0.36
15.00	24.42	0.53
50.00	61.05	0.72
85.00	119.66	0.90
100.00	244.21	1.15

FILTER LAYER

Layer Thickness = 1.00 ft

PERCENT LESS THAN BY WEIGHT	WEIGHT (lbs)	DIMENSION (ft)
0.00	0.02	0.05
15.00	0.03	0.06
50.00	0.11	0.09
85.00	0.38	0.13
100.00	0.64	0.16

IRREGULAR WAVE RUNUP

EXPECTED MAXIMUM = 3.06 ft
CONSERVATIVE = 3.84 ft

SURF PARAMETER = 1.1586
CERC STABILITY NUMBER = 1.3691
DUTCH STABILITY NUMBER = 2.1642

RUBBLE MOUND REVETMENT DESIGN

Significant Wave Height	Hs :	2.50	ft
Significant Wave Period	Ts :	2.90	sec
Cotangent of Nearshore Slope	COT(phi) :	50.00	
Water Depth at Toe of Revetment	ds :	10.00	ft
Cotangent of Structure Slope	COT(theta) :	2.50	
Unit Weight of Rock	wr:	162.24	lbs/ft3
Permeability Coefficient	P:	0.10	
Damage Level	S:	2.00	

STONE SIZE GRADATION

ARMOR LAYER

Layer Thickness = 1.58 ft

PERCENT LESS THAN BY WEIGHT	WEIGHT (lbs)	DIMENSION (ft)
0.00	10.03	0.40
15.00	32.10	0.58
50.00	80.26	0.79
85.00	157.30	0.99
100.00	321.02	1.26

FILTER LAYER

Layer Thickness = 1.00 ft

PERCENT LESS THAN BY WEIGHT	WEIGHT (lbs)	DIMENSION (ft)
0.00	0.03	0.05
15.00	0.04	0.06
50.00	0.15	0.10
85.00	0.50	0.15
100.00	0.84	0.17

IRREGULAR WAVE RUNUP

EXPECTED MAXIMUM = 3.46 ft
CONSERVATIVE = 4.35 ft

SURF PARAMETER = 1.3903
CERC STABILITY NUMBER = 1.3281
DUTCH STABILITY NUMBER = 1.9757

RUBBLE MOUND REVETMENT DESIGN

Significant Wave Height	Hs:	2.50	ft
Significant Wave Period	Ts:	2.90	sec
Cotangent of Nearshore Slope	COT(phi):	50.00	
Water Depth at Toe of Revetment	ds:	10.00	ft
Cotangent of Structure Slope	COT(theta):	2.00	
Unit Weight of Rock	wr:	162.24	lbs/ft3
Permeability Coefficient	P:	0.10	
Damage Level	S:	2.00	

STONE SIZE GRADATION

ARMOR LAYER

Layer Thickness = 1.77 ft

PERCENT LESS THAN BY WEIGHT	WEIGHT (lbs)	DIMENSION (ft)
0.00	14.02	0.44
15.00	44.86	0.65
50.00	112.16	0.88
85.00	219.83	1.11
100.00	448.64	1.40

FILTER LAYER

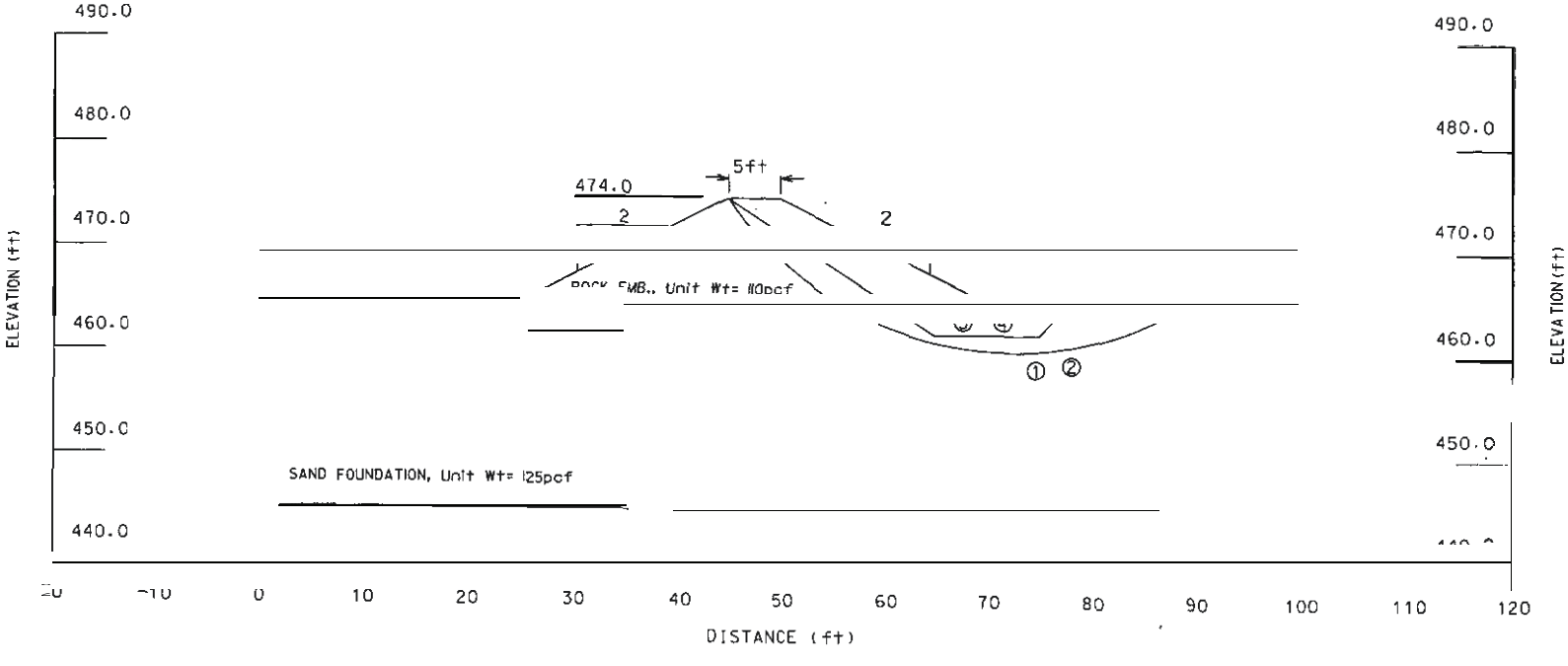
Layer Thickness = 1.00 ft

PERCENT LESS THAN BY WEIGHT	WEIGHT (lbs)	DIMENSION (ft)
0.00	0.04	0.06
15.00	0.06	0.07
50.00	0.21	0.11
85.00	0.70	0.16
100.00	1.18	0.19

IRREGULAR WAVE RUNUP

EXPECTED MAXIMUM = 3.98 ft
CONSERVATIVE = 5.01 ft

SURF PARAMETER = 1.7379
CERC STABILITY NUMBER = 1.2796
DUTCH STABILITY NUMBER = 1.7671



TRIAL #	EMBANKMENT COHESION (psf)	EMBANKMENT PHI (degree)	FOUNDATION COHESION (psf)	FOUNDATION PHI (degree)	CIRCLE CENTER X (ft)	CIRCLE CENTER Y (ft)	RADIUS OF CIRCLE(ft)	FACTOR OF SAFETY
①	0	37.0	0	28.0	72.0	493.0	33.0	2.50
②	0	45.0	0	28.0	72.0	493.0	33.0	2.70
③	0	37.0	0	28.0	78.8	481.2	WEDGE	2.58
④	0	45.0	0	28.0	78.8	481.2	WEDGE	2.81

US Army Corps of Engineers Rock Island District

Revisions

Designed by MES Drawn by MES Checked by RSK Approved by CLM

Scales AS SHOWN Drawing Date 16 JUNE 1998

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

SLOPE STABILITY

Sheet Reference Numbers

PLATE G-14

CEMVR-ED-G

14 March 2000
Mr. Hotchkiss/gah/5290

MEMORANDUM FOR RECORD

SUBJECT : Value Engineering Proposal (VEP) : Gardner Division Environmental Management Program (EMP), Mississippi River, HREP

1. Option 1. Given the understanding that the Shandrew Chute dredging is only for access to the site of the O'Dell Chute closure structure, Option 1 is acceptable from a geotechnical stand point. Placing the closure farther downstream in O'Dell Chute may eventually cause siltation in the upper reach of the chute.

2. Option 2.

a. Steepening the shore protection from 3H:1V to 2H:1V is acceptable as long as the rock gradation and layer thickness is increased appropriately; and toe protection is added. The original report calculations show that at 2H:1V is acceptable with approximately 21 inches of 450 pound stone on one foot of bedding (Plate G-13). Additional iterations of the ACES program show that if rock with a higher specific gravity is used; or, some slight damage at the design wave height is tolerable, that a 400 pound gradation (ILDOT #5) may be used.

b. The original design drawings indicate that the slope would be cut to a 3H:1V until it intersected the average slope below water of 6H:1V. This in effect gives a weighted toe, i.e. toe protection to the original design. Proposal drawings indicate that the 2H:1V slope would be carried to the same elevation as the original structure, just below 466. This indicates a cut of underwater material to fit the proposed template if a slope of 2H:1V is carried to this elevation. As drawn, the 2H:1V requires a weighted toe to provide scour protection. This toe should be calculated based on projected scour depth at each placement site. Assuming not severe scour, and applying a rough rule of thumb to this project, this toe should be at least two riprap layer thicknesses thick (high) by three layer thicknesses long (projected out from the toe). If the 2H:1V slope is only graded until it intersects the natural slope of 6H:1V then this toe protection should be carried out to an elevation below the active wave zone at the design pool elevation; or, a weighted toe provided which, based on volume, would extend the riprap layer to that elevation at a 2H:1V slope.

GLEN A. HOTCHKISS, P.G.
Geologist,
Geotechnical Branch

CF: ED-G (Kinney)
ED-DN (Mitvalsky)

ATTACHMENT 1

APPENDIX H

SEDIMENTATION

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-15F)

GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 21, MISSISSIPPI RIVER MILES 332.5 THROUGH 340.2
ADAMS COUNTY, ILLINOIS

APPENDIX H
SEDIMENTATION

1. INTRODUCTION

Sedimentation in the backwater areas of Gardner Division, including Canton, Shandrew and O'Dell Chutes, has not been measured. Bathymetric measurements were taken in 1994 and 1999, but drawing long-term conclusions from a 5-year span is problematical. The backwater area has filled in considerably from the time that Lock and Dam 21 went into operation. The process is ongoing, as demonstrated by the new sand bars at the upper end of O'Dell Chute.

This appendix will estimate how much sedimentation can be expected in the future. Without specific information from this area, the sediment load entering the area and the trap efficiency were used to estimate the net sedimentation. The increase in river bottom elevation was then calculated by considering total area where deposition is likely and the compaction rate of the sediment. Finally, the rate was compared to another backwater area in Pool 21 where sedimentation rates have been thoroughly evaluated, to ensure that these estimates appear reasonable.

2. ESTIMATED SEDIMENTATION FOR GARDNER DIVISION

A. Sediment Flow. Quantities of sediments entering Canton Chute from both the Mississippi River and Bear Creek were estimated. The average suspended load for Keokuk, Iowa, for water years 1968 through 1990 was 10,920,479 tons per water year. Since this location was in the vicinity of the Gardner Division, these data were used for the purposes of this study. Flow measurements show that 26 percent to 28 percent of the total discharge travels down Canton Chute.

An assumption was made that the percent of the sediment load traveling down the chute is proportional to the percent of the discharge traveling down the chute. Other studies on the Mississippi River have shown that the bed load is equal to about 10 percent of the suspended sediment load. Additionally, the sediment observed in the project area, and as shown in boring samples (plates 10 and 11 of the Definite Project Report), consisted of a sandy material. Therefore, a factor of 10 percent was used to convert sediment load to bed load. Using this information, the estimated yearly bed load was calculated to be 295,000 tons.

The drainage area at the mouth of Bear Creek is unpublished. The drainage area for the USGS Marcelline Gage 12.3 miles upstream is 349 square miles. The area downstream of the gage measured about 32 square miles on a Burlington, Iowa, large scale USGS map (1 inch equals 4 miles). Suspended sediment load was estimated using Appendix G of the 1970 *Upper Mississippi River Comprehensive Basin Study*. The basin is in zone 109 of Figure G-37 and

produces about 800 tons of sediment per square mile per year. This value is in agreement with the station near the La Moine River at Ripley for which data (845 tons per square mile per year average) were published in the 1996 *USGS Water Supply Resource Data for Illinois*. Using the earlier described factor of 1 to 10 for a ratio between bed load and suspended sediment, and using all of the gage information mentioned, the yearly bedload for Bear Creek was estimated at 3,540 tons per year.

b. Sediment Volume. The density of submerged sand is 85 to 100 pounds per cubic foot. The density of a submerged clay-silt-sand mixture is 50 to 80 pounds per cubic foot. Using median values in both cases, the estimated volume of sand from the Mississippi is 6,410,000 cubic feet per year, and the volume of silty clay from Bear Creek is 109,000 cubic feet per year. The total volume of sediment available is 6,520,000 cubic feet per year. However, all of this sediment will not be deposited in the river, since some will continue to be transported downstream.

The average annual flow through Pool 21 is 74,500 cubic feet per second (53,900,000 acre-feet in a year). At this flow, the capacity of the pool is 84,300 day-second feet. This results in a capacity-inflow ratio of 0.0016, which indicates a trap efficiency between 0 percent and 12 percent. Six percent was used for this study.

An average deposition of 391,000 cubic feet per year can be expected in the backwater areas of Gardner Division. Shandrew and O'Dell Chutes carry about one-fourth of the flow in this backwater area and in Canton Chute about three-fourths (measured opposite O'Dell Chute). Therefore, Shandrew and O'Dell Chutes can receive about 98,000 cubic feet of deposition per year and Canton Chute can receive about 293,000 cubic feet per year.

c. Rate of Deposition. Sedimentation deposition does not take place evenly over a given reach of river. Several assumptions were made in order to estimate a reasonable depth of sedimentation.

Because Shandrew and O'Dell Chutes have experienced wide-spread sedimentation since the pool's dam was constructed, the Corps has estimated that the sediment would be deposited over half of the surface area. Shandrew and O'Dell Chutes have a surface area of about 11,000,000 square feet. Therefore, Shandrew and O'Dell Chutes would experience a deposition rate of 0.21 inch per year or 10 inches in the 50-year life of the project.

Canton Chute has relatively high velocities. Sedimentation likely occurs in isolated locations within the chute. The Corps estimated that the sediment aggregation would occur over one-third the total surface area. Canton Chute has a surface area of about 57,500,000 square feet. Therefore, Canton Chute would experience a deposition rate of 0.18 inch per year or 9 inches in the 50-year life of the project.

3. SEDIMENTATION FROM COTTONWOOD ISLAND

Cottonwood Island is located on the right bank of the Mississippi River just downstream of Gardner Division. Net sedimentation was estimated by looking at total sedimentation between 1938 plane table topographic maps and 1994 channel surveys supplemented with aerial photography from 1977. Five sites were studied with an average sedimentation rate per year of 0.54 inch per year with 1.2 inches per year being the highest and 0.11 inch per year being the lowest. The estimates made of sedimentation above 0.21 inch per year for Canton Chute and 0.18 inch per year for O'Dell Chute are within the range measured at Cottonwood.

4. SEDIM NTATION FROM GARDNEVISION

The 1938 and 1953 plane table topographic maps were reviewed. Cross-sectional information was analyzed at River Miles 333.0, 334.0, 335.0, 336.0,337.0, 338.0, 339.0, 340.0, and 341.0 Additionally, 1994 channel surveys were reviewed for River Miles 333.0, 334.0, 335.0, 336.0, 337.0, 338.0, 339.0, and 340.0. This information is shown in plates 14 though 18 of the Definite Project Report. A review of this data determined that the information from the average sedimentation rates calculated in this appendix were consistent with the information seen from these maps.

5. CONCLUSIONS

During the 50-year life of this project, about 1 foot of sediment can be expected to be deposited in areas where sedimentation is likely to occur. Dredging is to be done at the lower end of O'Dell Chute to maintain a 6-foot depth. Dredging depth should be to 7.5 feet. Additionally, the Mississippi River contributes approximately 10 times as much sedimentation in Canton Chute than Bear Creek. Therefore, any efforts to reduce sedimentation from Bear Creek will have only minimal environmental effects on Canton Chute.

SEDIMENT CALCULATIONS

Mississippi River

10,920,479 tons/yr. * 0.27(%in Chute)*0.10(%bed load)=295,000 tons/year
295,000 tons/yr. * 2000 lb./ton / 92 lbs/ft^3 (sand)= 6,410,000 ft^3/yr

Bear Creek

800 tons/yr./sq. mile * 44.3 sq. miles *0.1(%bed load) = 3,540 tons/year
3,540 tons/yr. *2000 lb./ton / 65 lbs/ft^3 (clay-silt-sand) = 109,000 ft^3/yr

Total volume

6,410,000 ft^3/yr + 109,000 ft^3/yr = 6,520,000 ft^3/yr

Capacity-inflow ratio

Inflow
74,500 ft^3/sec * 365 days/yr. * (1.9835 af/dsf) = 53,900,000 af/yr.
Capacity
84,300 acre-feet (at average flow of 7,500)
Capacity-inflow ratio
84,300 af / 53,900,000 af = 0.0016

Rate of deposition

Total

6,520,000 ft^3/year * 0.06 (trap efficiency) = 391,000 ft^3/yr

Shandrew and O'Dell Chutes

391,000 ft^3/yr * 0.25 (%flow) = 97,800 ft^3/yr
97,800 ft^3/yr / 5,500,000 ft^2 (dep. Area) *12in/ft = 0.21 inches/yr.

Canton Chute

391,000 ft^3/yr *0.75(%flow) = 293,000 ft^3/yr
293,000 ft^3/yr / 19,200,000 (deposition area) *12 in/ft = 0.18 inches/yr.

Abbreviations:

yr	year
lbs	pounds
ft^3	cubic foot
af	acre-foot
dsf	day second foot, volume of one cubic foot per second for one day
in	inch
ft	foot

REFERENCES

"The Great Flood of 1993, Post Flood Report; Upper Mississippi River Basin; Appendix B," September 1994, Rock Island District, U.S. Army Corps of Engineers, page 24.

Letter from John La Tour; USGS, Urbana, IL, to Tom Kirkeeng, USACE, Rock Island, IL, dated November 3, 1992.

Letter from John La Tour, USGS, Urbana, IL, to Tom Kirkeeng, USACE Rock Island, IL, dated February 3, 1993.

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(Appendix G, figure G-21).

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APPENDIX I

HYDROLOGY AND HYDRAULICS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-15F)

GARDNER DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 21, MISSISSIPPI RIVER MILES 332.5 THROUGH 340.2
ADAMS COUNTY, ILLINOIS

APPENDIX I
HYDROLOGY AND HYDRAULICS

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
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ADAMS COUNTY, ILLINOIS

APPENDIX I
HYDROLOGY AND HYDRAULICS

1. INTRODUCTION AND LOCATION OF SITE

Gardner Division is located on the Illinois side of the Mississippi River between River Miles (RM) 332.5 and 340.2, directly across the Mississippi main channel from La Grange, Missouri. Its downstream end is 4 miles upstream of Quincy, Illinois, which is the site of the nearest stage gage (RM 327) to the project. Gardner Division consists of Long Island and the various backwater chutes that form Long Island, along with several smaller islands in close proximity.

This appendix presents a hydrologic assessment of the area and summarizes the hydrologic and hydraulic evaluation of various project features considered as part of this project. This includes features that were not used, such as hard points on the upstream tip of Long Island, notches in wing dams, and V-dikes in O'Dell chute, and features that were used such as riprap protection, closure and dredging in O'Dell chute, and repair of existing wing dams.

The study of Gardner Division started with a two-dimensional flow model of Pool 21 evaluated using the Waterways Experiment Station's computer program RMA2 and visualized with Brigham Young University's Surface Water Modeling System (SMS). These models were used to evaluate flow changes associated with various design features considered in this project.

2. CLIMATE

Temperature and precipitation data used for this site were recorded over a 50-year period at the Quincy Airport from 1948 through 1997.

The climate of this area is typical of the Midwestern United States, with warm, wet summers and cold, dry winters. The maximum average temperature of 87 degrees Fahrenheit occurred in July, while the minimum average temperature of 16 degrees Fahrenheit occurred in January. The average annual precipitation is 37.658 inches with a standard deviation of 9.68. The average annual snowfall is 22.57 inches with a standard deviation of 9.46. Monthly mean values appear in Table I-1.

TABLE I-1. Summary of Monthly Precipitation and Snowfall

Month	Rain (inches)	Snow (inches)	Month	Rain (inches)	Snow (inches)
January	1.43	6.63	July	4.50	0.00
February	1.61	5.54	August	3.52	0.00
March	2.92	3.74	September	3.81	0.00
April	3.65	0.62	October	3.13	0.01
May	4.58	0.00	November	2.51	1.66
June	3.85	0.00	December	1.98	4.52

3. MISSISSIPPI RIVER

The closest Mississippi River gage to Gardner Division is the gage at Quincy. This gage is just downstream of the project at RM 327.9. Plates I-1 through I-5 show the past 15 years of stage hydrographs at that gage. Plate I-6 shows the flood flow frequency profiles for this reach of the river found in the *Upper Mississippi River Water Surface Profiles River Mile 0.0 to River Mile 847.5*, published in 1979 by the Technical Flood Plain Management Task Force. Table I-2 summarizes the flows and elevations at RM 336, near the middle of Gardner Division.

TABLE I-2. Discharges and Elevations for Various Flood Frequencies on the Mississippi River

Frequency %)	Recurrence Interval (years)	Discharge (cfs)	RM 336 Elevation (feet)	Quincy Elevation (feet)
0.2	500	441,000	492.6	490.0
0.5	200	404,000	490.8	488.4
1.0	100	374,000	489.5	486.8
2.0	50	349,000	488.3	485.7
10.0	10	277,000	484.7	481.5
20.0	5	245,000	483.0	479.6

Representative elevation-duration curves for Pool 21 are shown on plate I-7.

4. FEATURES STUDIED BUT NOT INCLUDED IN THIS PROJECT

a. V-Dikes. One problem noted in the smaller backwater chutes is their tendency to silt in, thereby becoming shallower and shallower. One possible remedy suggested by the U. S. Fish and Wildlife Service is to build two rock dikes in the chute, with a wide opening between them at the upstream end and a narrow opening at the downstream end. This would concentrate the flow, increasing the velocity to keep the channel clear. An RMA2 model (plate I-8) shows that increased velocities caused by the V-dikes rapidly dissipate downstream of the structure, with no beneficial effect past the downstream end of the dikes. Because one such structure could not beneficially affect the entire length of either Shandrew or O'Dell Chutes, the idea was abandoned.

b. Hard Points. The upstream end of Long Island is formed by the main Mississippi channel on its western shore and Smoot's Chute across the northern tip where it converges with Canton Chute to form the island's eastern shore. As water from the main channel enters Smoot's

Chute and turns east to Canton Chute, the tip of Long Island forms the outer bend of a fairly tight curve in the river, which is a prime area for erosion. One way to stop this erosion is to build a series of wing dams running from the shore of Long Island out into Smoot's Chute. These wing dams, called hard points, would decrease the velocities across the face of the island, cutting down on erosion and possibly promoting deposition that would start restoring the upstream end of the Island. A number of these hard points were modeled using RMA2 with three flow regimes, from low to high normal to high. The models indicated that the velocity along the shore was reduced and that hard points could protect the island from erosion caused by velocity. By reducing the velocity along the shore, the velocity in the remaining part of Smoot's Chute was increased. This increased velocity could cause erosion along the outer bend of Smoot's Chute as it turns from eastern flow to southern flow along the southwestern shore of Dillon Island before converging with Canton Chute. Plate I-9 shows the effects of the hard points.

This feature was not selected for several reasons. The total rock needed to build the hard points and protect Dillon Island would be as much as that needed to armor just the upstream end of Long Island. Also, the appearance of the eroded area at the head of the island, mainly steep bare cliffs of easily eroded material, matches the appearance of erosion along straight banks of the smaller chutes, like O'Dell, where erosion caused by velocity is unlikely. This leads to the conclusion that some of the erosion in this area was caused by the banks being saturated by high water and then sloughing when the water level fell. If this is true, armoring directly on the banks would help stabilize the area, while hard points would not address the problem.

c. Notching Existing Wing Dams. Several rock dikes called "wing dams" are along the left bank of the Mississippi River main channel. These wing dams were built to cut off flow conveyance along Long Island, forcing more flow into the main channel. The extra flow reduced sedimentation in the main channel, lowering the cost of maintaining navigation. Notching these dams can cause more water to flow through them near the center and develop deep holes just downstream of the dam. These deep holes are good wintering habitat for fish. Modeling of notches at representative wing dams showed an increase in velocities. From past experience at EMP projects in the Rock Island and St. Paul Districts, these increased velocities result in deep holes just downstream of the dikes. Additional visits to the project area indicated that deep water already exists downstream of the wing dams where the notches were proposed. Since the added depth will not be needed, notching the wing dams was not proposed for this project.

d. Shandrew Island Dredging. The downstream end of Shandrew Chute has experienced a considerable amount of sedimentation. Dredging this chute clear and putting in a couple of deep holes to provide wintering habitat for fish were considered as part of this project. An RMA2 model evaluated the effect that the dredging would have on the chute. The results showed little to no change in velocities. This indicates that the sediment problem would probably continue and eventually the chute would refill with sediment. Since there was no strong indication that this dredging would have a long-term benefit to the project, it was omitted as a feature.

e. Long Island Lake Water Level Management. Long Island Lake is a long, relatively flat drainage channel on Long Island that drains into the Mississippi at the southern end by Willow Island. The proposed plan was to draw down the lake using pumps near the mouth. A second solution that would utilize a closure structure near the upper end and pumps on the island was rejected because of high operation and maintenance. This plan was rejected because of Long Lake's many connections to the river, both directly from its braided end and indirectly through ground water.

f. Closure between Willow and Long Islands. The area just downstream of Long Island between Willow Island and Teal and Deadman Islands is good, deep fish habitat. Raising an existing closing dam between the upstream end of Willow Island and Long Island is proposed (RM 332.6) to improve this area as better over-wintering habitat. Raising this dam would reduce velocities during the winter, but still allow overtopping in the spring. The closing dam should be raised to elevation 472.2 feet MSL to meet the criteria of a 90 percent prevention of the dam overtopping from November 1 through February 28 (10 percent elevation duration). This feature was rejected when fisheries interests decided that the present configuration was adequate.

g. Wing Dam Repair. Existing wing dams have degraded at several locations along Long Island. Repairing these wing dams to their original design was modeled using RMA2. Repairs that would enhance fish habitat while maintaining navigation in the main channel will be made using the District's Operations and Maintenance budget.

5. FEATURES INCLUDED IN THIS PROJECT

a. Riprap Protection. This project includes riprap protection at several locations shown on plates 2 and 5 of the Definite Project Report. As noted previously, Gardner Division has experienced erosion, the exact mechanics of which are unknown. The head of Long Island is the most likely location for erosion caused by velocity. The island's head sits on the outer bank of the curve as water flows from the main channel into Smoot's Chute. Erosion at the other locations is most likely a combination of high waters saturating the banks and then flowing out when the waters return to normal levels, and low velocities eroding highly susceptible and exposed soils.

The riprap was designed using EM 1110-2-1601, Hydraulic Design of Flood Control Channels. The specific weight of stone was assumed at 165 pounds per cubic foot. The head of Long Island was considered to be the critical erosion area. It has a bend radius of 1,120 feet with a water surface width of 380 feet in Smoot's Chute. The banks are a steep 1.5 feet vertical on 1 foot horizontal. The average channel velocity is 7.0 feet per second at a flood of 430,000 cubic feet per second. The final design is for a 21-inch-thick layer of riprap. The upper level weight of stone should be between 185 and 463 pounds, with no more than 50 percent of the stone lighter than 93 to 137 pounds and no more than 15 percent of the stone lighter than between 29 and 69 pounds. This distribution is recommended for all sites in this project in order to simplify the buying, hauling, and placing of the riprap. This method will ensure that the most critical location is protected with the correct riprap distribution.

If all project areas could not be riprapped using the above design (21-inch thickness) because of availability or cost of stone, then a minimum riprap thickness of 9 inches could be used at all locations besides the tip of Long Island. If the 9-inch blanket is used, the maximum size stone must be between 15 and 35 pounds. No more than 50 percent of the stone should be lighter than 7 to 11 pounds, and no more than 15 percent of the stone should be lighter than 2 to 5 pounds.

b. O'Dell Chute. The upper reach of O'Dell Chute is experiencing heavy sedimentation, with sandbars making small boat access to the chute impossible except during periods of very high water. The lower reach is still open, with 5- to 6-foot depths reaching half way up the chute. The lower reach of the chute would be spot dredged to provide 6-foot depths. To preserve the depths in the lower reach, a closure structure would be built at the dredge cut's upper end to reduce the amount of sediment entering O'Dell Chute and to stop downstream migration of sand. The existing sediment would be removed and a rock cutoff dam would be constructed across the chute. Because sand travels downstream in waves, the higher the cutoff dam is built, the better for this

purpose. The 10 percent duration level at this site is 475 feet; a structure with a top elevation of 474 feet will eliminate 90 percent of the bedload migration. This is the recommended elevation. If an emergent structure is not desired, then as close to 470 feet as possible should be built.

An existing water quality sampling site exists in O'Dell Chute. This site will be monitored after the closure structure is built to monitor dissolved oxygen levels. If low levels exist, the closure structure will be modified to raise the dissolved oxygen levels and to maintain the chute as suitable fish habitat.

c. Mast Tree Planting. Mast trees are being planted on Long Island from approximate RM 334.5 to 336.5. A component of the probability of success for the mast tree planting is the amount of flooding that the trees will experience before they are established. As noted above, plate I-6 shows the elevation frequency for this reach of river. Another component of flood damage to the mast trees is the duration of flooding during the growing season. Plate I-1 0 shows the growing season elevation duration for this reach of river. Tables I-3 and I-4 summarize this information for the upstream and downstream ends of the mast tree planting area for various elevations. The final grade chosen for mast tree planting will range from 477 to 480 feet MSL.

TABLE I-3. Elevation Frequency at Mast Tree Planting Fields

Elevation (feet NGVD)	RM 334.5	RM 340.0
476	78%	94%
477	69%	90%
478	60%	85%
479	50%	77%
480	40%	67%

TABLE I-4. Growing Season Duration at Mast Tree Planting Fields
Percent of Time at or Above

Elevation (feet NGVD)	RM 334.5	RM 340.0
476	14%	26%
477	11%	20%
478	7%	16%
479	5%	13%
480	4%	10%

REFERENCES

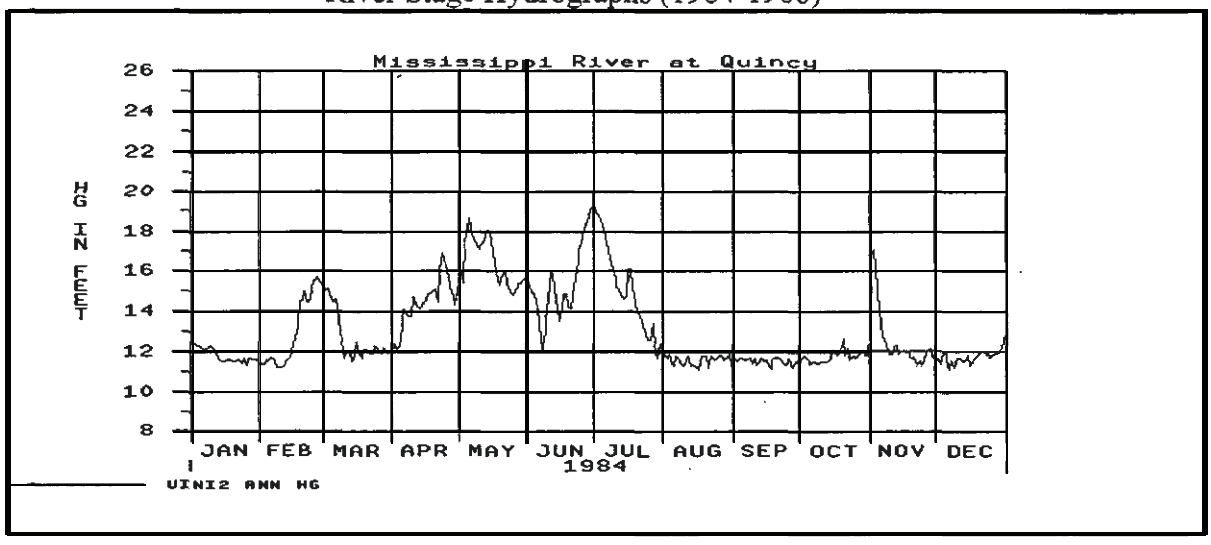
1993 Post Flood Report, Appendix B, U.S. Army Corps of Engineers, September 1994.

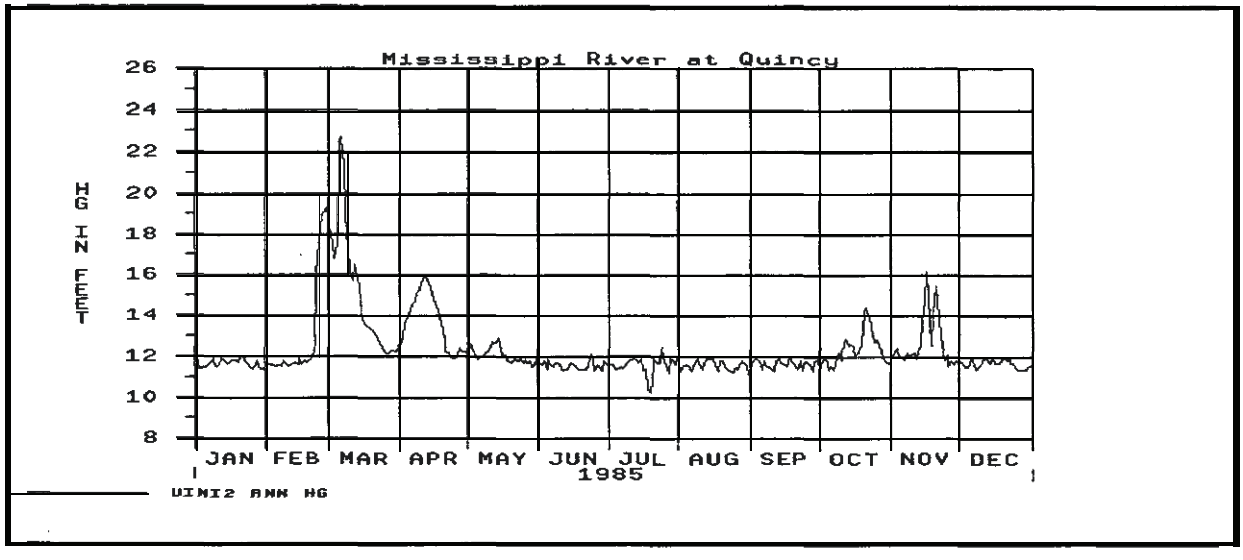
Technical Flood Plain Management Task Force, *Upper Mississippi River Water Surface Profiles River Mile 0.0 to River Mile 847.5*, 1979.

Upper Mississippi River Comprehensive Basin Study, Volume III, Appendix G: Fluvial Sediment, 1970.

U.S. Army Corps of Engineers Engineering Manual (EM) 1110-2-4000, Sediment Investigations of Rivers and Reservoirs, 31 October 1995.

River Stage Hydrographs (1984-1986)





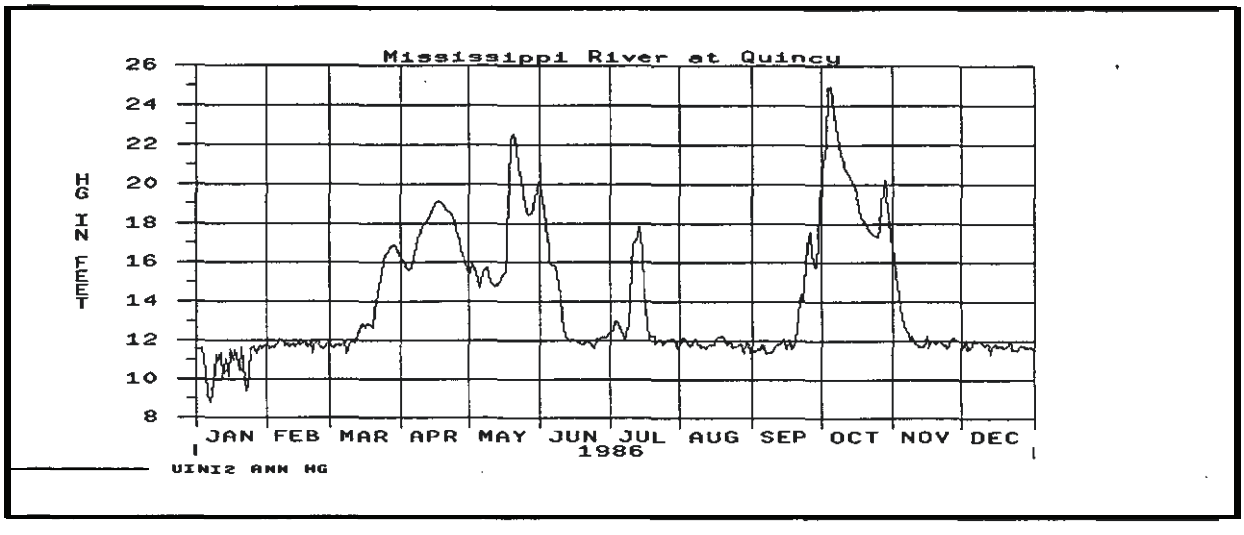
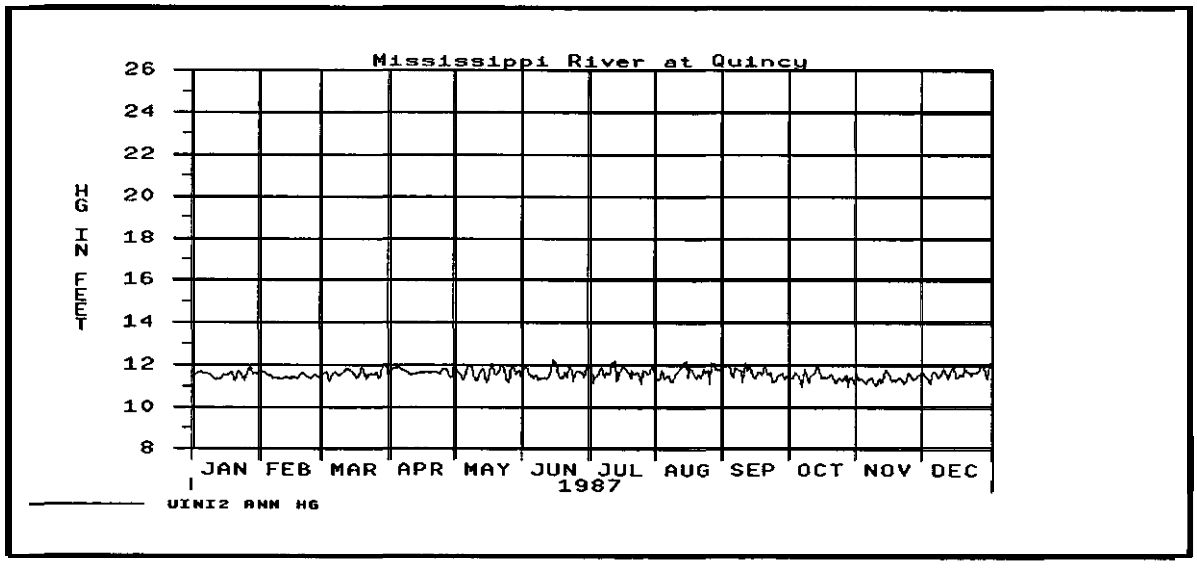
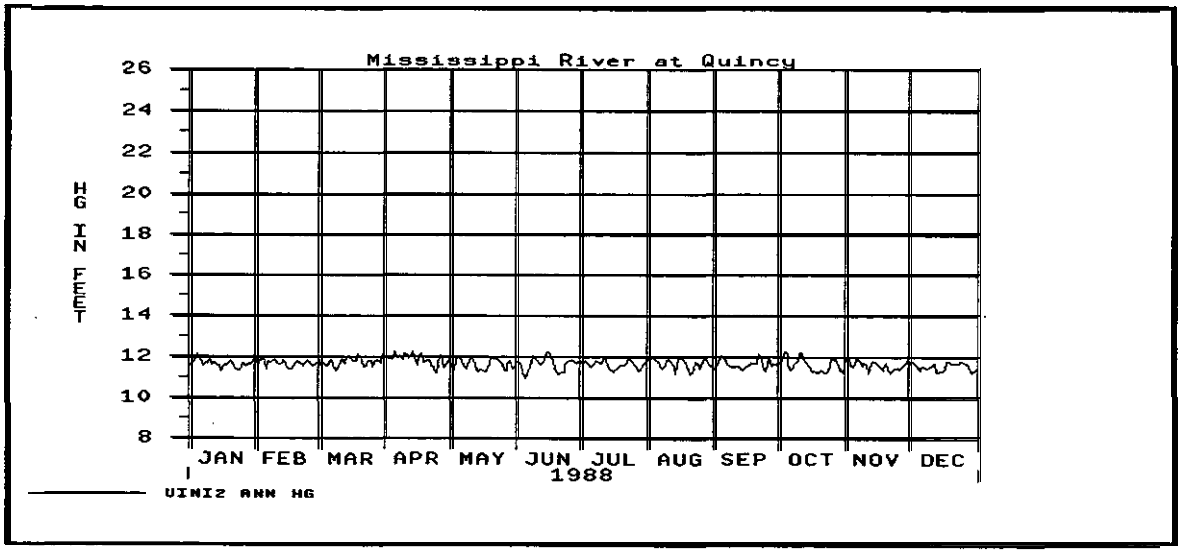


PLATE I-1

River Stage Hydrographs (1987-1989)





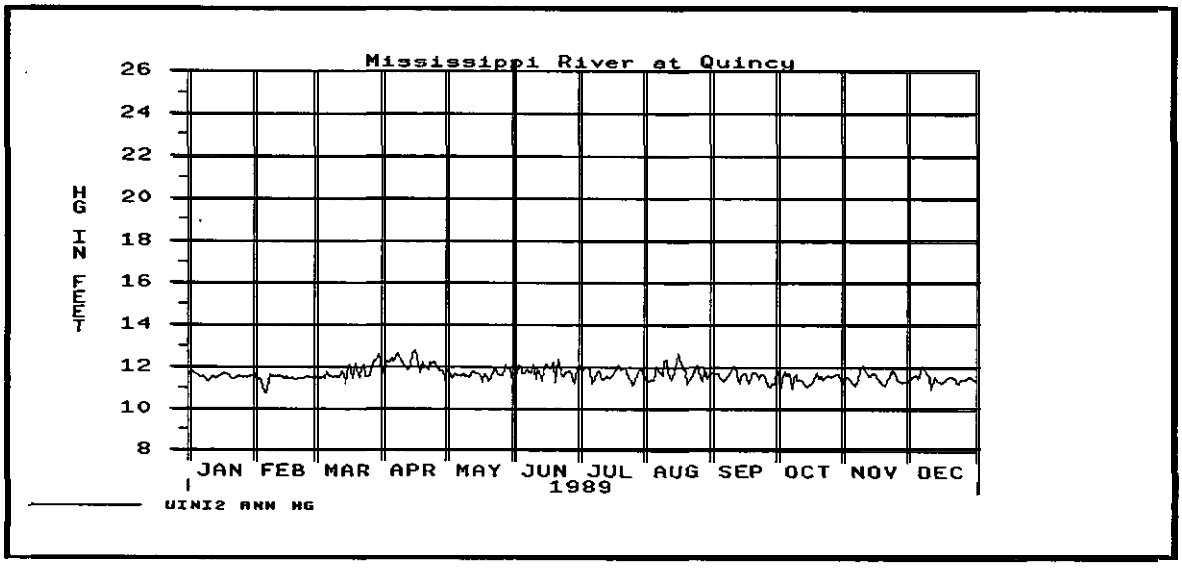
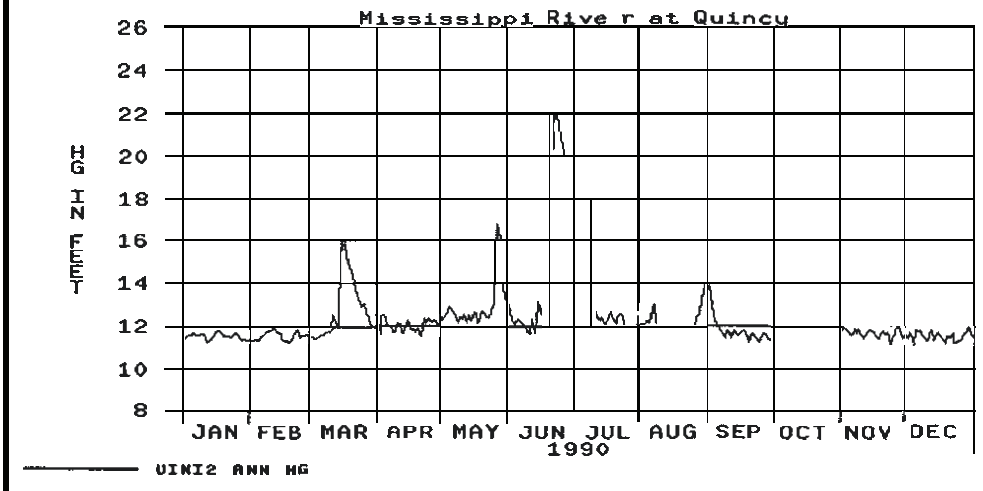
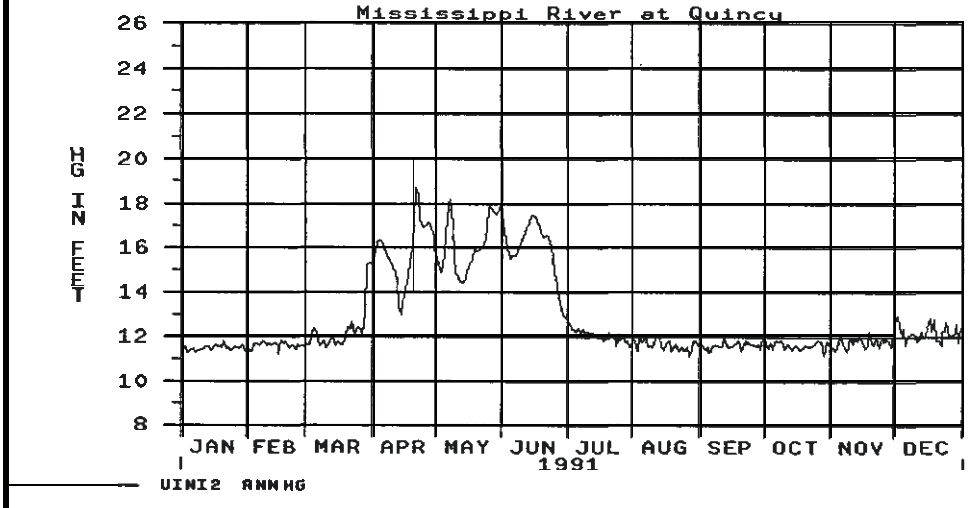


PLATE I-2

River Stage Hydrographs (1990-1992)





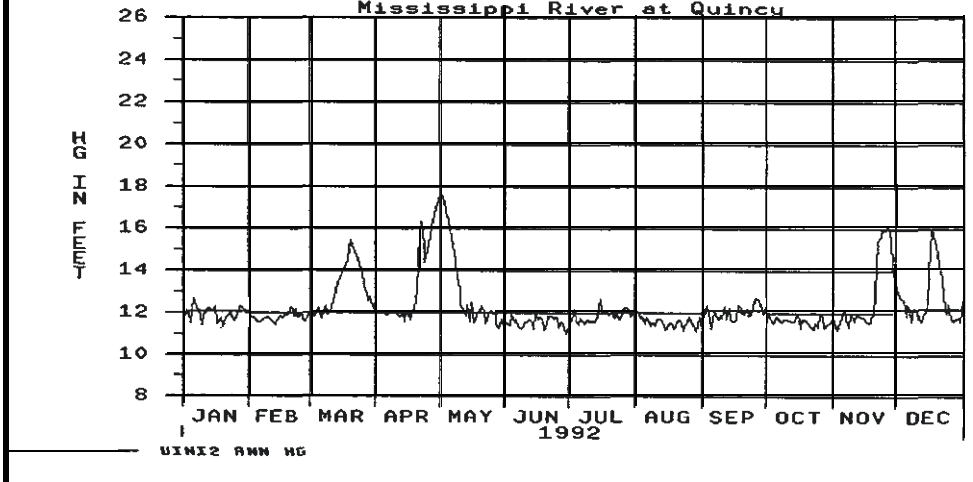
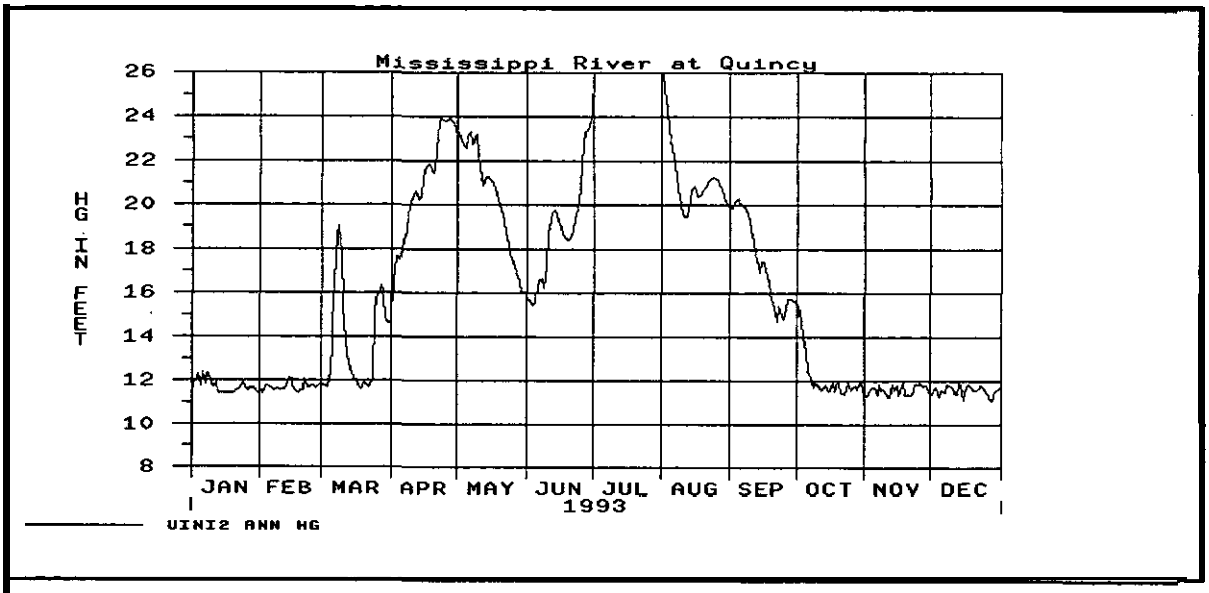
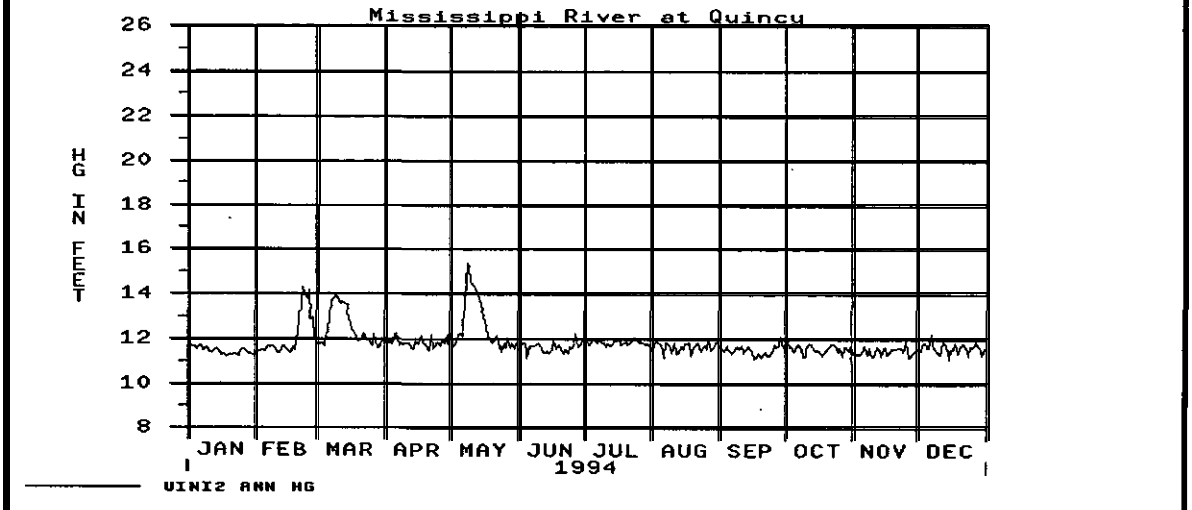


PLATE I-3

River Stage Hydrographs (1993-1995)





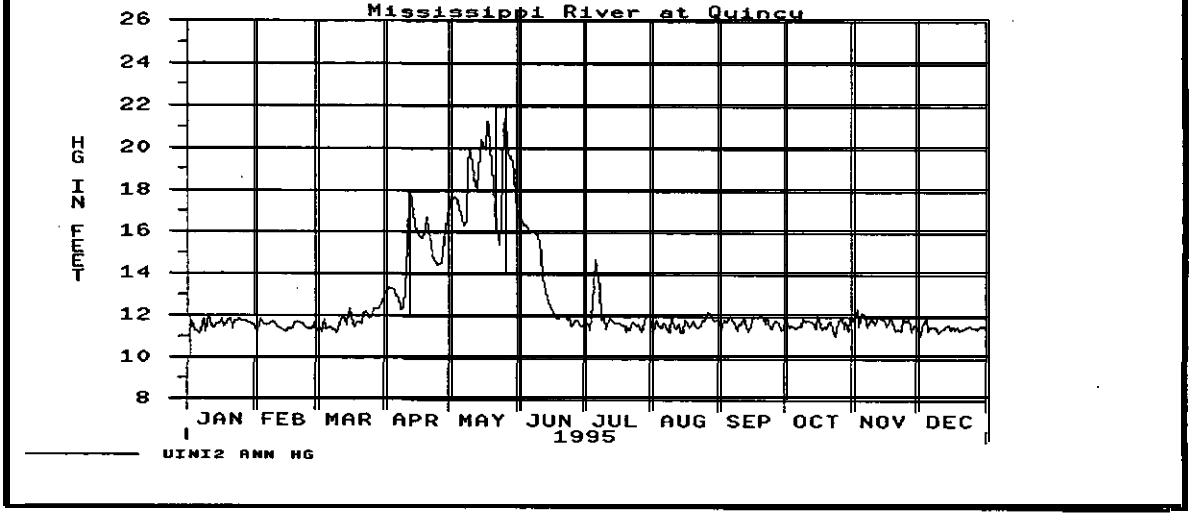


PLATE I-4

River Stage Hydrographs (1996-1998)

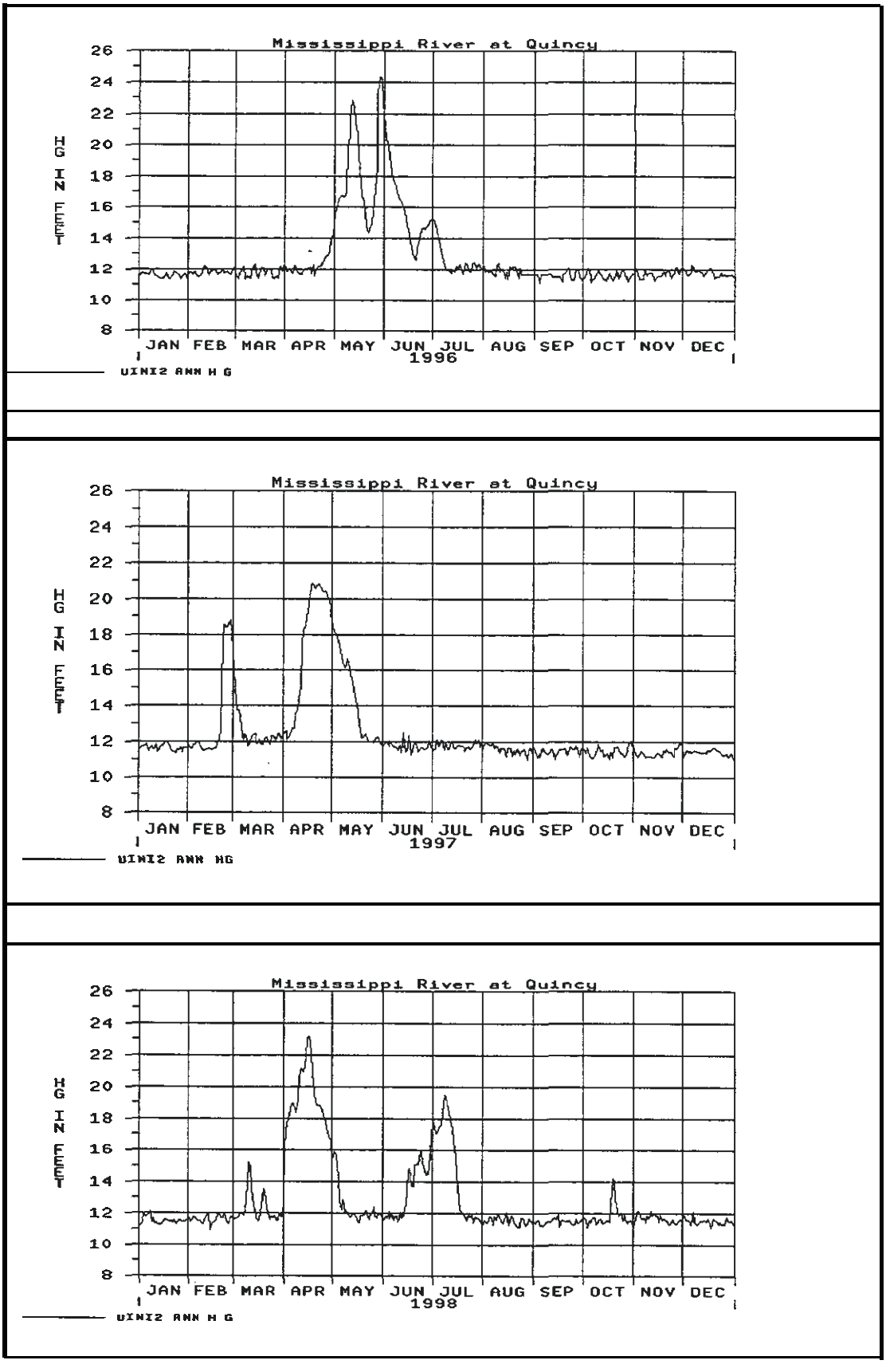
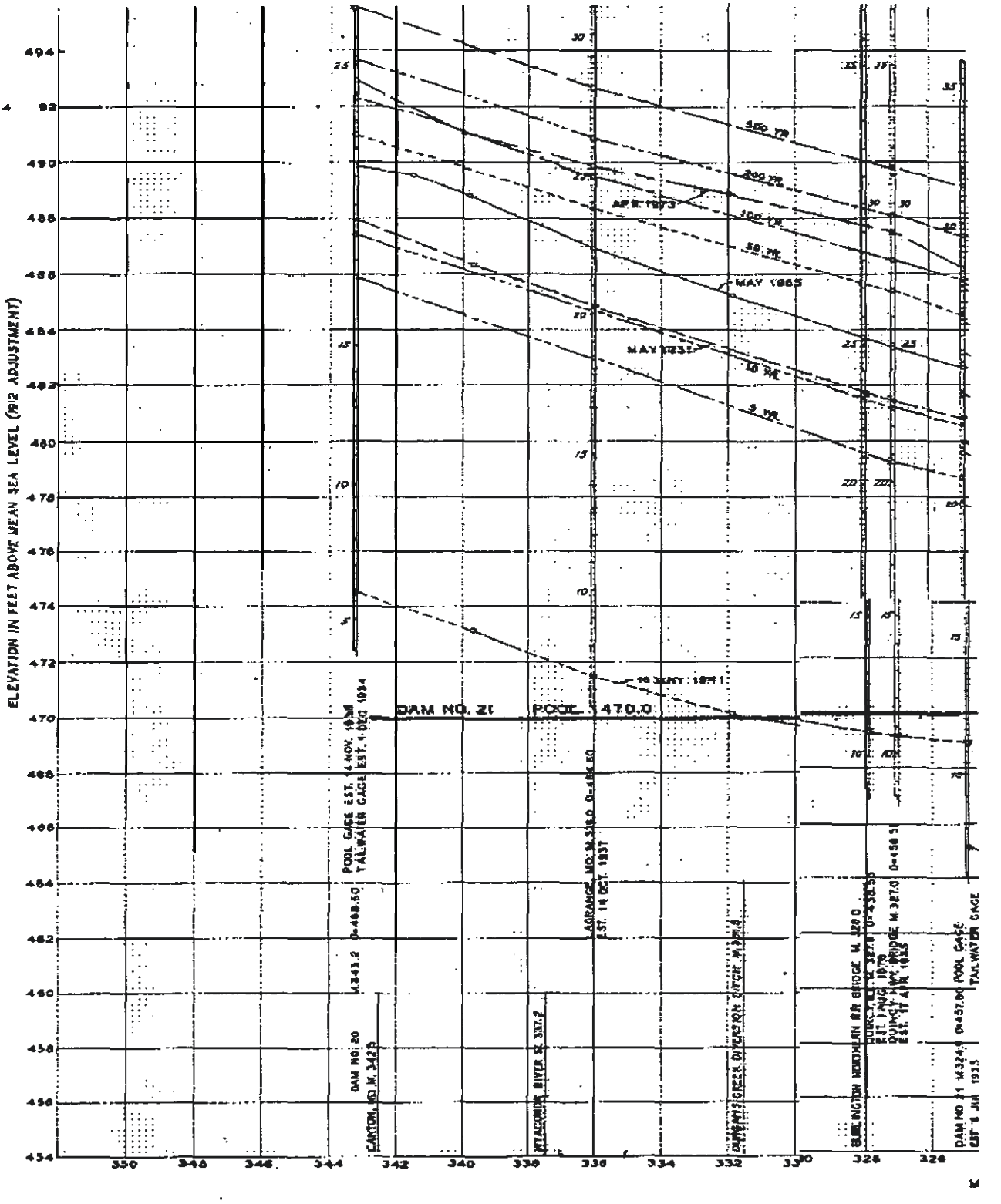


PLATE I-5

Pool 21 Elevation Frequency



Mississippi River Mile

PLATE I-6

Annual Stage Duration Curves
1938 - 1999

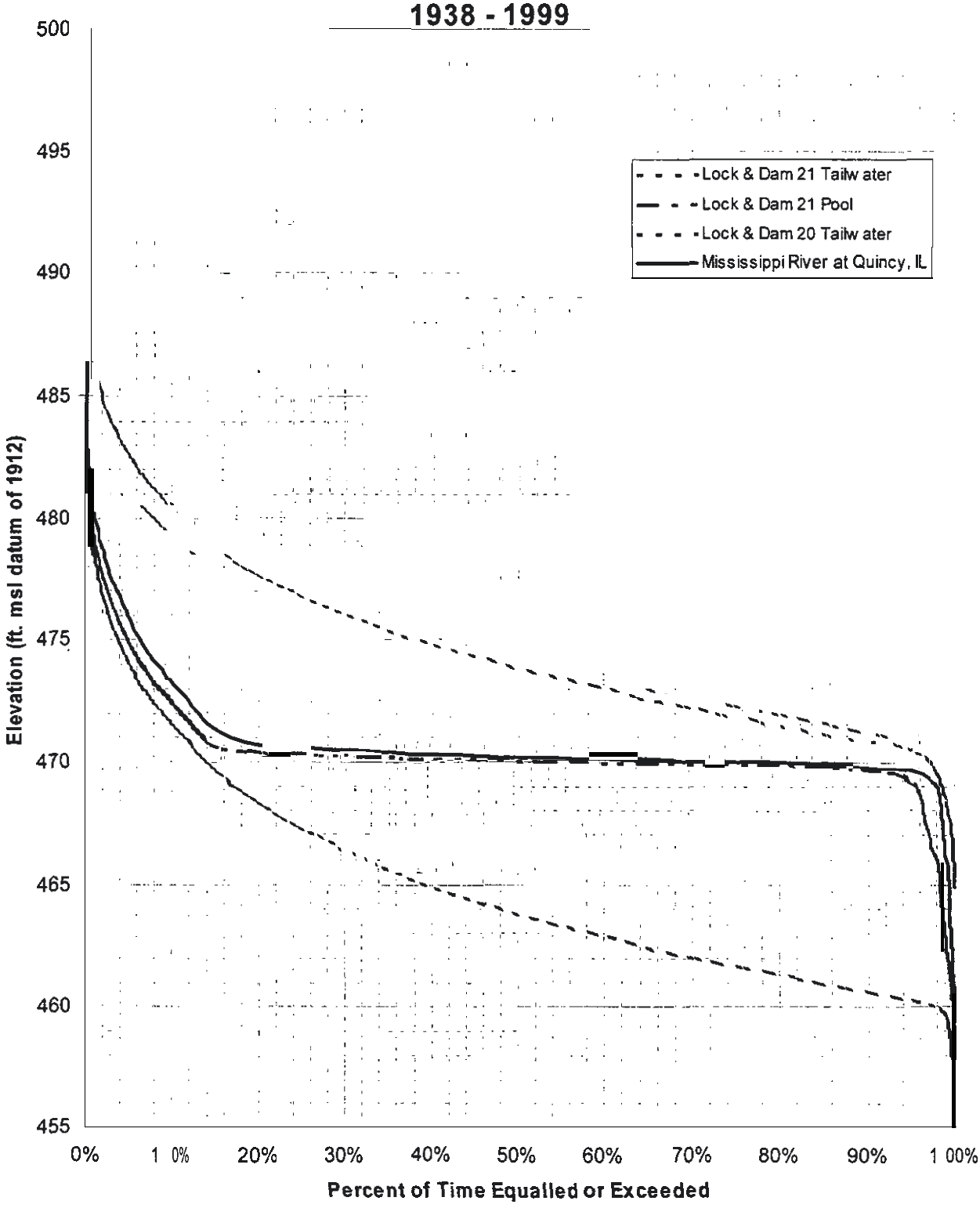
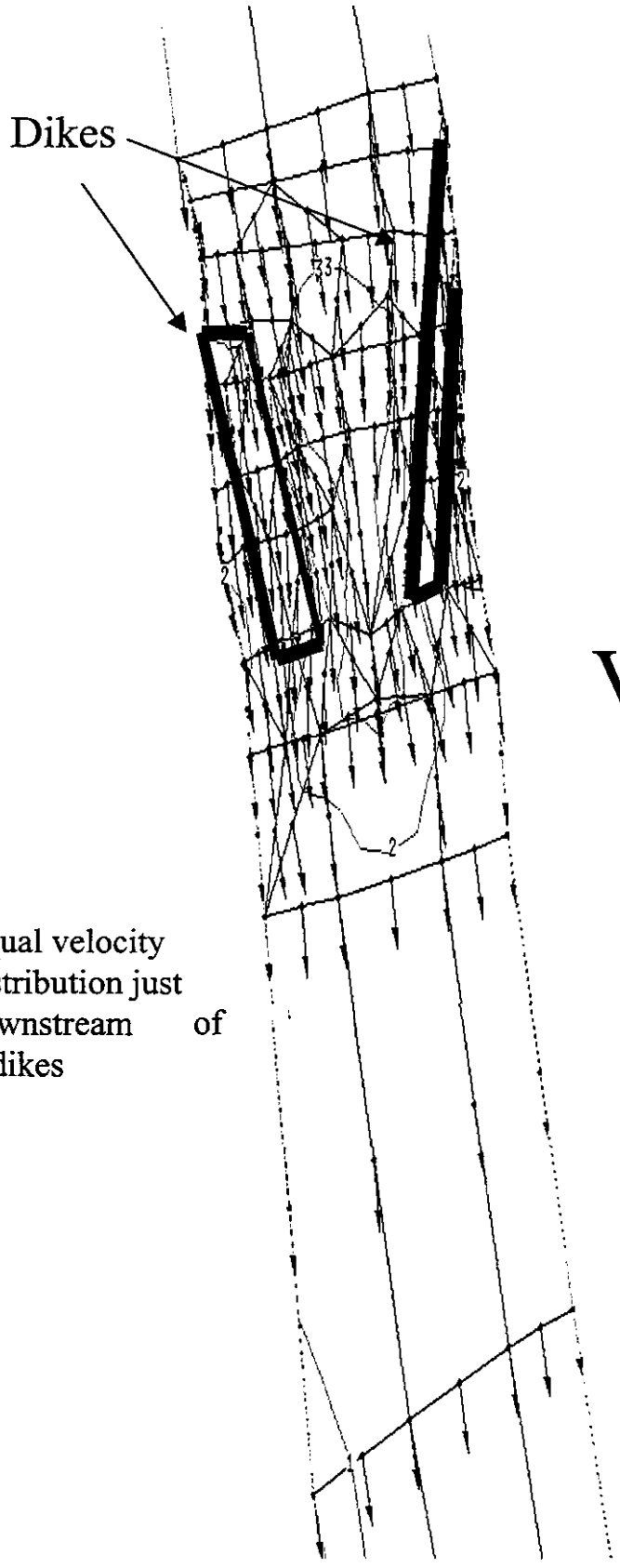


PLATE I-7



V-Dike

Equal velocity distribution just downstream of v-dikes

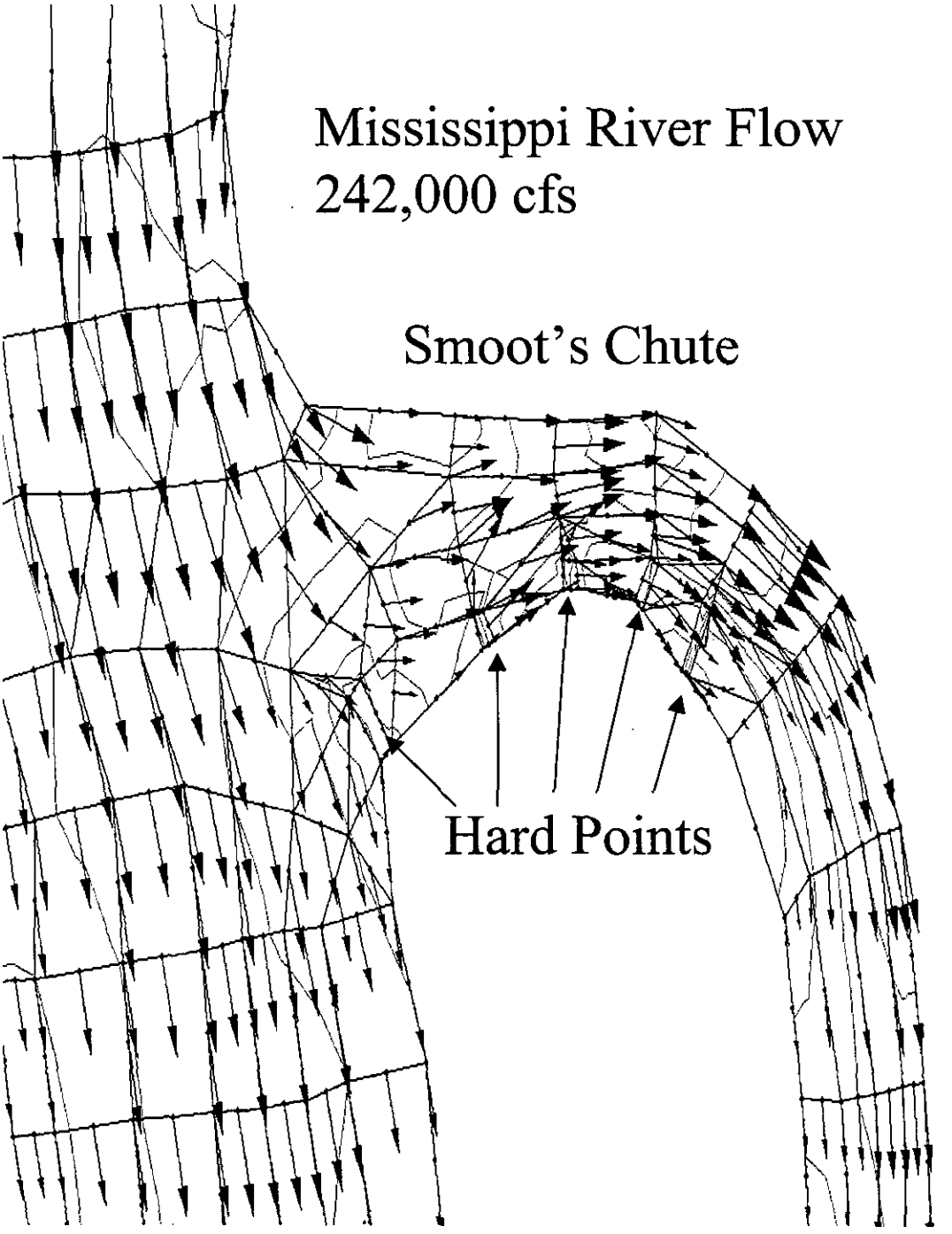

Mississippi River Flow
242,000 cfs
Smoot's Chute
Hard Points

PLATE I-9

Growing Season Elevation Duration

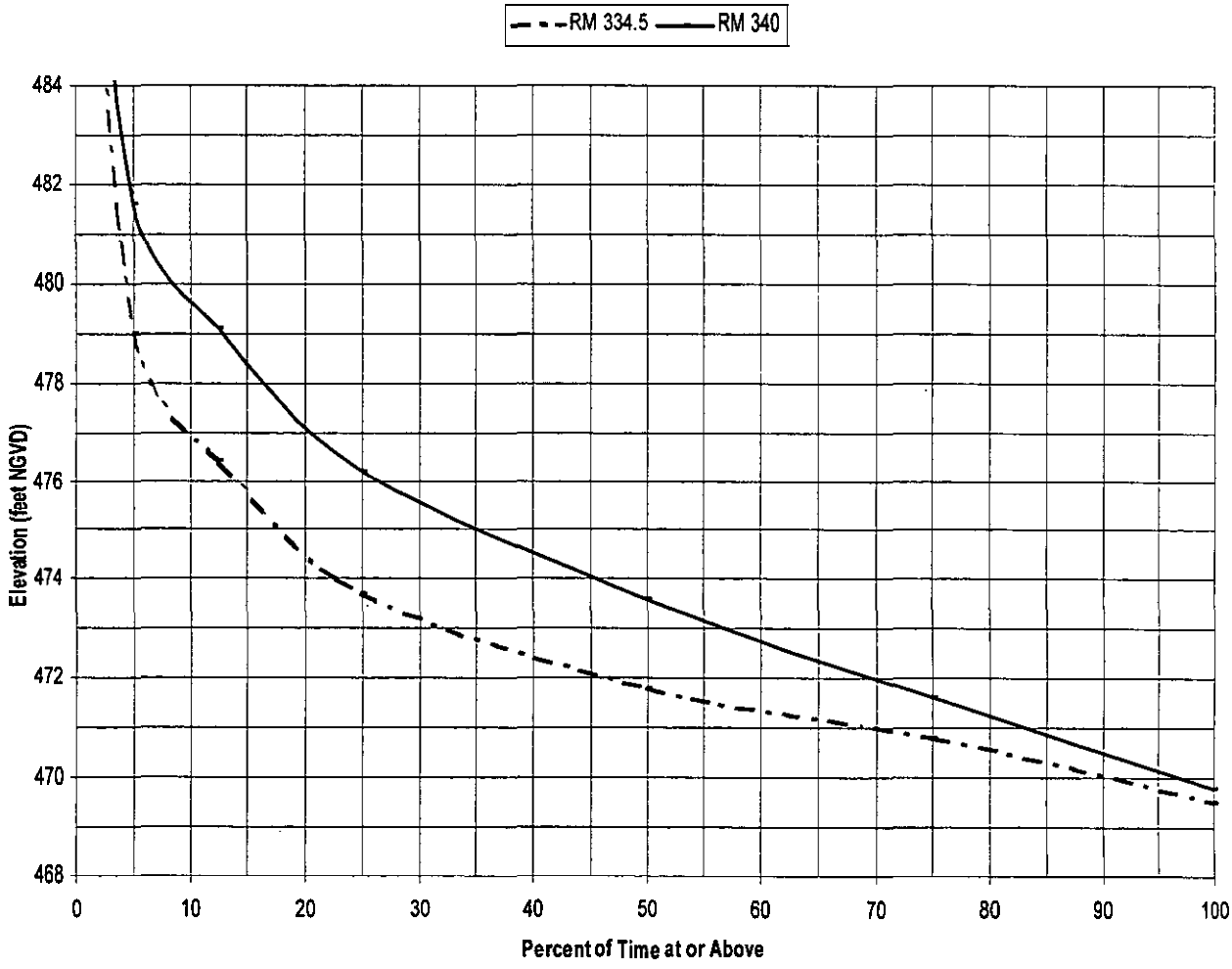


PLATE I-10

APPENDIX J

COST ESTIMATE

Gardner Division EMP
Upper Mississippi River
River Mile 332 to 341
Mississippi River
Definite Project Report

Designed By: CEMVR ED-DN(K.Mitvalsky)
Estimated By: R. Martin 8/99, revised TKirkeeng

Prepared By: CEMVR-ED-C

Preparation Date: 08/08/00
Effective Date of Pricing: 08/08/00
Est Construction Time: 970 Days

Sales Tax: 0.0%

1. Unknown quantity, unknown unit cost
2. Unknown quantity
3. Unknown quantity, unknown final design

	QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT	NOTES
1 Project Features			3,297,627	468,445	86,316	3,852,389		
TOTAL Gardner Division EMP	1.00	EA	3,297,627	468,445	86,316	3,852,389	3852389	

		QUANTY	UOM	CONTRACT	CONTI NGN	ESCALATN	TOTAL COST	UNIT	NOTES
1	Project Features								
1/	1 Lands and Damages			400	0	0	400		
1/	2 Relocations			0	0	0	0		
1/	6 Fish & Wildlife Facilities			2,342,227	468,445	77,996	2,888,669		
1/	30 Planning, Engineering & Design			695,000	0	0	695,000		
1/	31 Construction Management			260,000	0	8,320	268,320		
	TOTAL Project Features			3,297,627	468,445	86,316	3,852,389		
	TOTAL Gardner Division EMP	1.00	EA	3,297,627	468,445	86,316	3,852,389	3852389	

		QUANTY UOM	CONTRACT COST	CONTI NGN	ESCALATN	TOTAL COST	UNIT	NOTES
1 Project Features								
1/	1 Lands and Damages		400	0	0	400		
1/	2 Relocations		0	0	0	0		
1/	6 Fish & Wildlife Facilities							
1/	6.3 Wildlife Facilities &Sanctuaries		2,342,227	468,445	77,996	2,888,669		
	TOTAL Fish & Wildlife Facilities		2,342,227	468,445	77,996	2,888,669		
1/	30 Planning, Engineering & Design							
1/	30.1 Planning, Engineering & Design		695,000	0	0	695,000		
	TOTAL Planning, Engineering & Design		695,000	0	0	695,000		
1/	31 Construction Management							
1/	31.1 Construction Management		260,000	0	8,320	268,320		
	TOTAL Construction Management		260,000	0	8,320	268,320		
	TOTAL Project Features		3,297,627	468,445	86,316	3,852,389		
	TOTAL Gardner Division EMP	1.00 EA	3,297,627	468,445	86,316	3,852,389	3852389	

		QUANTY	UOM	CONTRACT	CONT I NGN	ESCALATN	TOTAL COST	UNIT	NOTES
	1 Project Features								
1/	1 Lands and Damages			400	0	0	400		
1/	2 Relocations			0	0	0	0		
1/	6 Fish & Wildlife Facilities								
1/	6.3 Wildlife Facilities &Sanctuaries								
1/	6.3.A Shoreline Protection			1,051,568	210,314	32,477	1,294,358		1
1/	6.3.B O'Dell Chute, Channel Prot & Enh			561,265	112,253	17,309	690,827		2
1/	6.3.C O'Dell Chute Clos Strctr P&E			165,268	33,054	5,097	203,418		1
1/	6.3.D Dispoal Placement Site Construct			172,125	34,425	5,308	211,858		3
1/	6.3.E Reforestation			194,926	38,985	11,727	245,638		2
1/	6.3.F O'Dell Chute, Closure Str. Drdg			197,076	39,415	6,078	242,569		2
	TOTAL Wildlife Facilities &Sanctuaries			2,342,227	468,445	77,996	2,888,669		
	TOTAL Fish & Wildlife Facilities			2,342,227	468,445	77,996	2,888,669		
1/	30 Planning, Engineering & Design								
1/	30.1 Planning, Engineering & Design								
1/	30.1.A Planning, Engineering & Design			695,000	0	0	695,000		
	TOTAL Planning, Engineering & Design			695,000	0	0	695,000		
	TOTAL Planning, Engineering & Design			695,000	0	0	695,000		
1/	31 Construction Management								
1/	31.1 Construction Management								
1/	31.1.A Construction Management			260,000	0	8,320	268,320		
	TOTAL Construction Management			260,000	0	8,320	268,320		
	TOTAL Construction Management			260,000	0	8,320	268,320		
	TOTAL Project Features			3,297,627	468,445	86,316	3,852,389		
	TOTAL Gardner Division EMP	1.00	EA	3,297,627	468,445	86,316	3,852,389	3852389	

		QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT	NOTES
1	Project Features								
1/	1 Lands and Damages			400	0	0	400		
1/	2 Relocations			0	0	0	0		
1/	6 Fish & Wildlife Facilities								
1/	6.3 Wildlife Facilities &Sanctuaries								
1/	6.3.A Shoreline Protection								
1/	6.3.A.1 Riprap, 400#	16600	TN	669,679	0	0	669,679	40.34	
1/	6.3.A.2 Bedding Stone, (CA6)	9700.00	TN	352,421	0	0	352,421	36.33	
1/	6.3.A.3 Shorline Clearing	1.40	ACR	4,965	0	0	4,965	3546.77	
1/	6.3.A.4 Debris Removal	3200.00	LF	11,350	0	0	11,350	3.55	
1/	6.3.A.5 Grade Shoreline	7500.00	CY	13,153	0	0	13,153	1.75	
	TOTAL Shoreline Protection			1,051,568	0	0	1,051,568		1
1/	6.3.B O'Dell Chute, Channel Prot & Enh								
1/	6.3.B.A Mobilization of Hydraulic Dredge			238,878	0	0	238,878		
1/	6.3.B.B O'Dell Chute (Cut)	51400	CY	214,298	0	0	214,298	4.17	
1/	6.3.B.C O'Dell Chute (Disposal)	51400	CY	108,089	0	0	108,089	2.10	
	TOTAL O'Dell Chute, Channel Prot & Enh			561,265	0	0	561,265		2
1/	6.3.C O'Dell Chute Clos Strctr P&E								
1/	6.3.C.D Closure Strucutre (400# Riprap)	4400.00	TN	109,753	0	0	109,753	24.94	
1/	6.3.C.E Closure Strucutre, (Riprap Del.)	4400.00	TN	23,949	0	0	23,949	5.44	
1/	6.3.C.F Closure Strucutre, (Riprap Place)	4400.00	TN	31,566	0	0	31,566	7.17	
	TOTAL O'Dell Chute Clos Strctr P&E			165,268	0	0	165,268		1
1/	6.3.D Dispoal Placement Site Construct								
1/	6.3.D.A Dispoal Berm Construction	3200.00	CY	23,572	0	0	23,572	7.37	
1/	6.3.D.B Dispoal Berm Grading	3200.00	CY	9,948	0	0	9,948	3.11	
1/	6.3.D.C Dredged Mat. Placement	373500	SY	138,605	0	0	138,605	0.37	
	TOTAL Dispoal Placement Site Construct			172,125	0	0	172,125		
1/	6.3.E Reforestation								
1/	6.3.E.A Pin Oak	1005.00	EA	40,543	0	0	40,543	40.34	

			QUANTY	UOM	CONTRACT	CONT I NGN	ESCALATN	TOTAL COST	UNIT	NOTES
1/	6.3.E.B	Sycamore	536.00	EA	21,623	0	0	21,623	40.34	
1/	6.3.E.C	Bur Oak	670.00	EA	27,029	0	0	27,029	40.34	
1/	6.3.E.D	Nothern Pecan	670.00	EA	27,029	0	0	27,029	40.34	
1/	6.3.E.E	Swamp White Oak	670.00	EA	27,029	0	0	27,029	40.34	
1/	6.3.E.F	Weed Barrier at Trees	3551.00	EA	17,256	0	0	17,256	4.86	
1/	6.3.E.G	Herbicide Application 1x Per Yr.	3551.00	EA	10,733	0	0	10,733	3.02	
1/	6.3.E.H	Plowing of Dredged Material Site	67.00	ACR	2,152	0	0	2,152	32.12	
1/	6.3.E.I	Cover Crop (Red Top & Rye Grass)	67.00	ACR	20,097	0	0	20,097	299.95	
1/	6.3.E.J	Disk Field 3x	201.00	ACR	1,436	0	0	1,436	7.14	
	TOTAL	Reforestation			194,926	0	0	194,926		
1/	6.3.F	O'Dell Chute, Closure Str. Drdg								
1/	6.3.F.B	O'Dell Chute (Cut)	31600	CY	130,625	0	0	130,625	4.13	
1/	6.3.F.C	O'Dell Chute (Disposal)	31600	CY	66,451	0	0	66,451	2.10	
	TOTAL	O'Dell Chute, Closure Str. Drdg			197,076	0	0	197,076		2
	TOTAL	Wildlife Facilities &Sanctuaries			2,342,227	0	0	2,342,227		
	TOTAL	Fish & Wildlife Facilities			2,342,227	0	0	2,342,227		
1/	30	Planning, Engineering & Design								
1/	30.1	Planning, Engineering & Design								
1/	30.1.A	Planning, Engineering & Design			695,000	0	0	695,000		
	TOTAL	Planning, Engineering & Design			695,000	0	0	695,000		
	TOTAL	Planning, Engineering & Design			695,000	0	0	695,000		
1/	31	Construction Management								
1/	31.1	Construction Management								
1/	31.1.A	Construction Management			260,000	0	0	260,000		
	TOTAL	Construction Management			260,000	0	0	260,000		
	TOTAL	Construction Management			260,000	0	0	260,000		
	TOTAL	Project Features			3,297,627	0	0	3,297,627		
	TOTAL	Gardner Division EMP	1.00	EA	3,297,627	0	0	3,297,627	3297627	

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GARDNER DIVISION	40X	17 AUG 2000	I	II	III	IV	V	VI	1/

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HONORABLE PETER FITZGERALD
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SPRINGFIELD IL 62703

HONORABLE PETER FITZGERALD
UNITED STATES SENATOR
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WASHINGTON DC 20510

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HONORABLE LANE EVANS
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261N BROAD ST STE 5
GALESBURG IL 61401-1319

HONORABLE LANE EVANS
REPRESENTATIVE IN CONGRESS-1 7TH DIST
US HOUSE OF REPRESENTATIVES
2335 RAYBURN HOUSE OFFICE BLDG
WASHINGTON DC 20515-1317

II: 1

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III - Administration Approval Documents
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DIRECTOR OFC OF ENVIRON COMPLIANCE RM 4G064 DEPT OF ENERGY 1000 INDEPENDENCE AVE SW RM 4G064 WASHINGTON DC 20585		1					
DIRECTOR OFFICE OF ENVIR POLICY & COMP DEPT OF THE INTERIOR MAIN INT BLDG-MS 2340 1849 C ST NW WASHINGTON DC 20240		12					
REGIONAL FORESTER US DEPT OF AGRICULTURE - FOREST SVC 310 W WISCONSIN AVE STE 500 MILWAUKEE WI 26203		1					
US FISH AND WILDLIFE SERVICE FEDERAL BUILDING - FORT SNELLING TWIN CITIES MN 551 1 1	1	1	1				
AL AMES GREAT LAKES REGIONAL DIRECTOR US DOT - MARITIME ADMINISTRATION 2860 S RIVER RD STE 185 DES PLAINES IL 60018-2413		1					
KEITH BESEKE EMP COORDINATOR UMRF&WR US FISH AND WILDLIFE SERVICE 51 E 4TH ST RM 101 WINONA MN 55987	1	1	1				

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CAROL M BROWNER ADMINISTRATOR OFFICE OF FEDERAL ACTIVITIES A-104 US ENVIRONMENTAL PROTECTION AGENCY 401 M ST SW WASHINGTON DC 20460		1					
VALERIE DECARLO HISTORIC PRESERVATION SPECIALIST ADVIS COUNCIL ON HISTORIC PRESERVATION 1100 PENNSYLVANIA AVE NW #809 WASHINGTON DC 20004		1					
JOHN DOBROVOLNY REG HISTORIC PRESERVATION OFCR US FISH AND WILDLIFE SERVICE FEDERAL BLDG - FORT SNELLING TWIN CITIES MN 55111	1	1	1			1	
JON DUYVEJONCK UMRCC COORDINATOR US FISH AND WILDLIFE SERVICE 4469 48TH AVE CT ROCK ISLAND IL 61201	1	1	1		1	1	
DAVE ELLIS ANNADA DISTRICT OFFICE US FISH AND WILDLIFE SERVICE PO BOX 88 ANNADA MO 63330	1	1	1			1	
AL FENEDICK PLANNING & ASSESSMENT BR ME-19J US ENVIRON PROTECTION AGENCY - REG 5 77 W JACKSON BLVD CHICAGO IL 60604		1					

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JOSEPH FERRANTE OFFICE OF FEDERAL ACTIVITIES A-104 US ENVIRONMENTAL PROTECTION AGENCY 401 M ST SW MAIL CODE 2124 WASHINGTON DC 20460		1					
ROBERT GOODWIN MID-CONTINENT OFFICE MARITIME ADMINISTRATION US DEPT OF AGRI-NAT RES CONSV SERVICE 1222 SPRUCE ST STE 2.202F ST LOUIS MO 63103-2831		1					
DR LESLIE HOLLAND-BARTELS CENTER DIRECTOR UPPER MIDWEST ENVIRON SCIENCES CTR US GEOLOGICAL SURVEY 575 LESTER AVE ONALASKA WI 54650-8552	1	1	1			1	
DR KEN LUBINSKI HREP & NAVIGATION STUDY COORDINATOR UPPER MIDWEST ENVIRON SCIENCES CTR US GEOLOGICAL SURVEY 575 LESTER AVE ONALASKA WI 54650-8552	1	1	1			1	
RICHARD NELSON FIELD SUPERVISOR US FISH AND WILDLIFE SERVICE 4469 48TH AVE CT ROCK ISLAND IL 61201	1	1	1			1	
PETE REDMON US ENVIRON PROTECTION AGENCY - REG 5 77 W JACKSON BLVD CHICAGO IL 60604		1					

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KEVIN SCHUMACHER COMMANDER DWRO OB US COAST GUARD 8TH DIST 1222 SPRUCE ST ST LOUIS MO 63103-2832		1					
DALE SHIPLEY DIRECTOR FEDERAL EMERGENCY MGMT AGENCY - REG 5 536 S CLARK ST 6TH FLOOR CHICAGO IL 60605		1					
DICK STEINBACH COMPLEX MANAGER MARK TWAIN NATIONAL WILDLIFE REFUGE 1704 N 24TH ST QUINCY IL 62301	3	3	3			1	
KAREN WESTPHALL US FISH AND WILDLIFE SERVICE 1704 N 24TH ST QUINCY IL 62301	2	2	2			2	
MARY WHITE OFC-STRATEGIC ENV ANALYSIS B-19J US ENVIRON PROTECTION AGENCY - REG 5 77 W JACKSON BLVD CHICAGO IL 60604		1					
HEIDI WOEBER US FISH & WILDLIFE SERVICE 4469 48TH AVE CT ROCK ISLAND IL 61201	1	1	1			1	

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POSTMASTER POST OFFICE PO BOX 9998 PALMYRA MO 63401-9998		1					
POSTMASTER POST OFFICE PO BOX 9998 HANNIBAL MO 63401-9998		1					
POSTMASTER POST OFFICE PO BOX 9998 CANTON MO 63435-9998		1					
POSTMASTER POST OFFICE PO BOX 9998 QUINCY IL 62301-9998		1					
POSTMASTER POST OFFICE PO BOX 9998 LAGRANGE MO 63448		1					
OWEN DUTT RIVER NAVIGATOR ATTN: CEMVS-PM-N US ARMY ENGINEER DIST - ST LOUIS 1222 SPRUCE ST ST LOUIS MO 63103-2833	1	1	1			1	

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BEN HAWICKHORST ATTN: CEMVS-PD-F US ARMY ENGINEER DIST - ST LOUIS 1222 SPRUCE ST ST LOUIS MO 63103-2833	1	1	1			1	
TOM PULLEN ATTN: CEMVD-PM-R US ARMY ENGR DIV - MISSISSIPPI VALLEY PO BOX 80 VICKSBURG MS 39180-0080	2	2	2	1	1	2	
GREG RUFF ATTN: CEMVD-PM-E US ARMY ENGINEER DIV, MISS VALLEY PO BOX 80 VICKSBURG MS 39180	3	3	8	1	1	2	
CHARLES SPITZACK ATTN: CEMVP-PE-M US ARMY ENGINEER DIST - ST PAUL 190 FIFTH ST E ST PAUL MN 55101-1638	1	1	1			1	
HONORABLE GEORGE RYAN GOVERNOR OF ILLINOIS 207 STATE CAPITOL BLDG SPRINGFIELD IL 62706		1					
IL DEPT OF TRANS 800 BLUFF RD QUINCY IL 62301		1					

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ILLINOIS NATURAL HISTORY SURVEY 704 N SCHRADER AVE PO BOX 599 HAVANA IL 62544	1	1	1			1	
WILLIAM BERTRAND PROGRAM ADMINISTRATOR MISSISSIPPI RIVER PROJECT IL DEPT OF NATURAL RESOURCES PO BOX 149 ALEDO IL 61231	1	1	1			1	
STEVE CHARD DEPUTY DIRECTOR DIVISION ADMINSTRATO BUREAU LAND AND WATER RESOURCES IL DEPT OF AGRICULTURE 801 SANGAMON AVE PO BOX 19281 SPRINGFIELD IL 62794-9281	1	1	1			1	
DEAN CORGAIT IL DEPT OF NATURAL RESOURCES RTE 106 W PO BOX 477 PITTSFIELD IL 62363	1	1	1			1	
KEN DALRYMPLE UPPER MISS RIV CONSERVATION AREA MO DEPT OF CONSERVATION BOX 201 2805 N HWY 79 ELSBERRY MO 63343	1	1	1			1	
GORDON FARABEE PLANNING DIVISION MO DEPT OF CONSERVATION 2901 W TRUMAN BLVD PO BOX 180 JEFFERSON CITY MO 65102-0180	1	1	1			1	

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MIKE GRIFFIN WILDLIFE BIOLOGIST MISS RIVER STATION IA DEPT OF NATURAL RESOURCES 206 ROSE ST BELLEVUE IA 52031	1	1	1			1	
ANNE HAAKER DEPUTY STATE HISTORIC PRES OFFICER ILLINOIS HISTORIC PRESERVATION AGENCY 1 OLD STATE CAPITOL PLAZA SPRINGFIELD IL 62701		1					
JEFF JANVRIN HABITAT PROJECTS COORDINATOR WI DEPT OF NATURAL RESOURCES 3550 MORMON COULEE RD LA CROSSE WI 54601	1	1	1			1	
STEVE JOHNSON RIVER MANAGEMENT SUPERVISOR MN DEPT OF NATURAL RESOURCES 500 LAFAYETTE RD BOX 32 ST PAUL MN 55155-4032	1	1	1			1	
DENNIS KENNEDY OFFICE OF WATER RESOURCES IL DEPT OF NATURAL RESOURCES 524 S 2ND ST SPRINGFIELD IL 62701-1787	1	1	1			1	
DECK MAJOR WILDLIFE BIOLOGIST REGION IV OFFICE IL DEPT OF NATURAL RESOURCES 4521 ALTON COMMERCE PARKWAY ALTON IL 62002	1	1	1			1	

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G BRENT MANNING DIRECTOR IL DEPT OF NATURAL RESOURCES 524 S SECOND ST RM 400 SPRINGFIELD IL 62701-1787		1					
TERRY MOE WESTERN BOUNDARY RIVERS COORDINATOR WI DEPT OF NATURAL RESOURCES 3550 MORMON COULEE RD LA CROSSE WI 54601	1	1	1			1	
BRAD POULTER IL DEPT OF NATURAL RESOURCES BOX 477 PITTSFIELD IL 62363	1	1	1			1	
DAN SALLEE CONSERVATION PROJECT MANAGER BOUNDARY RIVERS PROGRAM IL DEPT OF NATURAL RESOURCES PO BOX 149 2106 SE THIRD ALEDO IL 61231	1	1	1			1	
ROBERT SCHANZLE PERMIT PROGRAM MANAGER DIV OF NAT RESOURCES REVIEW & COORD IL DEPT OF NATURAL RESOURCES 524 S SECOND ST SPRINGFIELD IL 62701-1787	1	1	1	1			
AMY SPRUNGER-ALLWORTH US FISH AND WILDLIFE SERVICE 10728 COUNTY RD X61 WAPELLO IA 52653	1	1	1			1	

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MIKE STEUCK BELLEVUE FIELD STATION - LTRM IA DEPT OF NATURAL RESOURCES 206 ROSE ST BELLEVUE IA 52031	1	1	1			1	
NORM STUCKY MO DEPT OF CONSERVATION 2901 W TRUMAN BLVD PO BOX 180 JEFFERSON CITY MO 65102-0180	1	1	1			1	
SCOTT STUEWE WETLAND WATERSHED & EMP PROG ADMIN OFFICE OF RESOURCE CONSERVATION *IL DEPT OF NATURAL RESOURCES* 524 S SECOND ST SPRINGFIELD IL 62701-1787	3	3	3			1	
KEVIN SZCODRONSKI MISSISSIPPI RIVER COORDINATOR IA DEPT OF NATURAL RESOURCES WALLACE STATE OFC BLDG - 900 E GRAND AVE DES MOINES IA 50319-0034	1	1	1			1	
BRUCE YURDIN DIV OF WATER POLLUTION - PERMITS SEC IL ENVIRONMENTAL PROTECTION AGENCY 1021 N GRAND AVE E SPRINGFIELD IL 62794	1	1	1			1	
HONORABLE LAURA KENT DONAHUE ILLINOIS SENATOR - 48TH DIST 323 STATE HOUSE SPRINGFIELD IL 62706		1					

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HONORABLE ARTHUR TENHOUSE
ILLINOIS REPRESENTATIVE-96TH DIST
314 STATE HOUSE 1
SPRINGFIELD IL 62706

COUNTY ATTORNEY
ADAMS COUNTY COURT HOUSE 1
QUINCY IL 62301

COUNTY ENGINEER
ADAMS COUNTY COURT HOUSE 1
QUINCY IL 62301

COUNTY CLERK
ADAMS COUNTY COURT HOUSE 1
QUINCY IL 62301

ADAMS COUNTY ASCS OFFICE
338 S 36TH ST 1
QUINCY IL 62301

HONORABLE DANIEL CAMPAGNA
MAYOR
CANTON CITY OFFICE
124 N 5TH ST 1
CANTON MO 63435

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HONORABLE HAROLD LUDWIG
MAYOR
CITY HALL
200 W WASHINGTON ST 1
LA GRANGE MO 63448

HONORABLE CHARLES SCHOLZ
MAYOR
CITY HALL
730 MAINE 1
QUINCY IL 62301

MICHAEL KLINGNER
VICE CHAIRMAN - UMIMRA
KLINGNER & ASSOCIATES
616 N 24TH ST 1
QUINCY IL 62301-2797

RICHARD SIEGLE
CHAIRMAN
DES MOINES COUNTY DRAINAGE DIST NO 4
DIRECTOR – IOWA CORN GROWERS ASSN
4189 PUMPING STATION RD 1
OAKVILLE IA 52646

DUKE LYTER
COMMISSIONER
INDIAN GRAVE DRAINAGE DIST
RR 2 BOX 109 1
QUINCY IL 62301

BOB RICHTER
SECRETARY-COMMISSIONER
UNION TOWNSHIP DRAINAGE DIST
PO BOX 98 1
LA GRANGE MO 63448

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QUINCY IL 62301

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NATURAL RESOURCES CHAIRPERSON
LEAGUE OF WOMEN VOTERS
505 W CRESTWOOD DR 1
PEORIA IL 61614

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ALLIE LYMENSTULL PRESIDENT MISS VALLEY HUNTERS-FISHERMANS ASSOC 1806 HILL TOP QUINCY IL 62301-7215				1	1				
BILL GRANT DIRECTOR - MIDWEST OFFICE IZAAK WALTON LEAGUE OF AMERICA 1619 DAYTON AVE #202 MINNEAPOLIS MN 55104-6206				1					
PAUL HANSEN EXECUTIVE DIRECTOR IZAAK WALTON LEAGUE OF AMERICA 1619 DAYTON AVE #202 ST PAUL MN 55104-6206				1					
BILL REDDING ASSOCIATE REPRESENTATIVE SIERRA CLUB - MIDWEST OFFICE 214 N HENRY ST STE 203 MADISON WI 53703				1					
MIKE REUTER DIRECTOR OF CONSERVATION PROGRAMS THE NATURE CONSERVANCY 301 S W ADAMS ST STE 1007 PEORIA IL 61602				1					
HOLLY STOERKER DIRECTOR UPPER MISSISSIPPI RIVER BASIN ASSOC 415 HAMM BLDG 408 ST PETER ST ST PAUL MN 55102			1	1	1			1	

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STAUFFER COMMUNICATIONS INC
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HANNIBAL MO 63401

NEWS ROOM
KGRC RADIO
329 MAINE ST 1
QUINCY IL 62301-3928

NEWS ROOM
KHMO RADIO
PO BOX 711 119 N 3RD ST 1
HANNIBAL MO 63401

NEWS PRESS JOURNAL
PO BOX 277 1
CANTON MO 63435

QUINCY HERALD
PO BOX 909 1
QUINCY IL 62306

SPECTATOR
PO BOX 391 1
PALMYRA MO 63461

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NEWS ROOM WGEM-TV 513 HEMPSIRE QUINCY IL 62301				1					
WQCY RADIO 510 MAINE QUINCY IL 62301-3941				1					
WTAD RADIO 510 MAINE QUINCY IL 62301-3941				1					
DANIEL HOPKINS 1826 HARRISON ST QUINCY IL 62301					1				
RICHARD ROBERTS 35 LAKESHORE HILLS FOWLER IL 62308					1				
DAVID SMITH RR 1 BOX 213A URSA IL 62376					1				

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TIM SWANSON 1406 ADAMS QUINCY IL 62301			1	1	1			1	
CHESTER V TRIPP RR 1 BOX 217 URSA IL 62376					1				
MICHELLE R WOOD 520 8TH ST SPRINGFIELD IL 62703					1				

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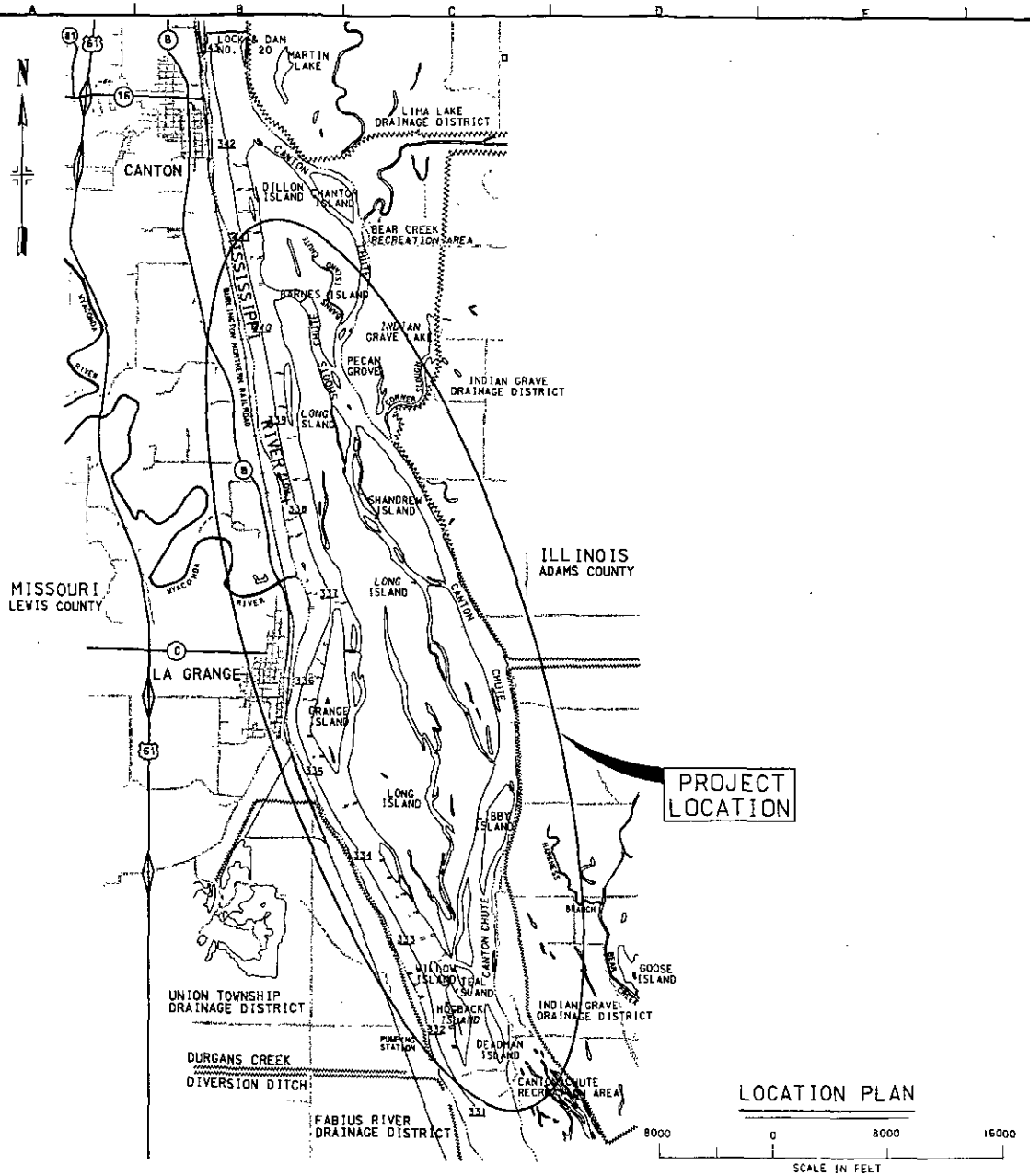
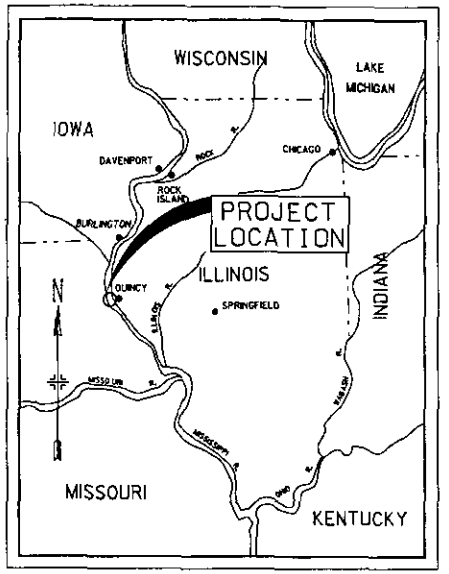
CEMVR-CT	1	1	1	1		
CEMVR-ED	1	1	1	1	1	1
CEMVR-ED-C				1		
CEMVR-ED-D	1	1	1	1	1	1
CEMVR-ED-DE				5		
CEMVR-ED-DN	3	3	3	1	1	1
CEMVR-ED-G	1	1	1	1	1	1
CEMVR-ED-H	1	1	1	1	1	1
CEMVR-ED-HH	1	1	1	1	1	1
CEMVR-ED-HQ	1	1	1		1	1
CEMVR-EM					1	
CEMVR-IM-CL			2			
CEMVR-LM				1		
CEMVR-OC	1	1	1	1		
CEMVR-OD	1	1	1	1	1	1
CEMVR-OD-P	1	1	1	1	1	1
CEMVR-OD-T (DEVOS)	1	1	1	1	1	1
CEMVR-OD-MN (SWENSON)	1	1	1	1	1	1
CEMVR-OD-MN (ADCOX)			1			
CEMVR-PA	1	1	1			1
CEMVR-PM	2	2	2			2
CEMVR-PM-AR	1	10	10	1	1	1
CEMVR-PM-M (NILES)	1	1	1	1	1	1
CEMVR-PM-M (FOLEY)	1	1	1		1	1
CEMVR-RE	1	1	1			
CEMVR-RE-A	1	1	1			

1/
I - Draft Coordination Documents
II - Public Review Documents
III - Administration Approval Documents
IV - Construction Plans and Specifications
V - Operations and Maintenance Instructions
VI - Project Performance Evaluation Documents

PLATES





VICINITY MAP

25 0 25 50 75

SCALE IN MILES

INDEX

US Army Corps of Engineers Rock Island District

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

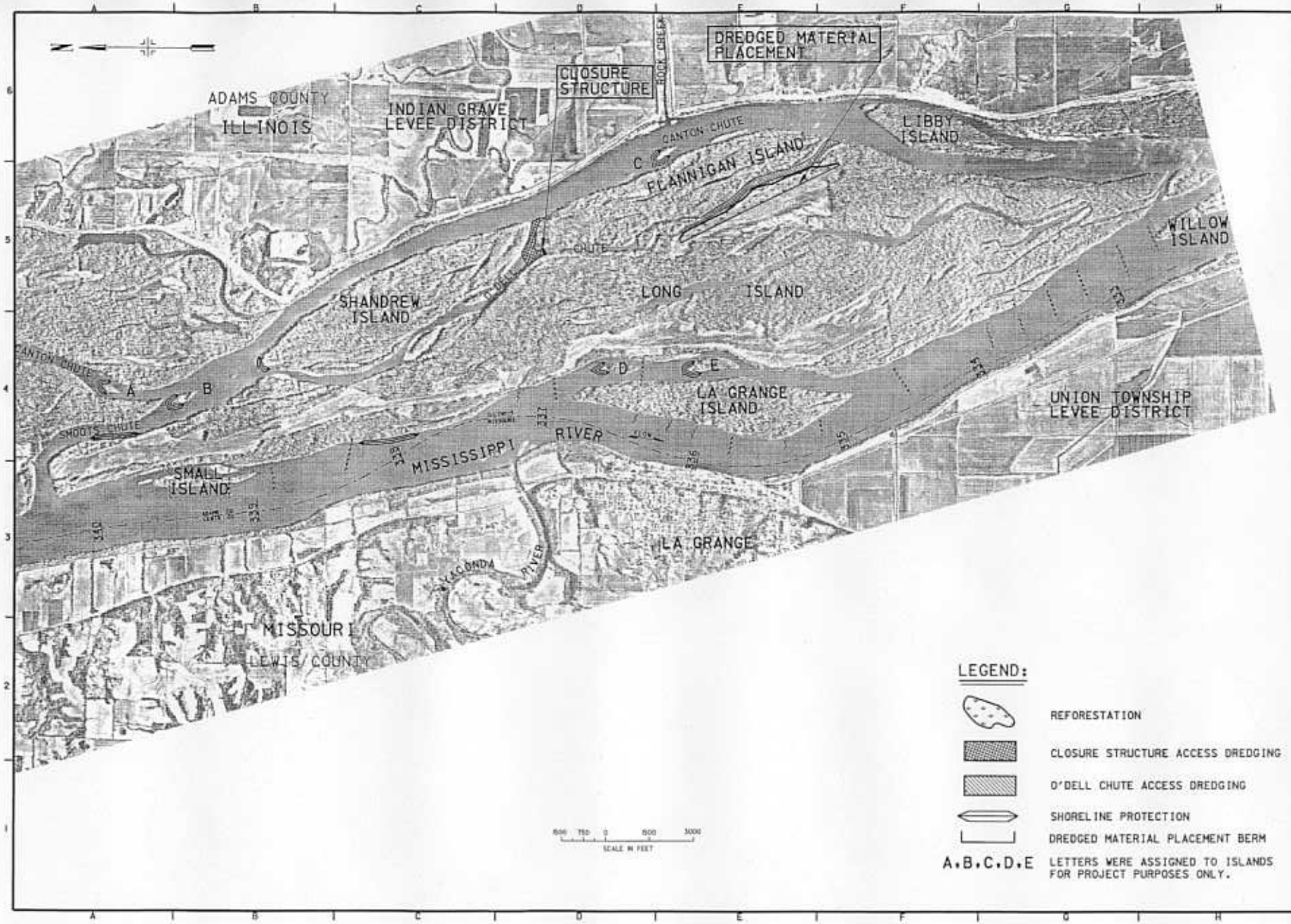
Designed by: KNM
Drawn by: SDW/TPD
Checked by: KTM
Approved by: KTM

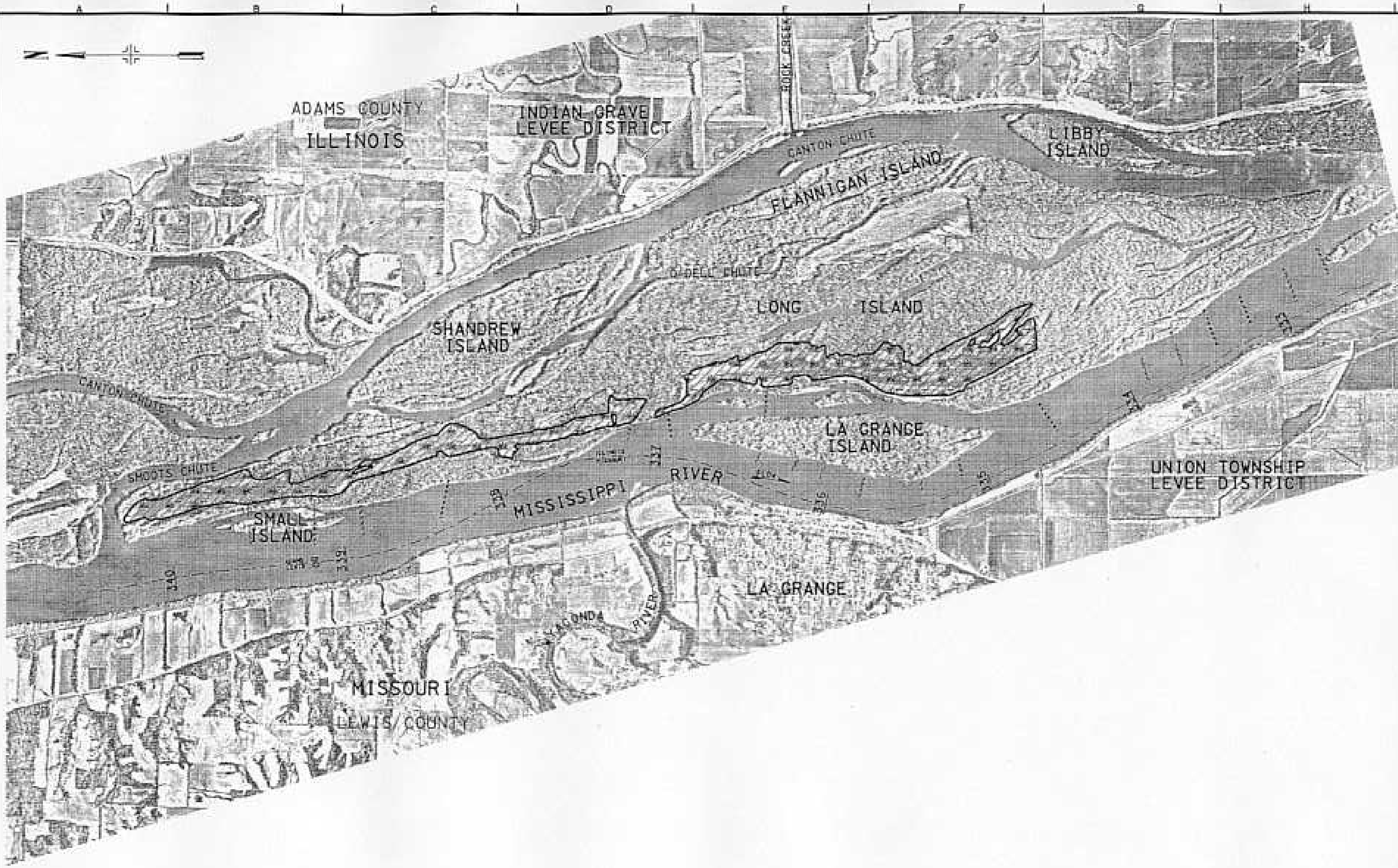
Date: 30 AUGUST '96
Scale: AS SHOWN
Drawing code:
Contract/Job Number:
BLK

UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM PROJECT NO. 95-R-2 GARDNER DIVISION JREP

LOCATION PLAN, VICINITY MAP AND INDEX

PLATE 1


DREDGED MATERIAL PLACEMENT
CLOSURE STRUCTURE
ROCK CREEK
ADAMS COUNTY
ILLINOIS
INDIAN GRAVE LEVEE DISTRICT
CANTON CHUTE
LIBBY ISLAND
FLANNIGAN ISLAND
WILLOW ISLAND
CHUTE
O'DELL
SHANDREW ISLAND
LONG ISLAND
CANTON CHUTE
A
B
C
D
E
LA GRANGE ISLAND
UNION TOWNSHIP LEVEE DISTRICT
SHOOTS CHUTE
MISSISSIPPI RIVER
SMALL ISLAND
LA GRANGE
MACONDA RIVER
MISSOURI
LEWIS COUNTY
LEGEND:
REFORESTATION
CLOSURE STRUCTURE ACCESS DREDGING
O'DELL CHUTE ACCESS DREDGING
SHORELINE PROTECTION
DREDGED MATERIAL PLACEMENT BERM
A,B,C,D,E LETTERS WERE ASSIGNED TO ISLANDS FOR PROJECT PURPOSES ONLY.
SCALE IN FEET
RECOMMENDED PLAN
PLATE 2



1500 750 0 1500 3000
SCALE IN FEET

LEGEND:

SECTION 1135 MAST TREE PLANTING AREA

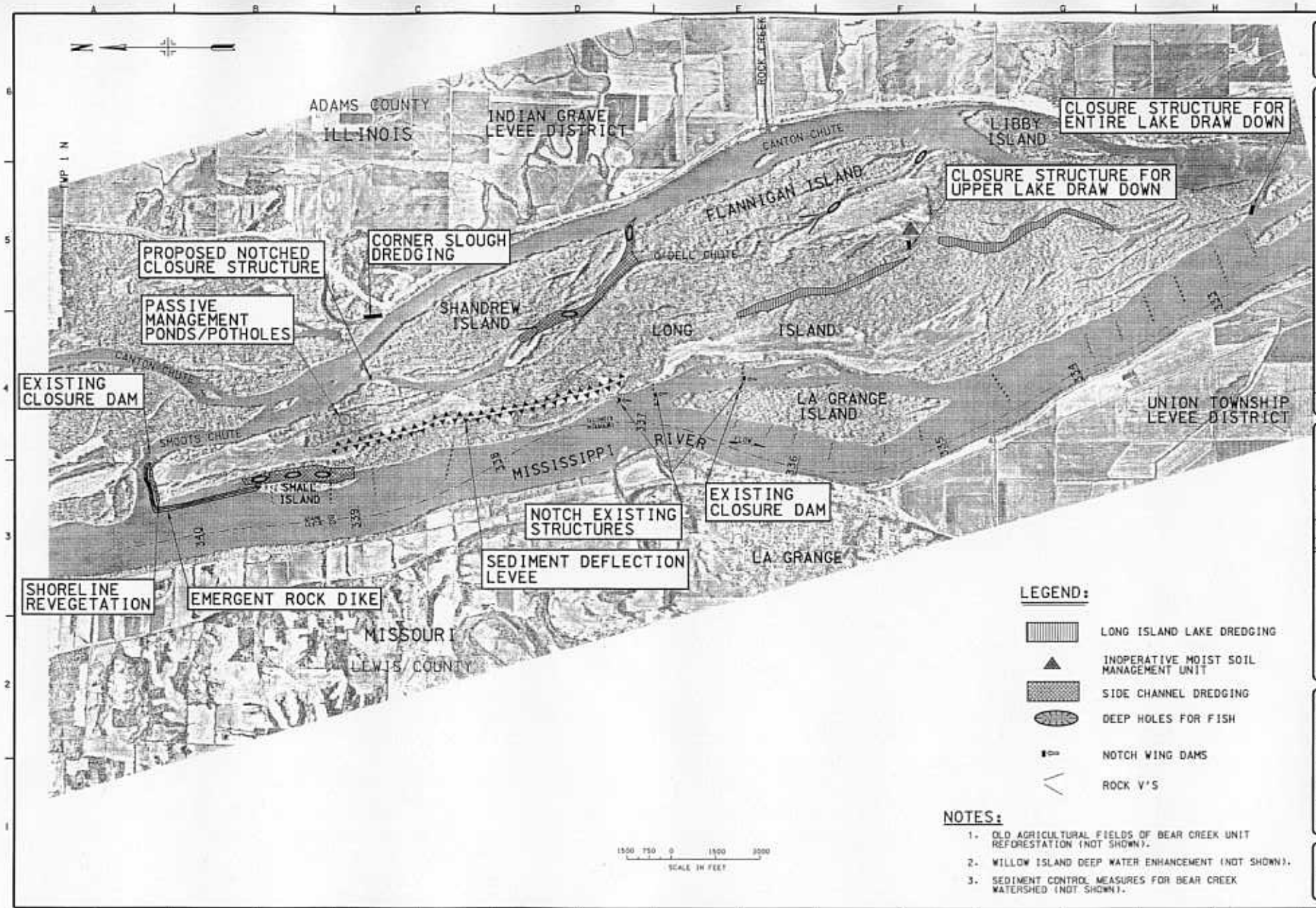
US Army Corps of Engineers Rock Island District

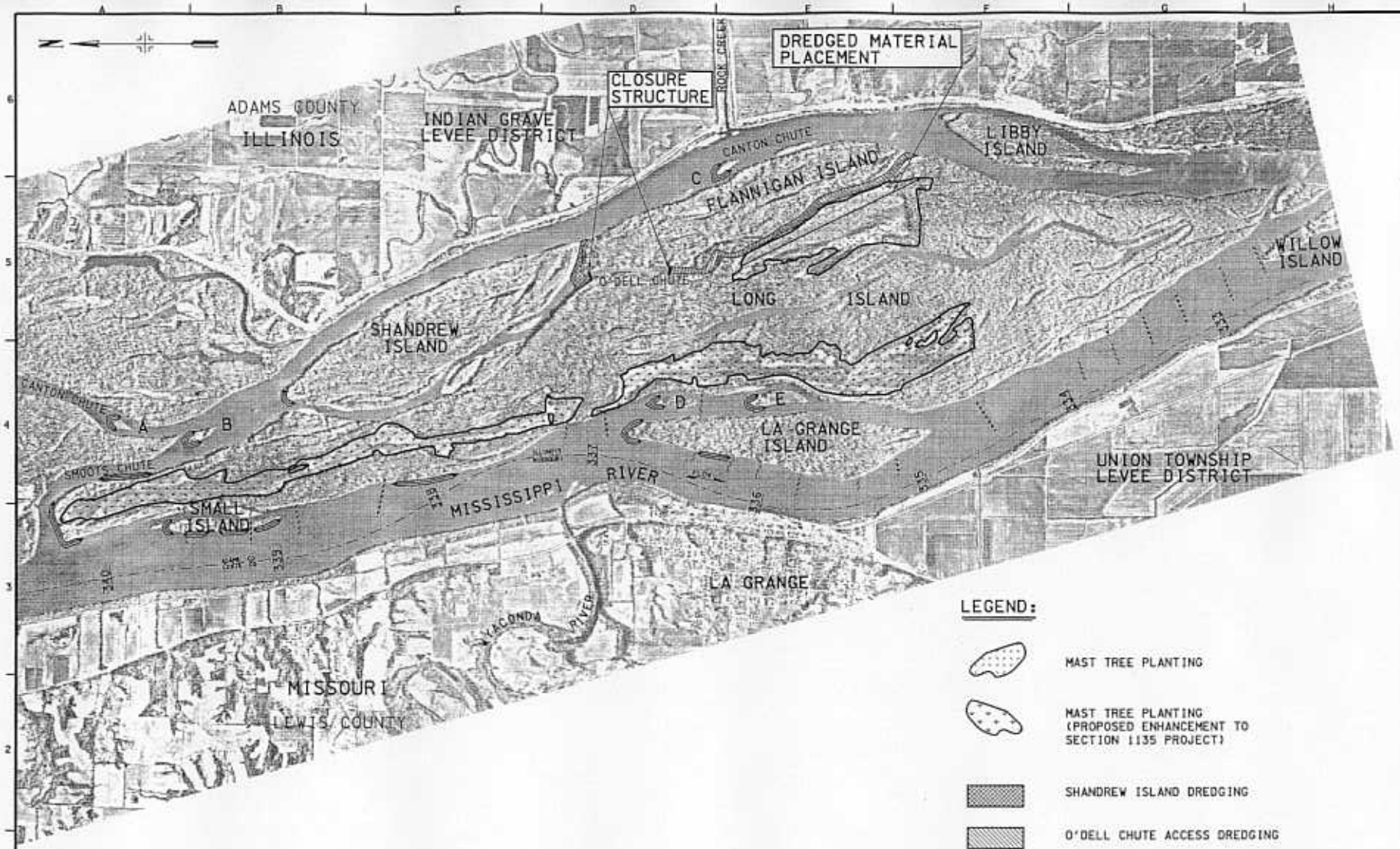
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM

EXISTING CONDITIONS
SITE PLAN

PLATE 3


ADAMS COUNTY
ILLINOIS
INDIAN GRAVE LEVEE DISTRICT
ROCK CREEK
CANTON CHUTE
LIBBY ISLAND
CLOSURE STRUCTURE FOR ENTIRE LAKE DRAW DOWN
FLANNIGAN ISLAND
CLOSURE STRUCTURE FOR UPPER LAKE DRAW DOWN
PROPOSED NOTCHED CLOSURE STRUCTURE
CORNER SLOUGH DREDGING
O'DELL CHUTE
PASSIVE MANAGEMENT PONDS/POTHOLES
SHANDREW ISLAND
LONG ISLAND
CANTON CHUTE
EXISTING CLOSURE DAM
LA GRANGE ISLAND
UNION TOWNSHIP LEVEE DISTRICT
SHOOTS CHUTE
MISSISSIPPI RIVER
SHALL ISLAND
EXISTING CLOSURE DAM
NOTCH EXISTING STRUCTURES
SEDIMENT DEFLECTION LEVEE
LA GRANGE
SHORELINE REVEGETATION
EMERGENT ROCK DIKE
MISSOURI
LEWIS COUNTY
LEGEND:
LONG ISLAND LAKE DREDGING
INOPERATIVE MOIST SOIL MANAGEMENT UNIT
SIDE CHANNEL DREDGING
DEEP HOLES FOR FISH
NOTCH WING DAMS
ROCK V'S
NOTES:
1. OLD AGRICULTURAL FIELDS OF BEAR CREEK UNIT REFORESTATION (NOT SHOWN).
2. WILLOW ISLAND DEEP WATER ENHANCEMENT (NOT SHOWN).
3. SEDIMENT CONTROL MEASURES FOR BEAR CREEK WATERSHED (NOT SHOWN).
1500 750 0 1500 3000
SCALE IN FEET
POTENTIAL ENHANCEMENT FEATURES - NOT EVALUATED
PLATE 4



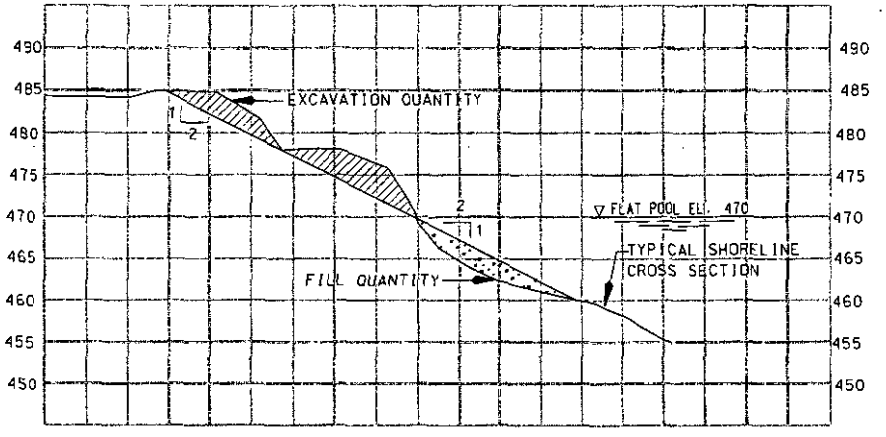
US Army Corps of Engineers Rock Island District

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

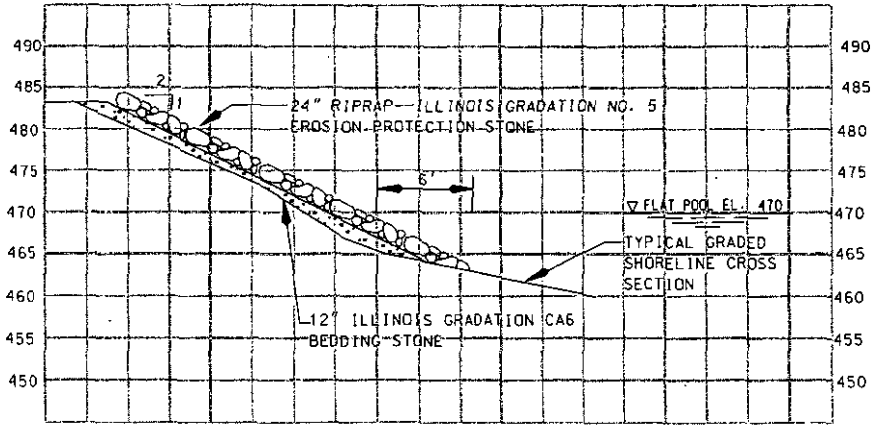
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 21 - RM 332 - 340.2 GARDEN DIVISION MAP

POTENTIAL ENHANCEMENT FEATURES - EVALUATED

PLATE 5



TYPICAL GRADING SECTION



TYPICAL ROCK PROTECTION SECTION

NOTE:

ROCK PLACEMENT SHALL EXTEND 6 HORIZONTAL FEET BELOW THE FLAT POOL WATER SURFACE (470 FEET MSL), AS SHOWN.

U.S. Army Corps of Engineers Rock Island District

No.	Description	Date	Approved

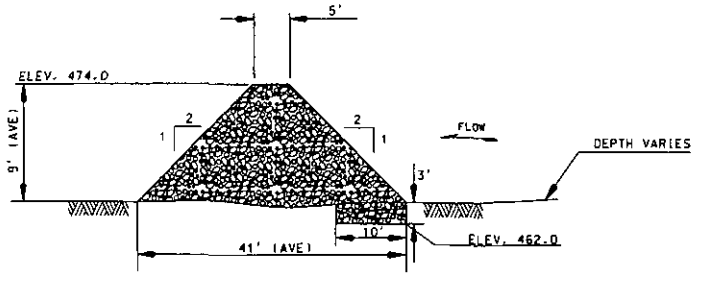
Designed By: KRM
Drawn By: DDR/TPD
Checked By: RTN
Submitted By: DJH
Date: 15 SEPT. '00
Scale: AS SHOWN
Drawing Code:
Solicitation Number:

U.S. ARMY ENGINEER DISTRICT
CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS

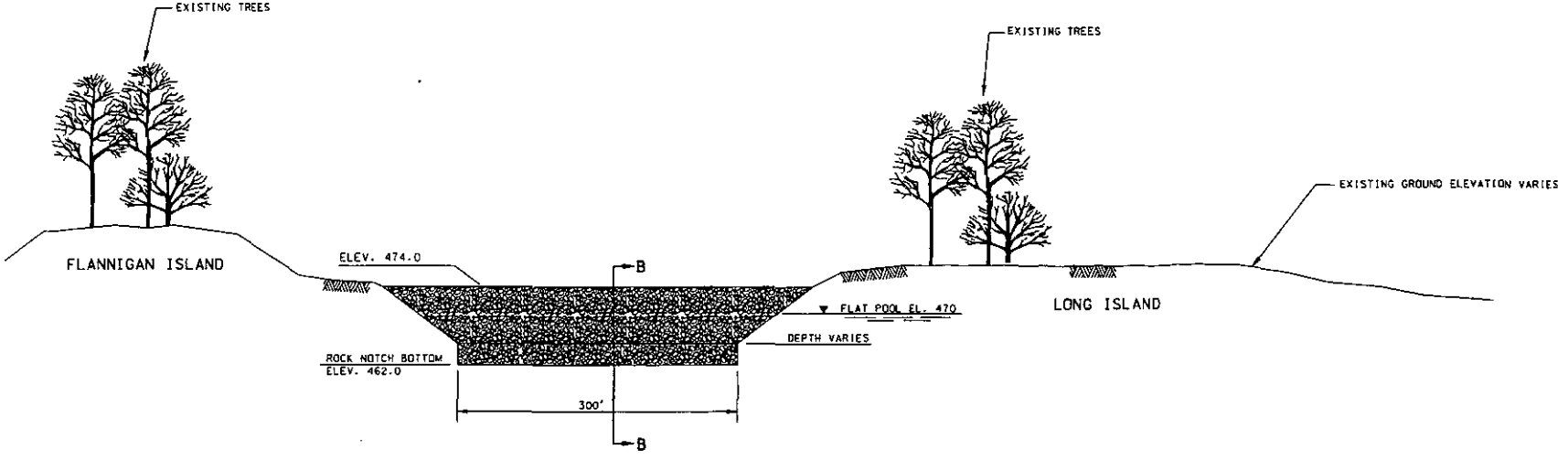
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21 - RM 332 - 340.2
GARDNER DIVISION HREP

TYPICAL ROCK PROTECTION SECTION

PLATE 6



SECTION B-B
NO SCALE



ROCK CLOSURE STRUCTURE
TYPICAL SECTION
NO SCALE

US Army Corps of Engineers Rock Island District

Symbol	Description Revisions	Date	Approved

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

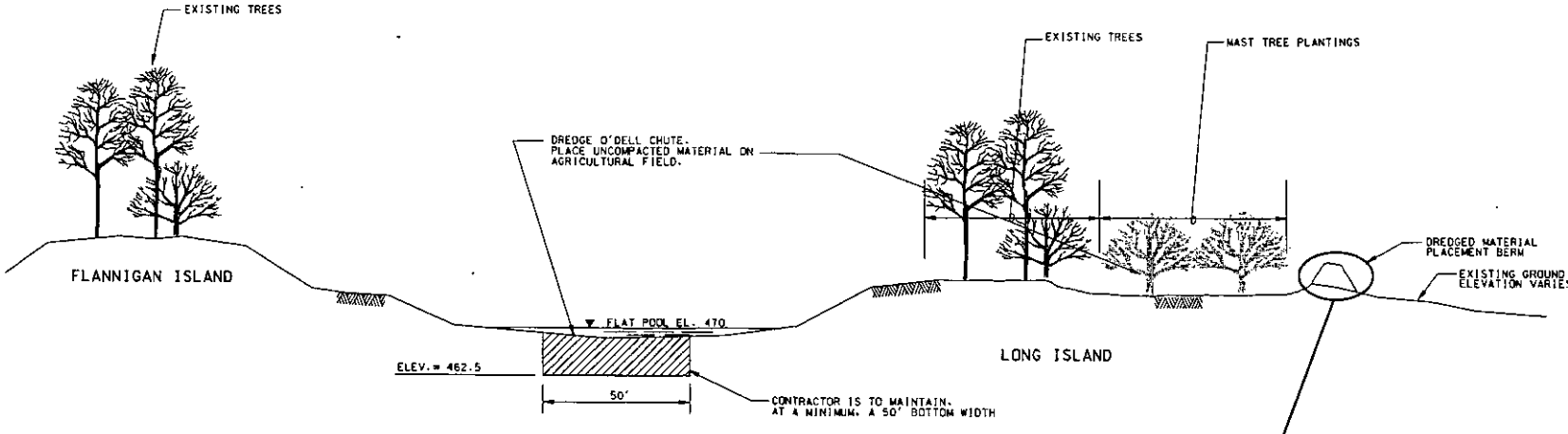
Designed By:	Date: 30 AUGUST '96
Drawn By: SDB/TPD	Scale: AS SHOWN
Checked By:	Drawing Code:
Reviewed By: DLK	Certification Number:

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21 - PM 332 - 340.2
CARONDER DIVISION HREP

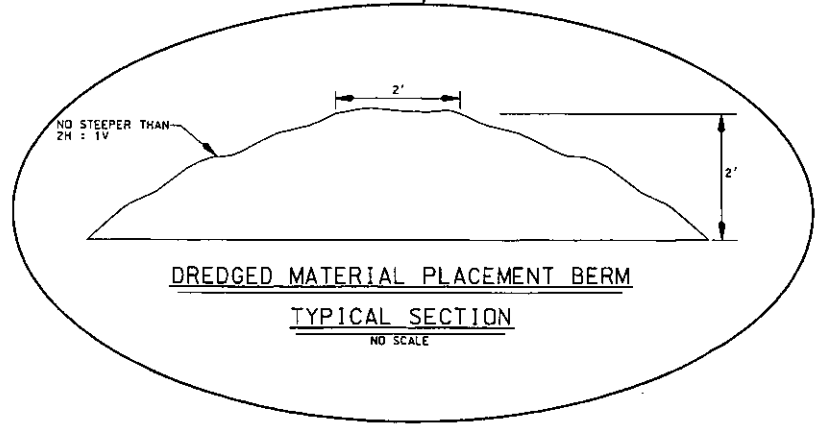
TYPICAL ROCK CLOSURE STRUCTURE SECTION

PLATE 7

11-NAE-2300 07/96



CHANNEL DREDGING
TYPICAL SECTION
NO SCALE



DREDGED MATERIAL PLACEMENT BERM
TYPICAL SECTION
NO SCALE

US Army Corps of Engineers
Rock Island Dist. Of

Symbol	Description Revisions	Date	Approved

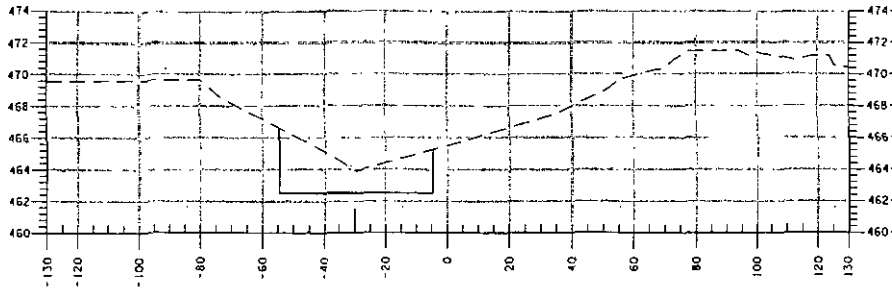
Designed by: KMM
Drawn by: SDR/TPG
Checked by: PTH
Approved by: BLK
Date: 30 AUGUST '96
Scale: AS SHOWN
Drawing Code:
Substitution Number:

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

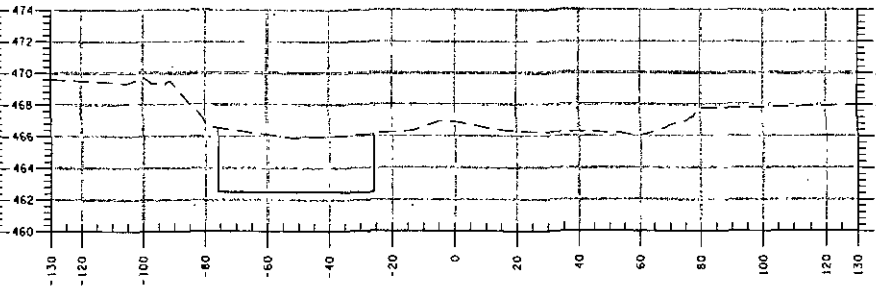
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
CONTRACT 21, PM 332, 340.2
GARDNER DIVISION HREP

TYPICAL CHANNEL DREDGING SECTION

PLATE 8



10+00



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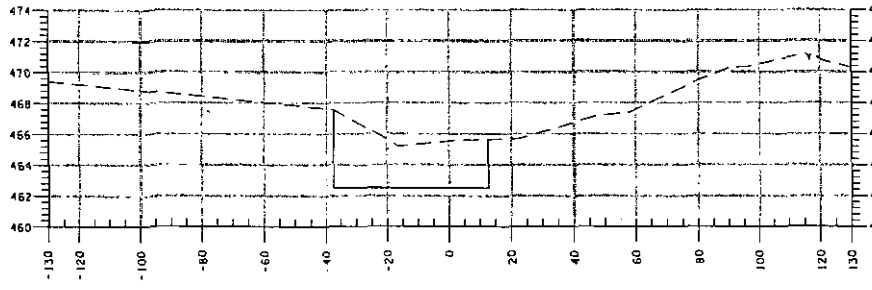
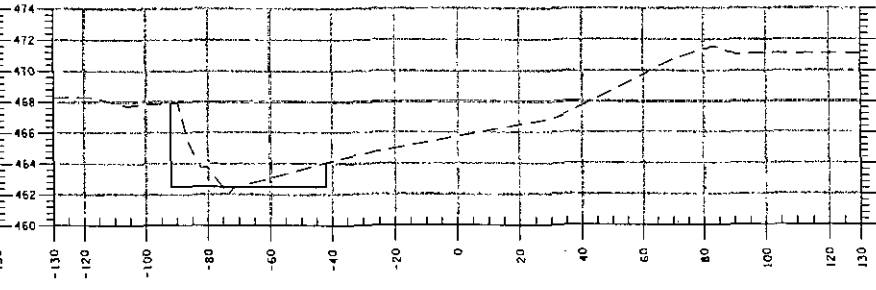


30+00



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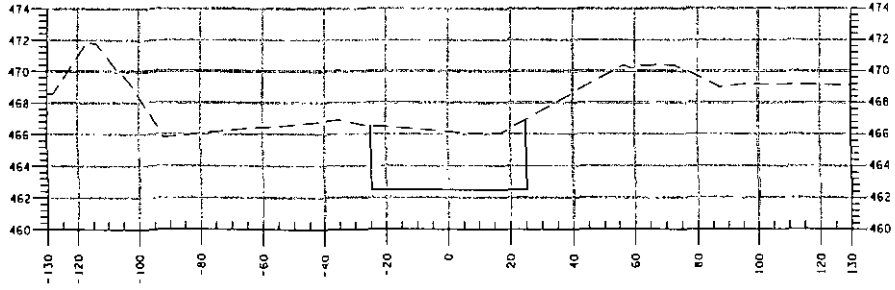
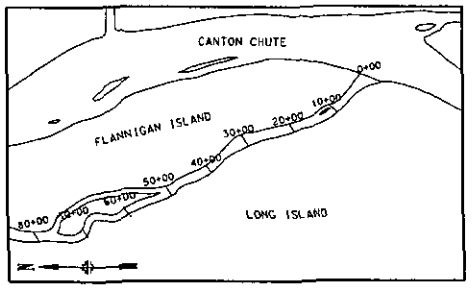


50+00



LEGEND:

DREDGE CUT FOR CONSTRUCTION

EXISTING CHANNEL BOTTOM

NOTE:
0+00 IS LOCATED AT THE DOWNRIVER ENTRANCE TO O'DELL CHUTE.

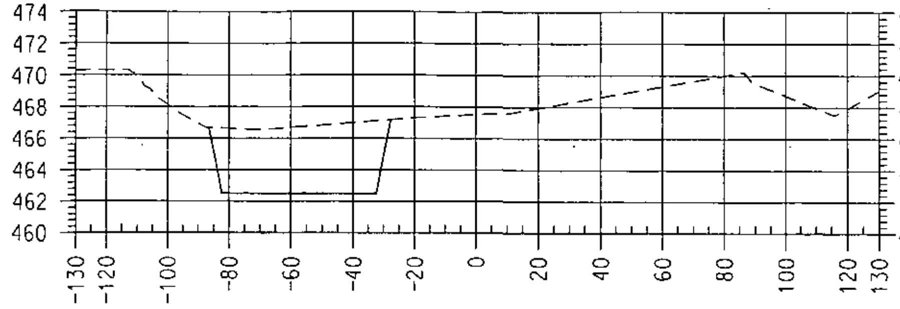
US Army Corps of Engineers Rock Island District

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

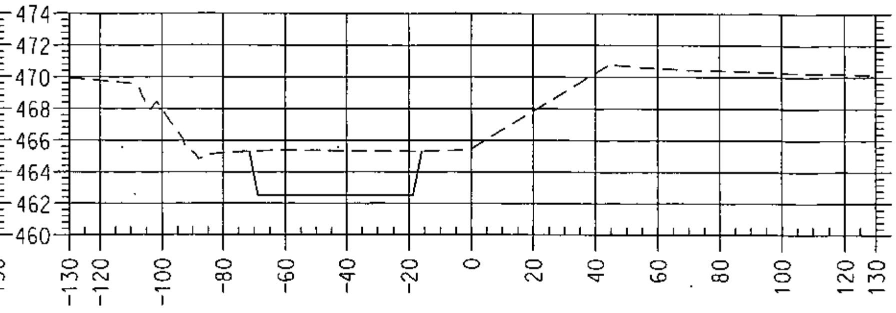
Designed By: KMM
Drawn By: SDB/PMD
Checked By: RTN
Approved By: GLK
Date: 30 AUGUST '96
Scales: AS SHOWN
Drawing Code:
Submitted Number:

UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM
NAVIGATION STUDY
GARDNER DIVISION IHREP
CHANNEL DREDGING-
TYPICAL CROSS SECTIONAL TRANSECTS
10+00 THRU 50+00

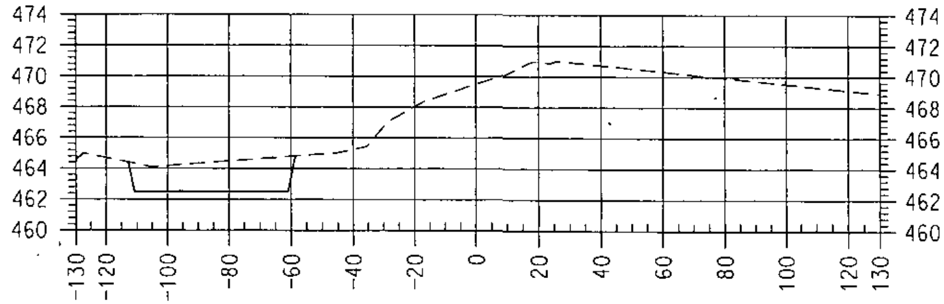
PLATE 9A



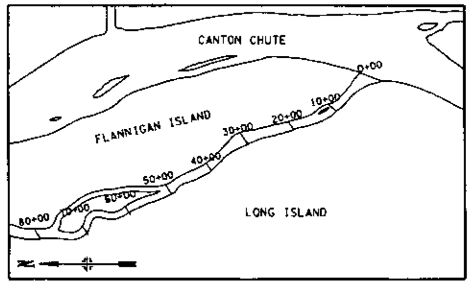
60+00



70+00



80+00



LEGEND:

——— DREDGE CUT FOR CONSTRUCTION

– – – EXISTING CHANNEL BOTTOM

NOTE:
0+00 IS LOCATED AT THE DOWNRIVER ENTRANCE TO O'DELL CHUTE.

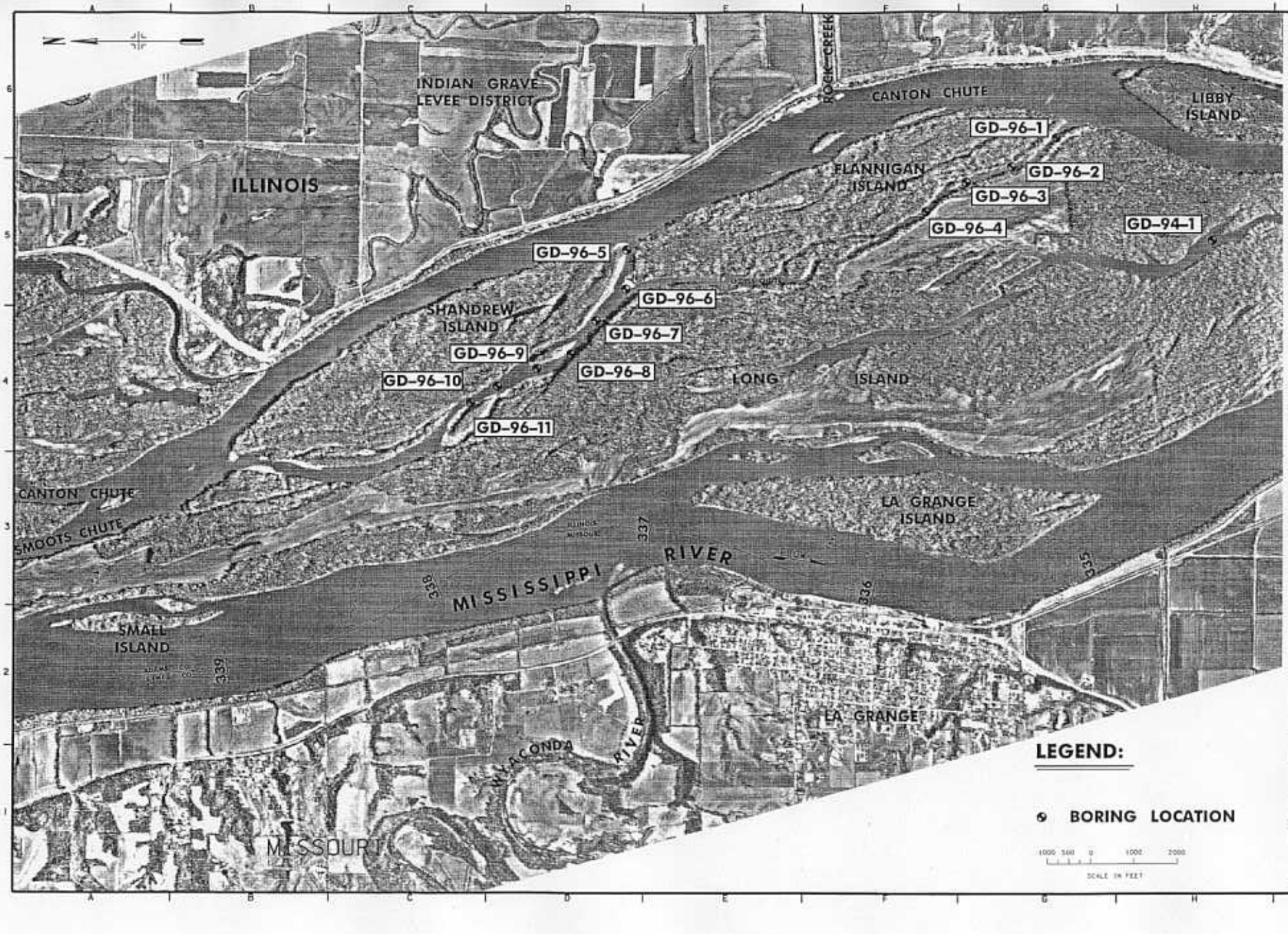
US Army Corps of Engineers Rock Island District

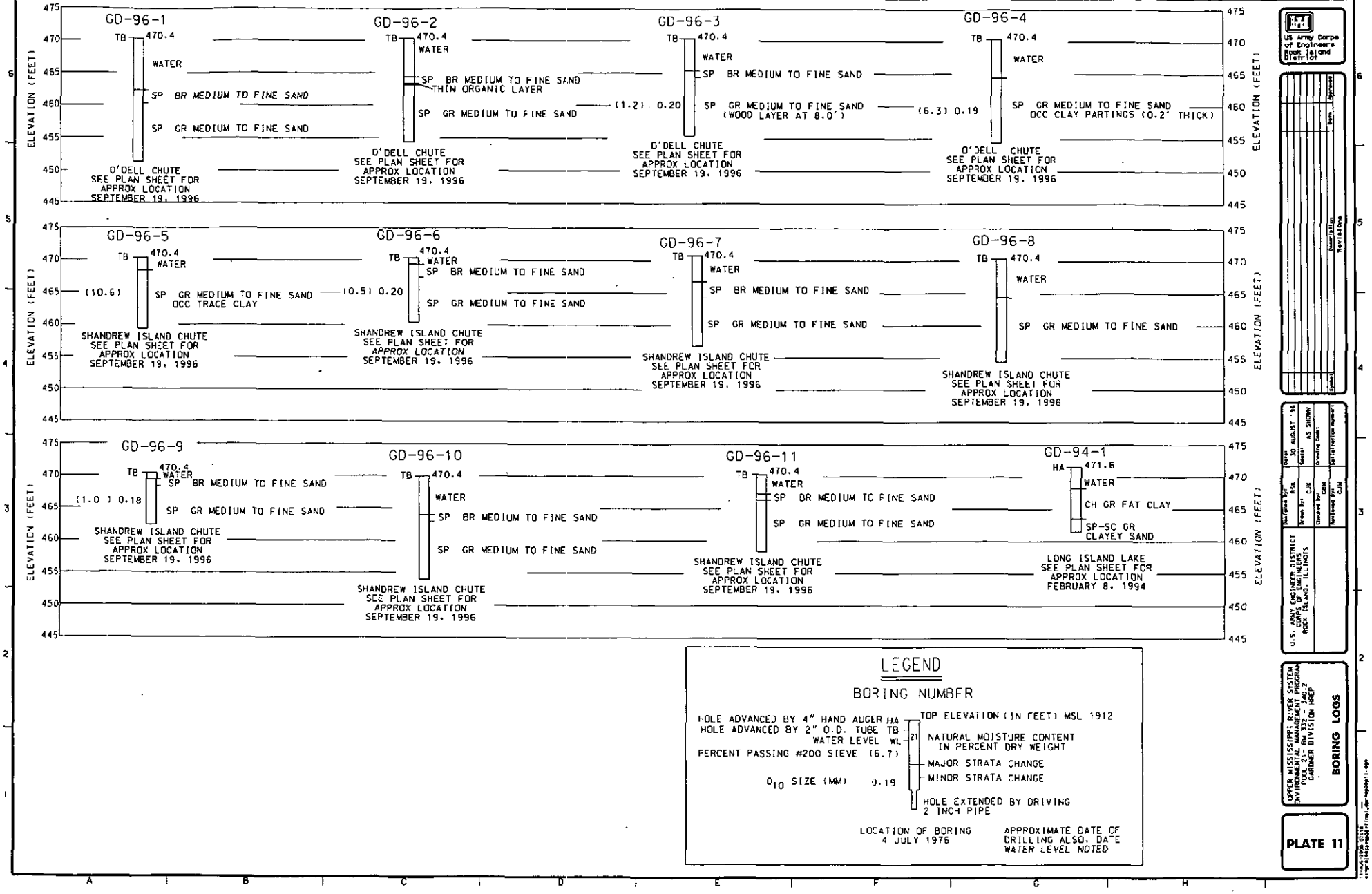
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

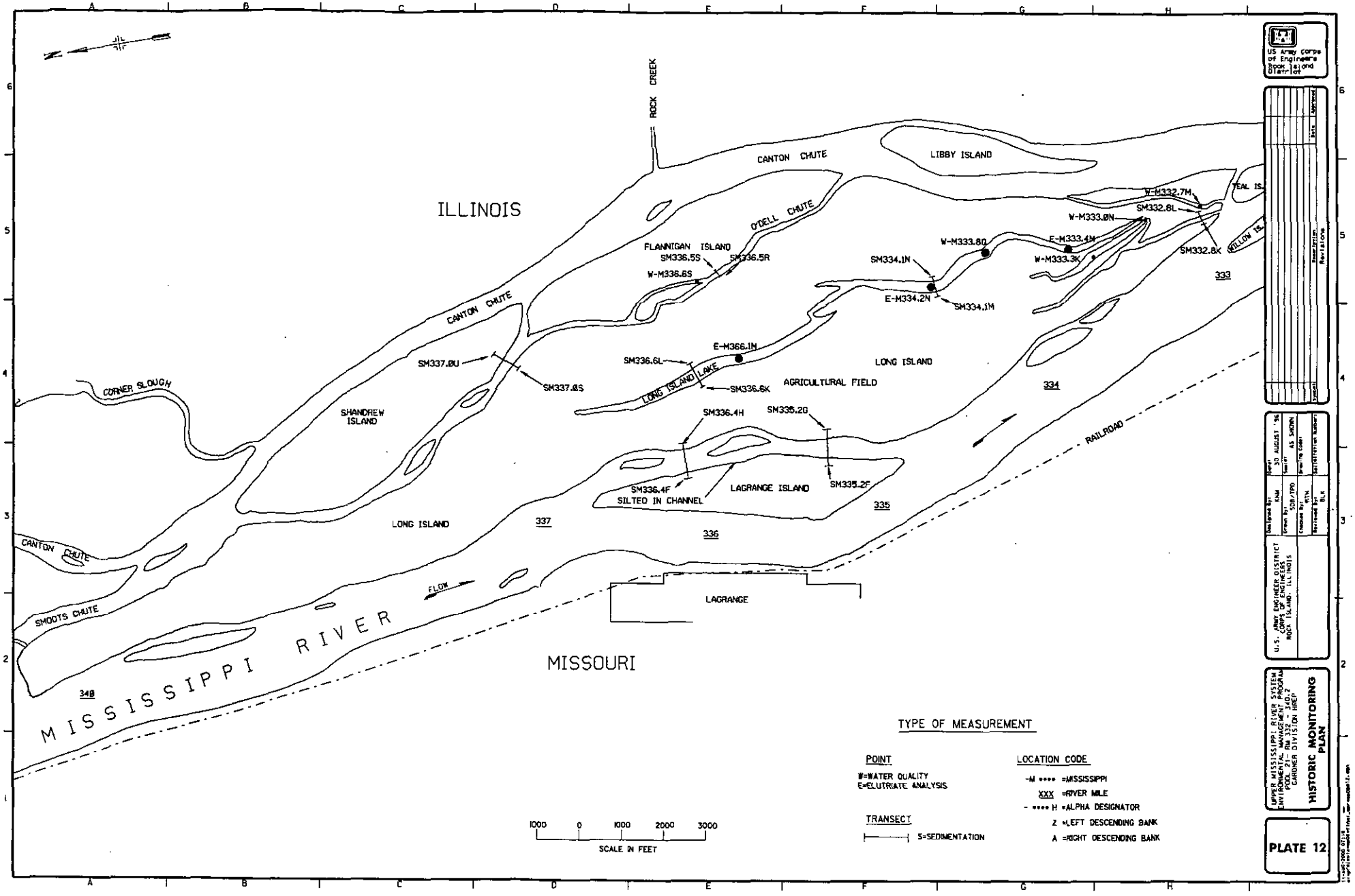
Designed By: KNM
Drawn By: SDB/TPD
Checked By: ATN
Reviewed By: BLK
Date: 30 AUGUST '96
Scale: AS SHOWN

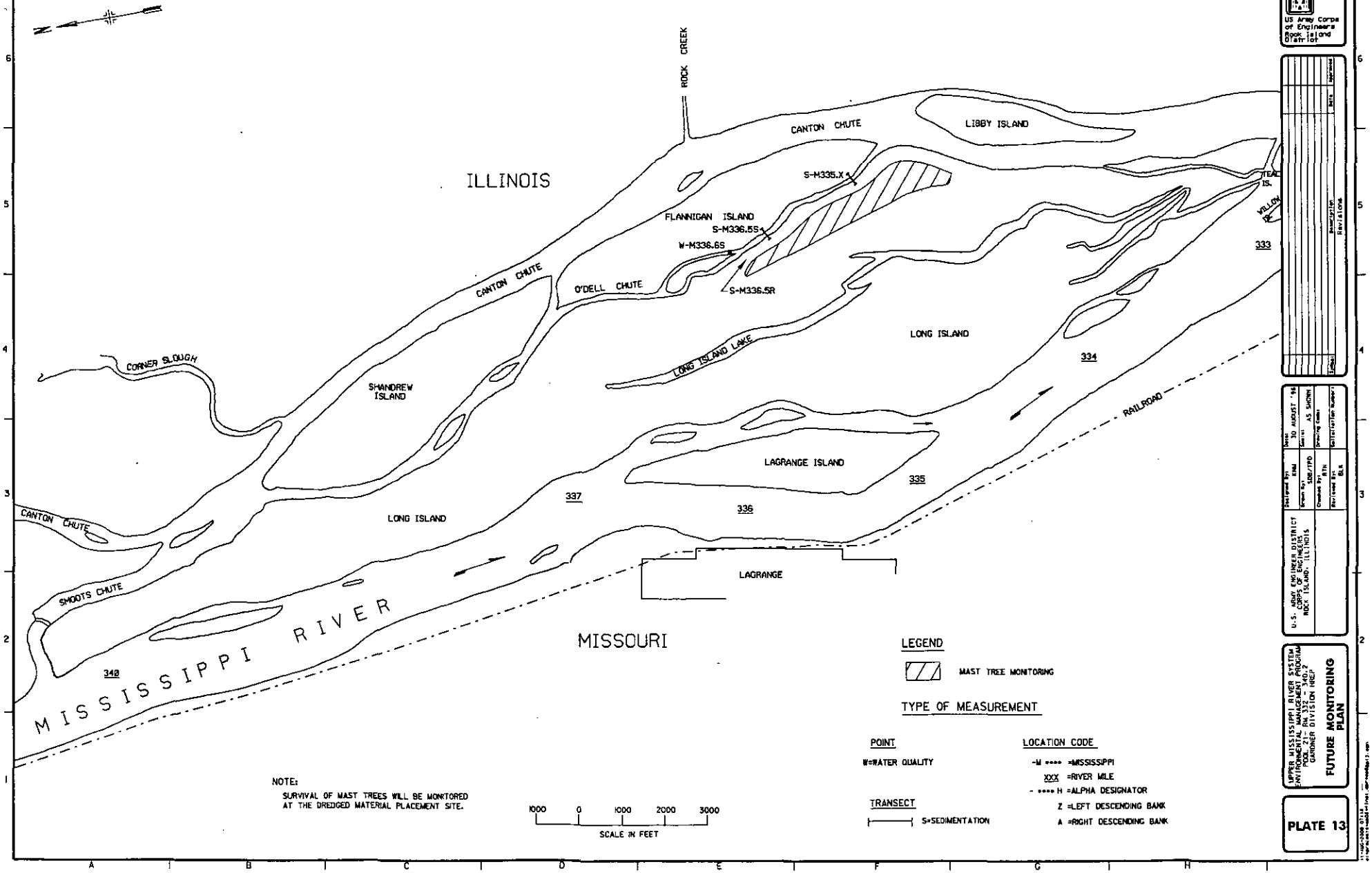
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21 - RM 332 - 340.2
GARDNER DIVISION HREP
CHANNEL DREDGING-
TYPICAL CROSS
SECTIONS - TRANSECTS
60+00 THRU 80+00

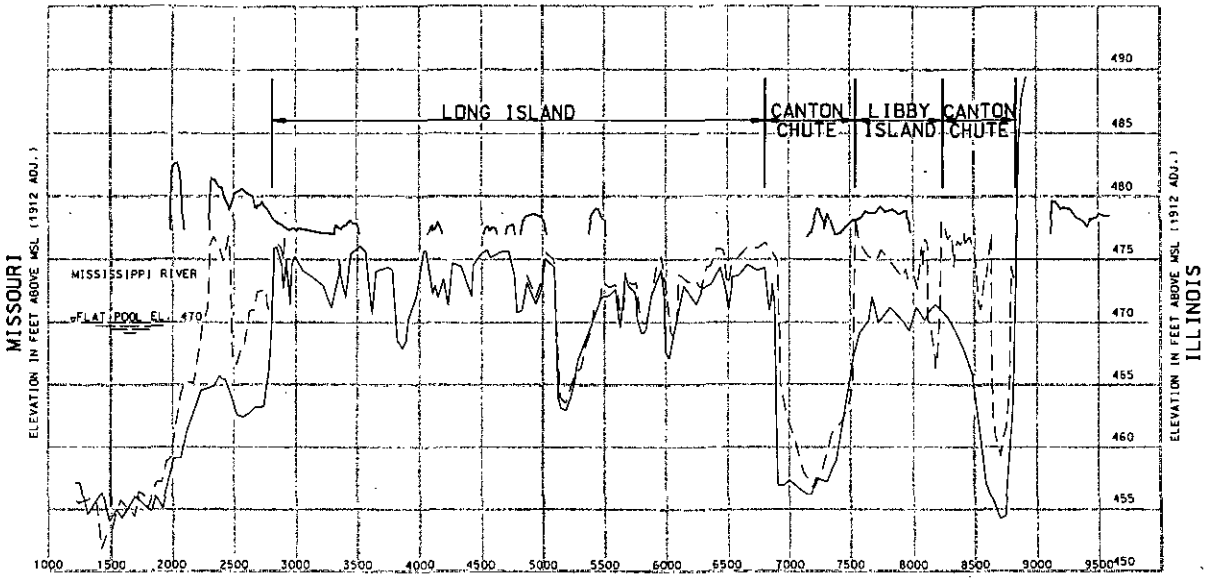
PLATE 9B


INDIAN GRAVE
LEVEE DISTRICT
ILLINOIS
ROCK CREEK
CANTON CHUTE
LIBBY
ISLAND
GD-96-1
FLANNIGAN
ISLAND
GD-96-2
GD-96-3
GD-96-4
GD-94-1
GD-96-5
GD-96-6
SHANDREW
ISLAND
GD-96-7
GD-96-9
GD-96-8
GD-96-10
LONG
ISLAND
GD-96-11
CANTON CHUTE
SMOOTS CHUTE
LA GRANGE
ISLAND
MISSISSIPPI
RIVER
338
337
336
335
339
SMALL
ISLAND
MISSOURI
MACONDA
RIVER
LA GRANGE
LEGEND:
BORING LOCATION
SCALE IN FEET
PLATE 10
LOCATIONS
OF BORINGS

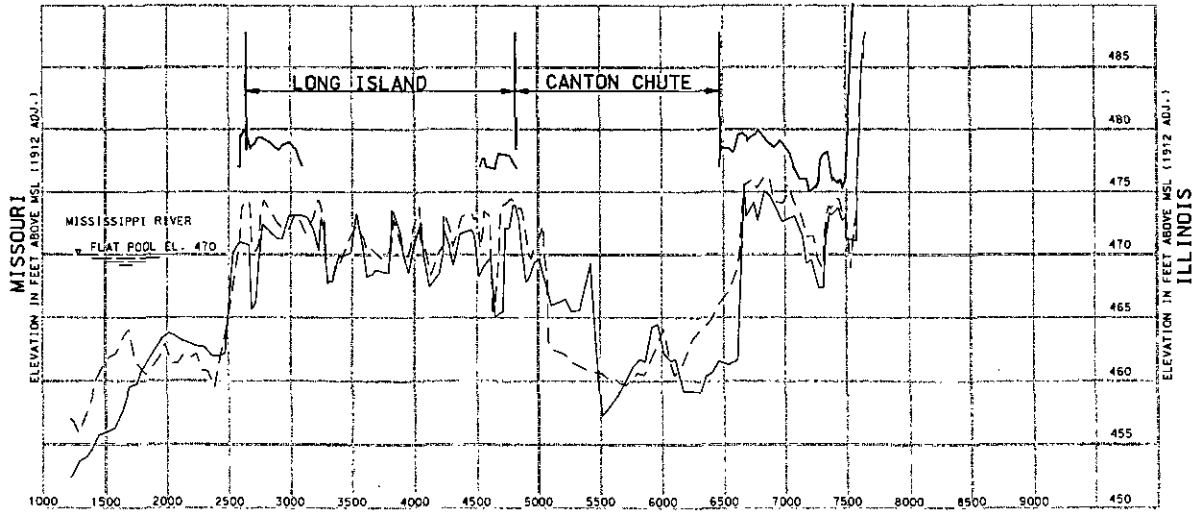

GD-96-1
TB 470.4
WATER
SP BR MEDIUM TO FINE SAND
SP GR MEDIUM TO FINE SAND
O'DELL CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-96-2
TB 470.4
WATER
SP BR MEDIUM TO FINE SAND
THIN ORGANIC LAYER
SP GR MEDIUM TO FINE SAND
(1.2) 0.20
O'DELL CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-96-3
TB 470.4
WATER
SP BR MEDIUM TO FINE SAND
SP GR MEDIUM TO FINE SAND
(WOOD LAYER AT 8.0')
(6.3) 0.19
O'DELL CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-96-4
TB 470.4
WATER
SP GR MEDIUM TO FINE SAND
OCC CLAY PARTINGS (0.2' THICK)
O'DELL CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-96-5
TB 470.4
WATER
(10.6)
SP GR MEDIUM TO FINE SAND
OCC TRACE CLAY
SHANDREW ISLAND CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-96-6
TB 470.4
WATER
SP BR MEDIUM TO FINE SAND
(0.5) 0.20
SP GR MEDIUM TO FINE SAND
SHANDREW ISLAND CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-96-7
TB 470.4
WATER
SP BR MEDIUM TO FINE SAND
SP GR MEDIUM TO FINE SAND
SHANDREW ISLAND CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-96-8
TB 470.4
WATER
SP GR MEDIUM TO FINE SAND
SHANDREW ISLAND CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-96-9
TB 470.4
WATER
SP BR MEDIUM TO FINE SAND
(1.0) 0.18
SP GR MEDIUM TO FINE SAND
SHANDREW ISLAND CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-96-10
TB 470.4
WATER
SP BR MEDIUM TO FINE SAND
SP GR MEDIUM TO FINE SAND
SHANDREW ISLAND CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-96-11
TB 470.4
WATER
SP BR MEDIUM TO FINE SAND
SP GR MEDIUM TO FINE SAND
SHANDREW ISLAND CHUTE
SEE PLAN SHEET FOR
APPROX LOCATION
SEPTEMBER 19, 1996
GD-94-1
HA 471.6
WATER
CH GR FAT CLAY
SP-SC GR
CLAYEY SAND
LONG ISLAND LAKE
SEE PLAN SHEET FOR
APPROX LOCATION
FEBRUARY 8, 1994
ELEVATION (FEET)
475
470
465
460
455
450
445
LEGEND
BORING NUMBER
HOLE ADVANCED BY 4" HAND AUGER HA
HOLE ADVANCED BY 2" O.D. TUBE TB
WATER LEVEL WL
PERCENT PASSING #200 SIEVE (6.7)
D_{10} SIZE (MM) 0.19
TOP ELEVATION (IN FEET) MSL 1912
21 NATURAL MOISTURE CONTENT IN PERCENT DRY WEIGHT
MAJOR STRATA CHANGE
MINOR STRATA CHANGE
HOLE EXTENDED BY DRIVING 2 INCH PIPE
LOCATION OF BORING 4 JULY 1976
APPROXIMATE DATE OF DRILLING ALSO, DATE WATER LEVEL NOTED
U.S. Army Corps of Engineers Rock Island District
Revisions
Description
Approved
Date
Designed
Drawn
Checked
Traced
Submitted
Approved
30 AUGUST '96
AS SHOWN
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 21 - PH 732 - 340.2 LOCKMER DIVISION MAP
BORING LOGS
PLATE 11


ROCK CREEK
CANTON CHUTE
LIBBY ISLAND
ILLINOIS
O'DELL CHUTE
FLANNIGAN ISLAND
SM336.5S
SM336.5R
W-M336.6S
W-M332.7M
SM332.6L
W-M333.0N
E-M333.4M
W-M333.3K
SM332.8K
YELLOW IS.
W-M333.6Q
SM334.1N
E-M334.2N
SM334.1M
333
CANTON CHUTE
SM337.0U
SM337.0S
E-M366.1M
SM336.6L
LONG ISLAND LAKE
SM336.6K
AGRICULTURAL FIELD
LONG ISLAND
334
CORNER SLOUGH
SHANDREW ISLAND
SM336.4H
SM335.2G
SM336.4F
SILTED IN CHANNEL
LAGRANGE ISLAND
SM335.2F
335
RAILROAD
LONG ISLAND
337
336
CANTON CHUTE
FLOW
SMOOTS CHUTE
LAGRANGE
MISSISSIPPI RIVER
MISSOURI
340
1000 0 1000 2000 3000
SCALE IN FEET
TYPE OF MEASUREMENT
POINT
W=WATER QUALITY
E=ELUTRIATE ANALYSIS
TRANSECT
S=SEDIMENTATION
LOCATION CODE
-M **** =MISSISSIPPI
XXX =RIVER MILE
- **** H =ALPHA DESIGNATOR
Z =LEFT DESCENDING BANK
A =RIGHT DESCENDING BANK
US Army Corps of Engineers
Rock Island District
U.S. ARMY ENGINEER DISTRICT
CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS
30 AUGUST '96
AS SHOWN
KNM
SDB/JPD
BLK
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21 - RM 332 - 340.2
GARDNER DIVISION HREP
HISTORIC MONITORING PLAN
PLATE 12


ROCK CREEK
CANTON CHUTE
LIBBY ISLAND
ILLINOIS
S-M335.X
FLANNIGAN ISLAND
S-M336.5S
W-M336.6S
S-M336.5R
O'DELL CHUTE
CANTON CHUTE
333
LONG ISLAND
CORNER SLOUGH
LONG ISLAND LAKE
334
SHANDREW ISLAND
RAILROAD
LAGRANGE ISLAND
335
337
336
CANTON CHUTE
LONG ISLAND
SMOOTS CHUTE
LAGRANGE
MISSISSIPPI RIVER
MISSOURI
340
LEGEND
MAST TREE MONITORING
TYPE OF MEASUREMENT
POINT
W=WATER QUALITY
TRANSECT
S=SEDIMENTATION
LOCATION CODE
-M **** =MISSISSIPPI
XXX =RIVER MILE
- **** H =ALPHA DESIGNATOR
Z =LEFT DESCENDING BANK
A =RIGHT DESCENDING BANK
NOTE:
SURVIVAL OF MAST TREES WILL BE MONITORED AT THE DREDGED MATERIAL PLACEMENT SITE.
1000 0 1000 2000 3000
SCALE IN FEET
US Army Corps of Engineers Rock Island District
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 21: RM 332 - 340.2 GARDNER DIVISION (WEST)
FUTURE MONITORING PLAN
PLATE 13



RIVER MILE 334.0



RIVER MILE 333.0

LEGEND

1938 ——

1953 – – –

1992 ——

NOTE:

1992 DATA OBTAINED FOR LAND FEAUTURES ONLY.

US Army Corps of Engineers Rock Island Dist

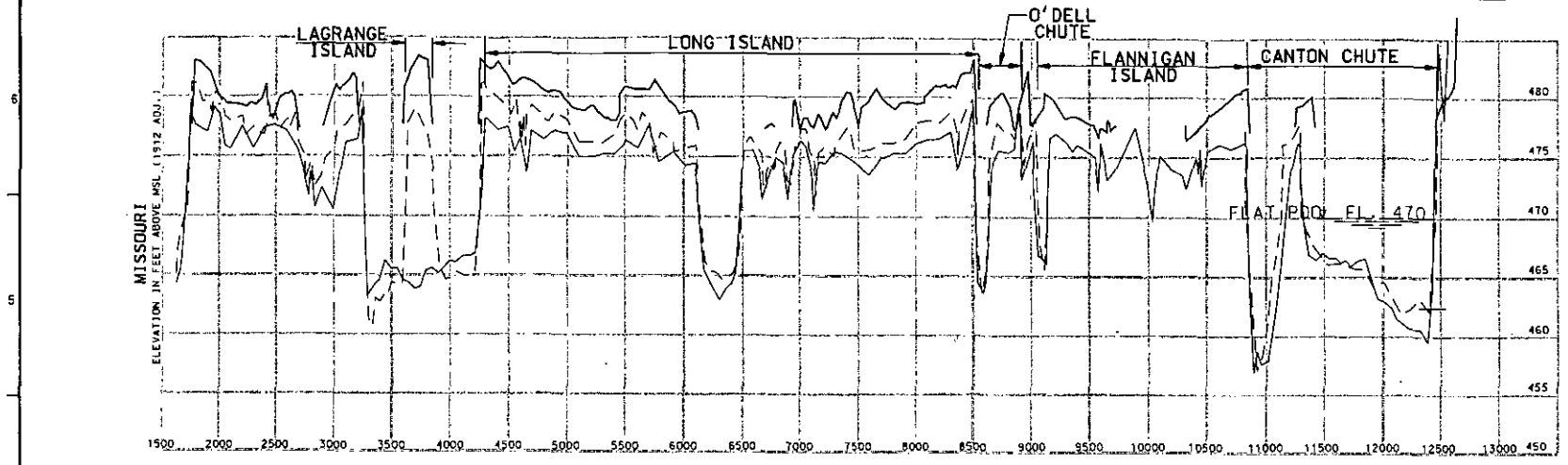
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS

Designed by: RSM
Drawn by: SSB/TPD
Checked by: RTN
Reviewed by: BLK
Date: 30 AUGUST '96
Scale: AS SHOWN
Drawing Code:
Contract/Permit Numbers:

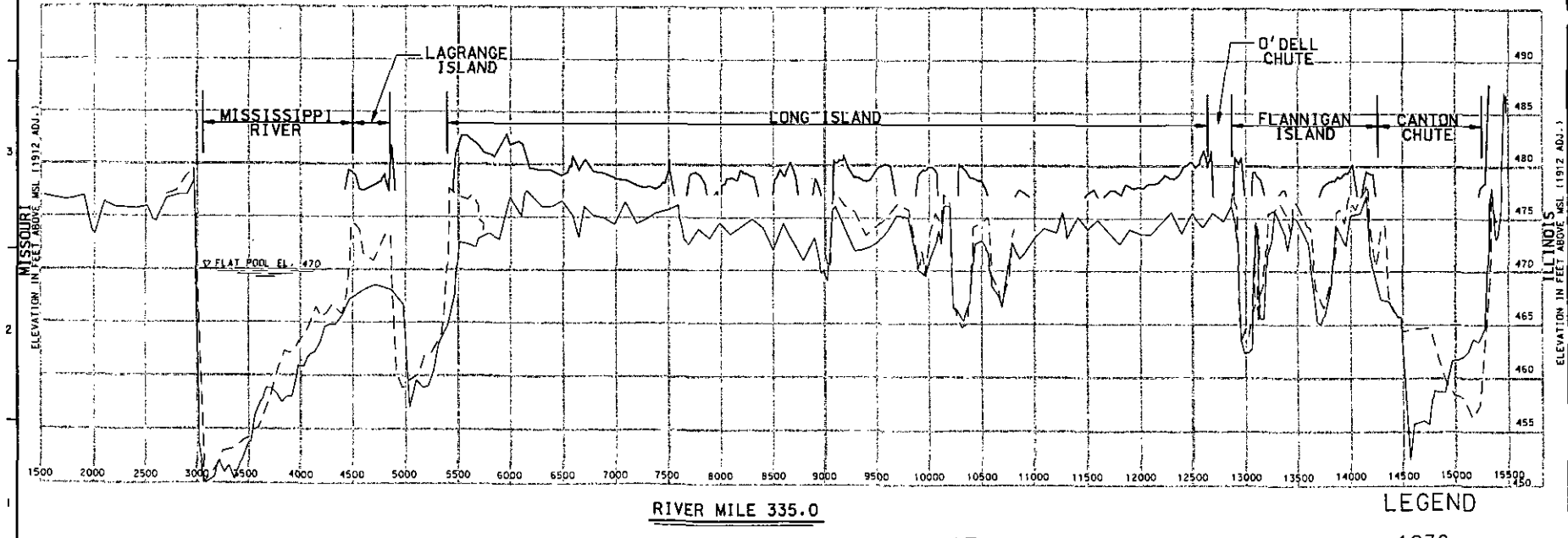
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21 - RM 332 - 340.2
GARDNER DIVISION HREP

CROSS SECTIONS RIVER MILES 333.0 AND 334.0

PLATE 14



RIVER MILE 336.0



RIVER MILE 335.0

NOTE:

1992 DATA OBTAINED FOR LAND FEATURES ONLY.

LEGEND

1938 ——

1953 - - - -

1992 ——

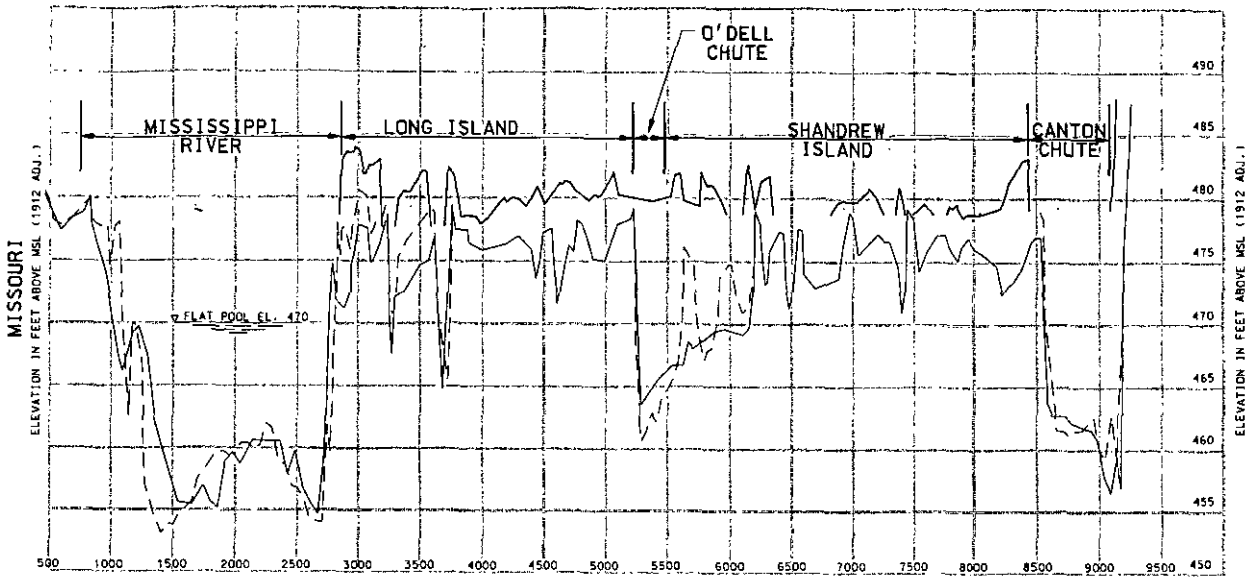
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS

Designed by: KMH
Drawn by: SDR/TPD
Checked by: RTN
Approved by: BLK
Date: 30 AUGUST '96
Scales: AS SHOWN

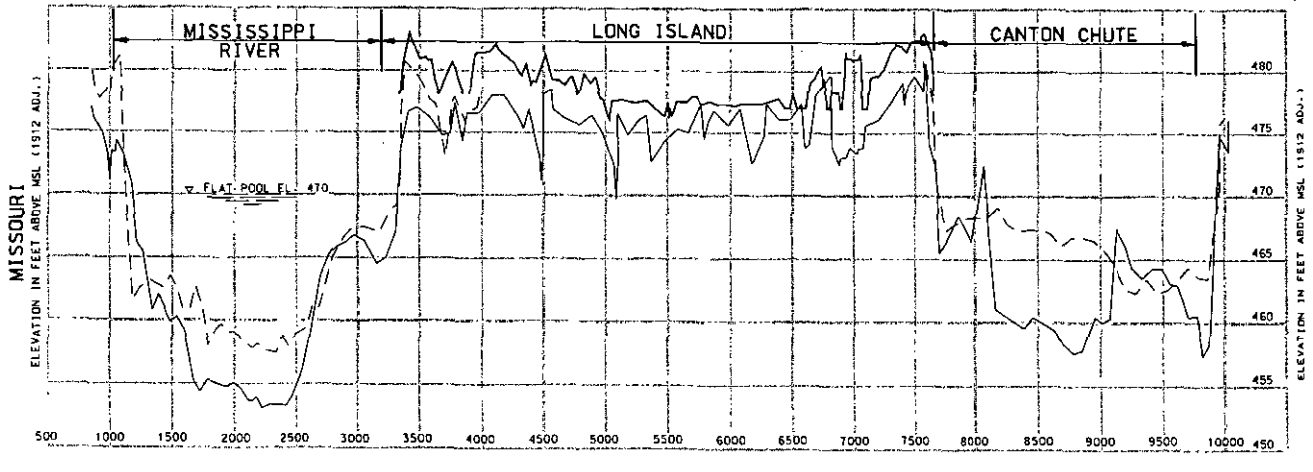
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 21 TO MILE 402.2 GARDNER DIVISION HREP

CROSS SECTIONS RIVER MILES 335.0 AND 336.0

PLATE 15



RIVER MILE 338.0



RIVER MILE 337.0

NOTE:
1992 DATA OBTAINED FOR LAND FEATURES ONLY.

LEGEND
1938
1953
1992

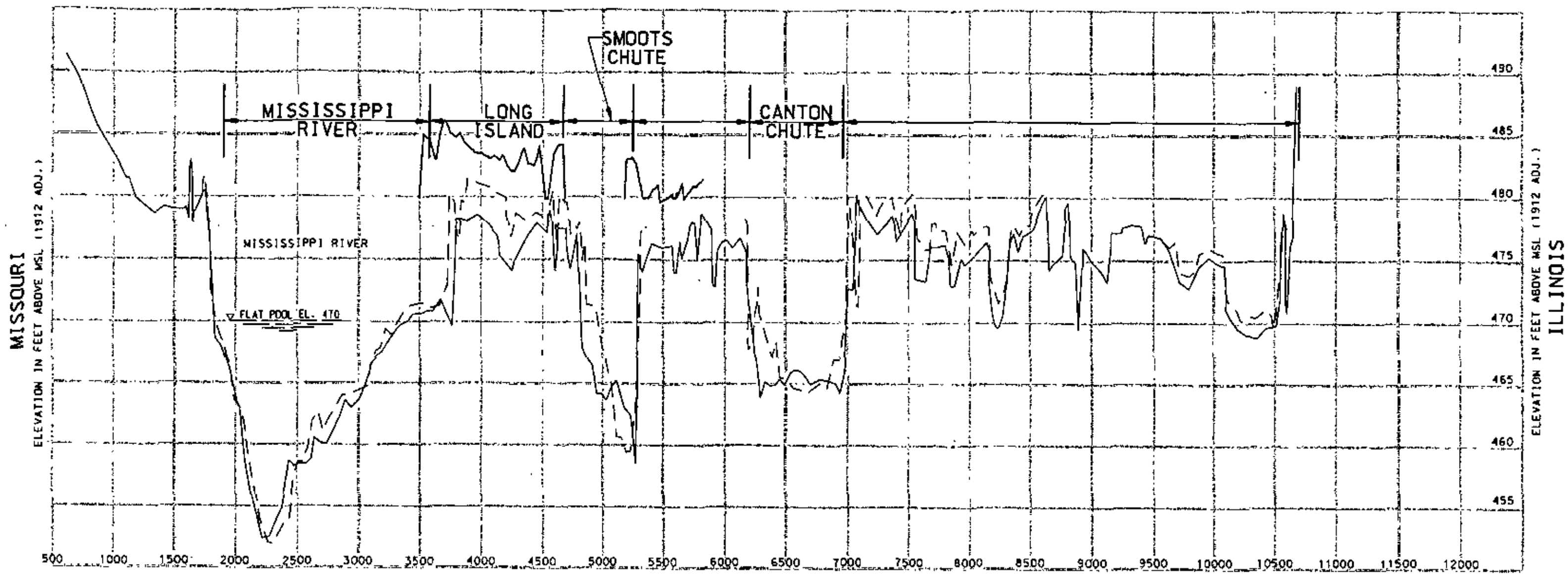
US Army Corps of Engineers Rock Island District

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

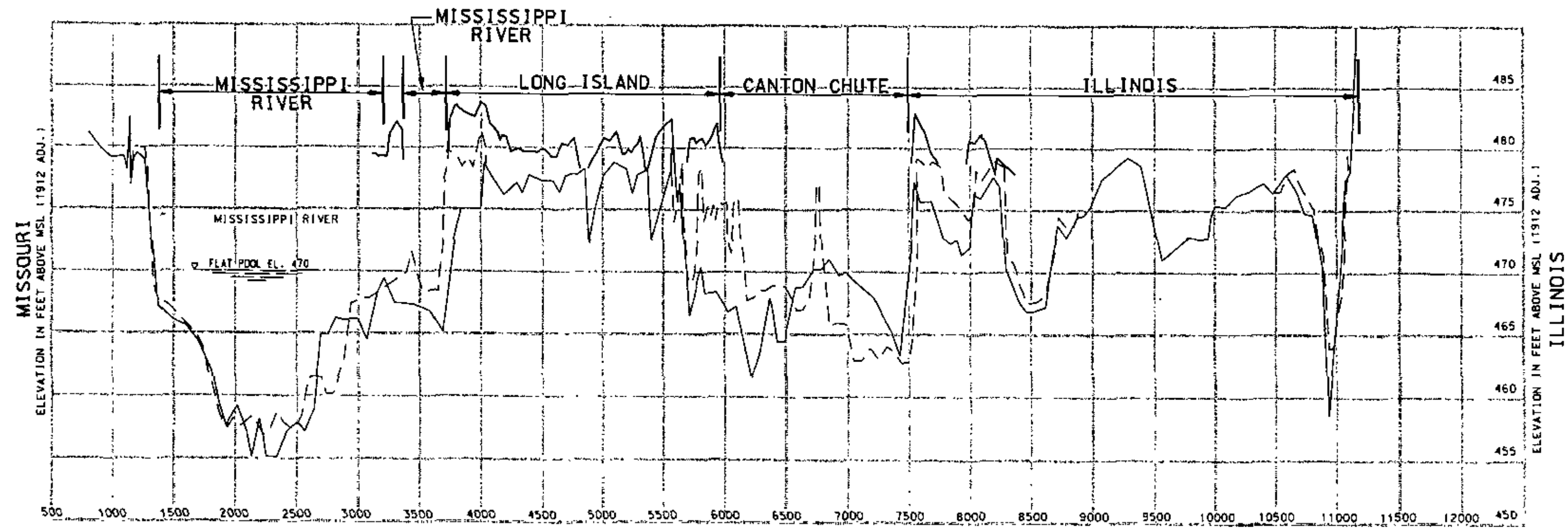
Designed by: RAM
Drawn by: RAM
Checked by: SDR/TPD
Approved by: MTW
Date: 30 AUGUST '94
Scale: AS SHOWN
Drawing Code:
Submitted by: BLK
Sheet
Description, Revisions
Date
Approved

UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21 & DUBUQUE LOCK & DAM
CROSS SECTIONS
RIVER MILES
337.0 AND 338.0

PLATE 16



RIVER MILE 340.0



RIVER MILE 339.0

NOTE:
1992 DATA OBTAINED FOR LAND FEATURES ONLY.

LEGEND

1938 ———
1953 — — —
1992 ———

US Army Corps of Engineers Rock Island District

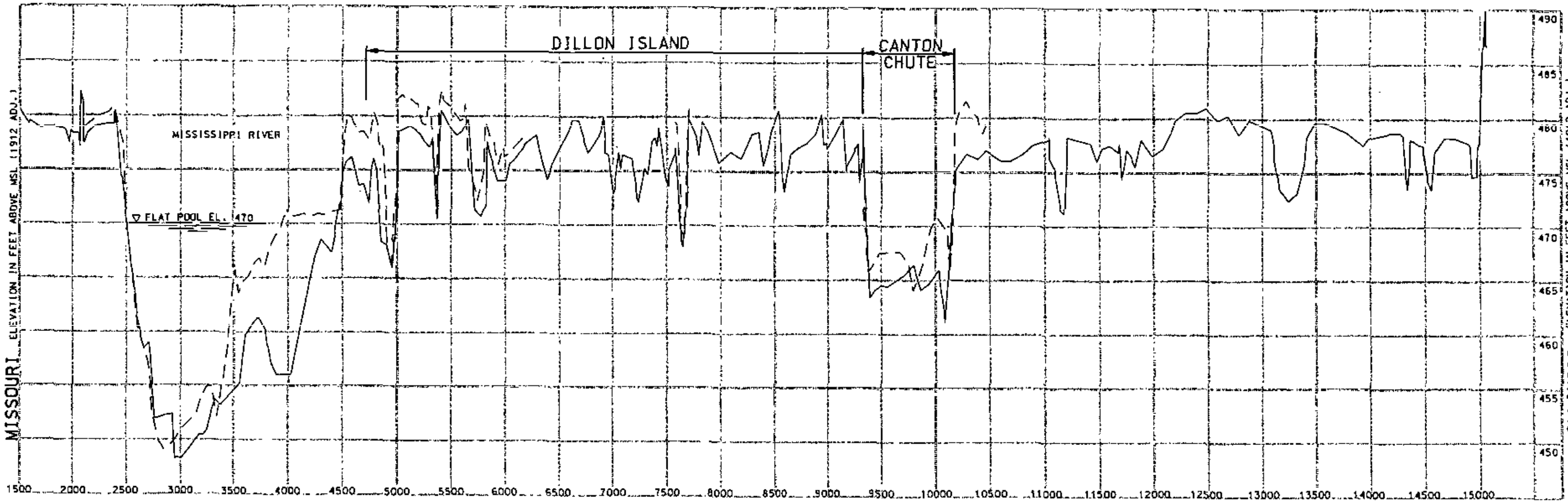
Revisions

Designed By: KMA | Date: 30 AUGUST '96
Drawn By: SDB/TPD | Scale: AS SHOWN
Checked By: RTN
Reviewed By: BLK

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

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21- RM 332 - 340.2
GARDNER DIVISION HREP
CROSS SECTIONS
RIVER MILES
339.0 AND 340.0

PLATE 17



RIVER MILE 341.0

LEGEND

1938 ————

1953 — — —

US Army Corps of Engineers
Rock Island District

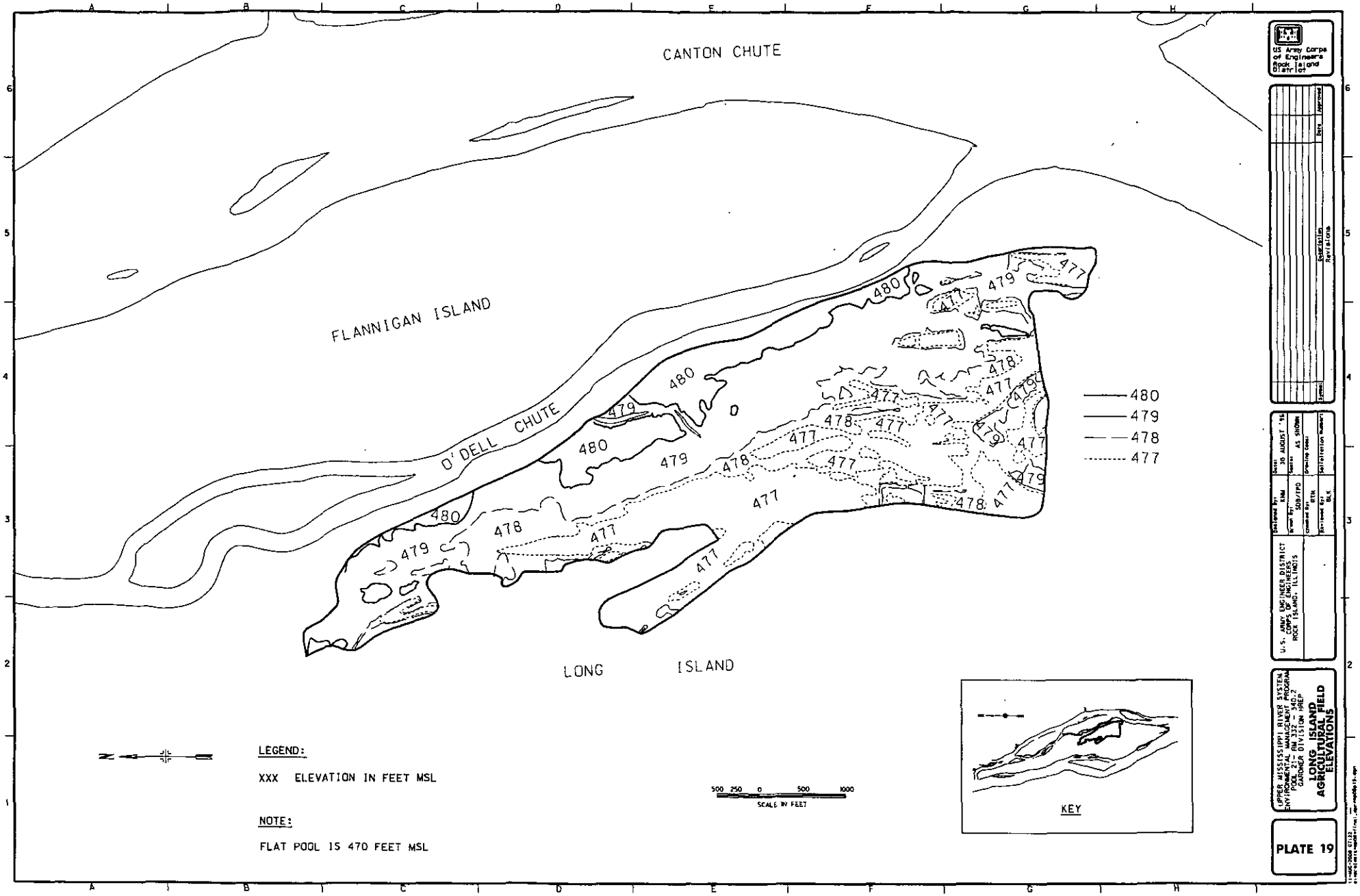
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed By: KNM	Date: 30 AUGUST '96
Drawn By: SDB/TPD	Scale: AS SHOWN
Checked By: RTN	Drawing Code:
Reviewed By: BLK	Sol/Spec Number:

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21 - RM 332 - 340.2
GARDNER DIVISION HREP

CROSS SCECTION
RIVER MILE
341.0

PLATE 18



US Army Corps of Engineers Rock Island District

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

Designed by: HNM
Drawn By: SOB/FPD
Checked By: RTH
Surveyed By: BLK
Dates: AUGUST '96
Scales: AS SHOWN
Drawing Code:
Submitted Date:

UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM DESIGNER DIVISION MAP

LONG ISLAND AGRICULTURAL FIELD ELEVATIONS

PLATE 19